



Final:

TECHNICAL SUPPORTING DOCUMENT

AQUATIC ENVIRONMENT

MATTAGAMI LAKE DAM GENERATING STATION

Submitted To:

Ontario Power Generation Inc.

Submitted By:

**SENES Consultants Limited
and C. Portt & Associates**

November 2010


**MATTAGAMI LAKE DAM GENERATING STATION
AQUATIC ENVIRONMENT
TECHNICAL SUPPORT DOCUMENT**

Submitted to:


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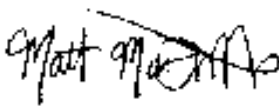
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1.0 INTRODUCTION

This Technical Support Document (TSD) provides a summary of the Aquatic Environment assessment undertaken as part of the environmental assessment of the construction and operation of the proposed Mattagami Lake Dam hydroelectric development.

Other technical support documents address the terrestrial environment, transmission, cultural heritage, socio-economics and land-use, public and agency consultation and First Nations and Aboriginal consultation.

This report was prepared by C. Portt & Associates and assisted by SENES Consultants Limited as a Technical Support Document to the Environmental Review Report (ERR) prepared pursuant to the Guide to Environmental Assessment Requirements for Electricity Project (MOE 2001). The ERR report provides a description of the proposed undertaking, summarizes the overall baseline environmental setting and anticipated environmental effects, recommends appropriate mitigative measures to minimize or obviate these effects, and describes agency, public and First Nation consultation.

This Supporting Document is organized into seven sections:

- Section 1.0 **Introduction** – this section;
- Section 2.0 **Project Description** – describes the project in detail;
- Section 3.0 **Baseline Aquatic Environment Conditions** – describes the field assessment methods, regional and local study areas;
- Section 4.0 **Impact Assessment and Mitigative Measures** – summarizes the various consultation activities; and,
- Section 5.0 **Summary and Conclusions** – outlines the summary conclusions with respect to the project and its impact on the aquatic environment and mitigation measures.
- Appendices – five separate appendices are included.

2.0 PROJECT DESCRIPTION

2.1 PROJECT PURPOSE

Ontario Power Generation Inc. (OPG) is proposing to develop a 5-7 megawatt (MW) hydroelectric generating station (GS) (Proposed Undertaking), in the immediate vicinity of OPG's existing Mattagami Lake Control Dam. The Proposed Undertaking also includes construction of a new transmission line. The proposed GS will be connected to the provincial grid via an existing Hydro One 115 kilovolts (kV) Transmission line (T61S) located about 3 kilometres (km) to the east.

OPG and Mattagami First Nation have entered into a non-binding Memorandum of Understanding (MOU) to discuss the possibility of the parties entering into a commercial relationship with respect to the Proposed Undertaking.

2.2 PROJECT LOCATION

The existing Mattagami Lake Dam is located at the outlet of Mattagami Lake (at Kenogamissi Falls) on the Mattagami River, about 54 km southwest of the City of Timmins and about 25 km north of the Mattagami First Nation Reserve. The dam controls the flows from Mattagami Lake into Kenogamissi Lake, which is the forebay of OPG's Wawaitin Generating Station. The dam's latitude and longitude are N48° 00' 48", W81° 33' 30", respectively. The site is about 2 km east of Highway 144 and accessible by Kenogamissi Falls Road (a primary forest access road) as shown in Figure 2.1.

Figure 2.1 General Location of Mattagami Lake Control Dam

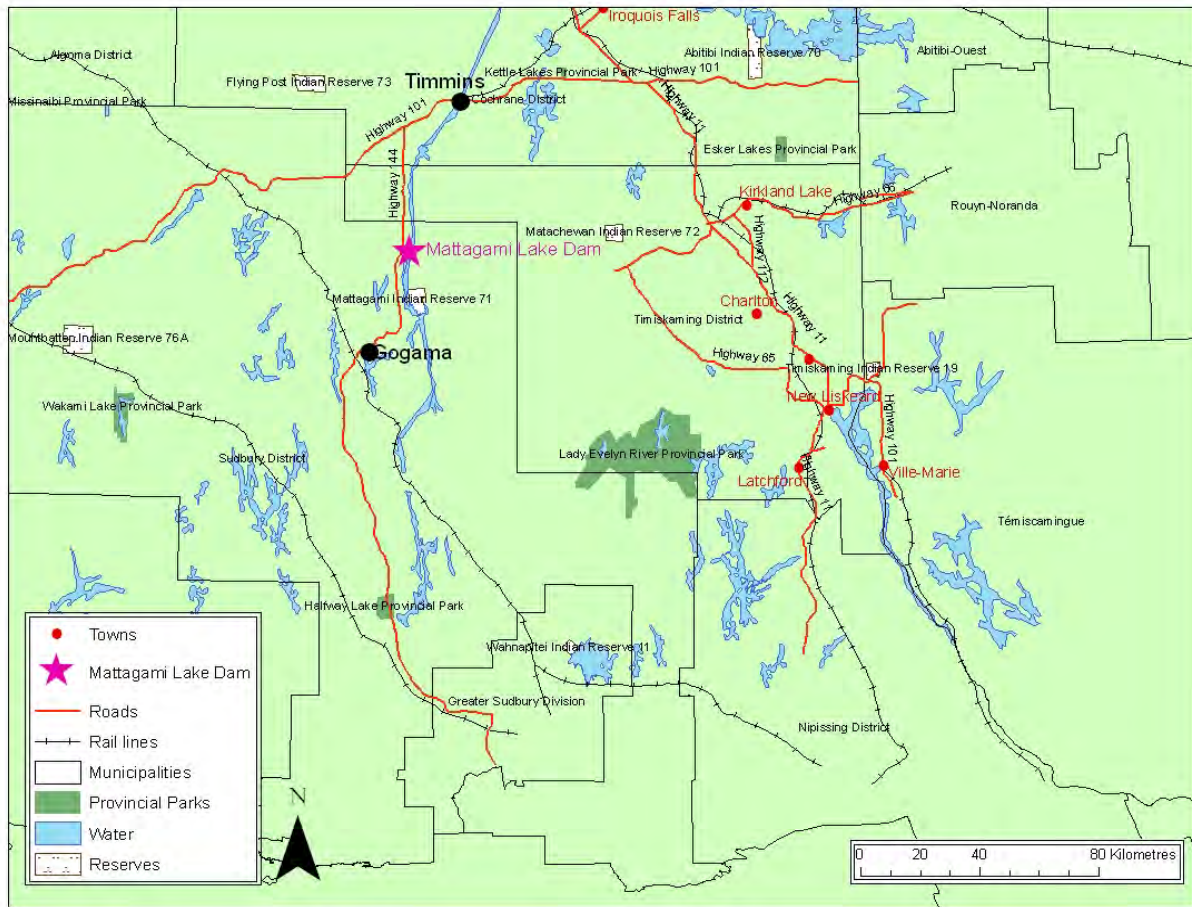


Figure 2.2 show the location of the Proposed Undertaking with respect to the Hydro One transmission Line, existing roads and natural, physical and human features.

Figure 2.3 show the proposed layout for the Mattagami Lake control dam generating station.

Figure 2.2 General Location of Mattagami Lake Control Dam and Kenogamissi Falls

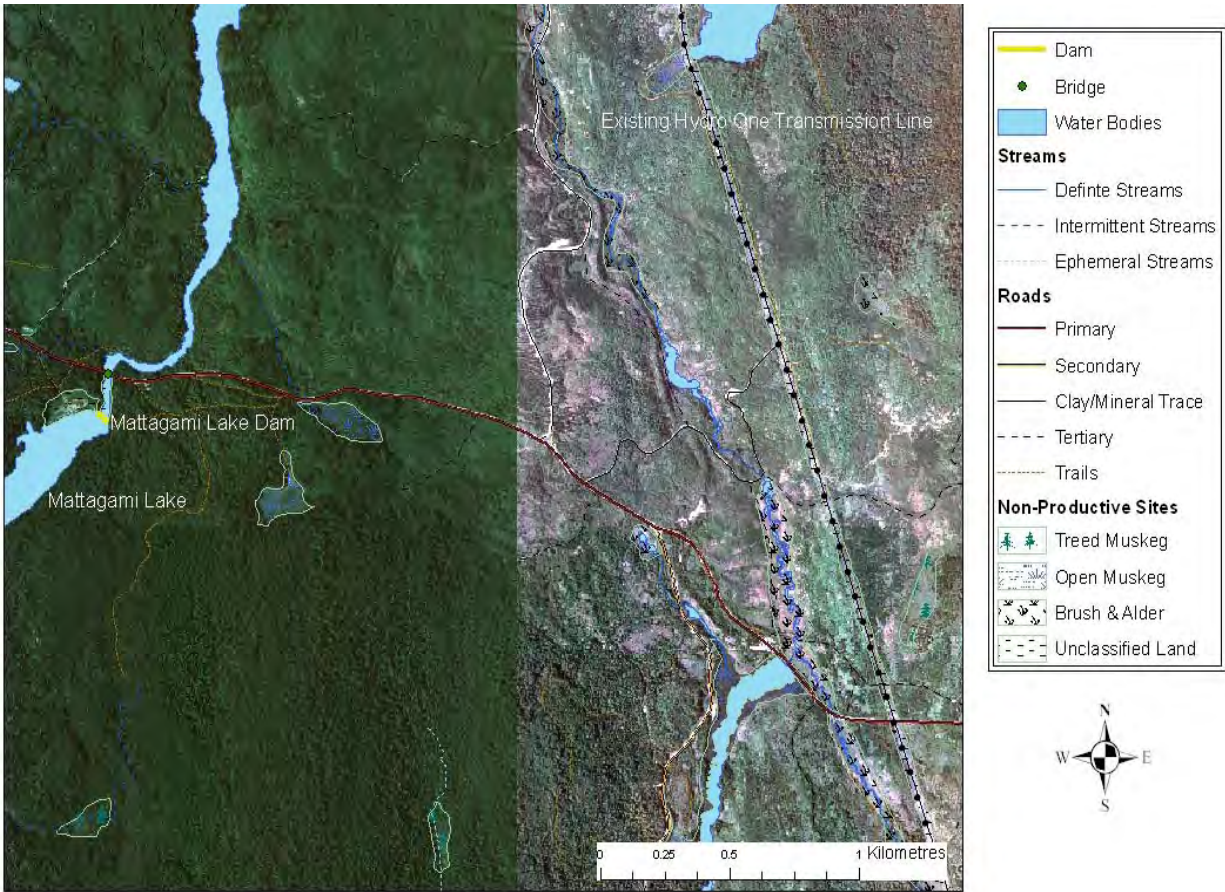


Figure 2.3 Proposed Layout for Mattagami Lake Control Dam Generating Station



1

¹ The intake, penstock, powerhouse and tailrace are exaggerated for illustrative purposes in the maps

2.3 PROJECT DESCRIPTION

2.3.1 Existing Site and Facilities

The existing Mattagami Lake Dam (Photograph 2-1) was built by Northern Power Company in 1921 and acquired by Hydro-Electric Power Commission of Ontario (HEPCO) in 1944. It is currently owned and operated by OPG (the successor to Ontario Hydro which is the successor to HEPCO). The dam controls the flows from Mattagami Lake into Kenogamissi Lake. Mattagami Lake provides flood mitigation for the City of Timmins as it has the largest storage capacity on the Upper Mattagami River system.

Photograph 2-1 Mattagami Lake Control Dam



The dam consists of the following structures: east earth dyke, east concrete gravity wall, central concrete sluiceway, west concrete gravity wall and west earth dyke. The overall length of the dam is approximately 115 metres.

The centre sluiceway is 40 metres long and 9 metres high and consists of six sluices with a total discharge capacity of 524 cubic metres per second at reservoir water level of 331.48 metres (all levels and elevations are referred to Canadian Geodetic Datum). Sluices #3 and #4 are equipped with underwater ports to assist in winter drawdown operations.

The east concrete gravity wall extends from the #6 sluice side pier to the east earth dyke. It is 19 metres long and 0.9 metres wide at the crest with a maximum height of 7.6 metres. A vertical concrete core wall extends into the east earth dyke which is 13 metres long.

The west concrete gravity wall extends from the #1 sluice side pier to the west earth dyke. It is 16 metres long and 4 metres wide at the crest with an average height of 7 metres. A vertical concrete core wall extends into the west earth dyke which is 27 metres long.

Figure 2.4 Scheme of Existing Mattagami Lake Control Dam

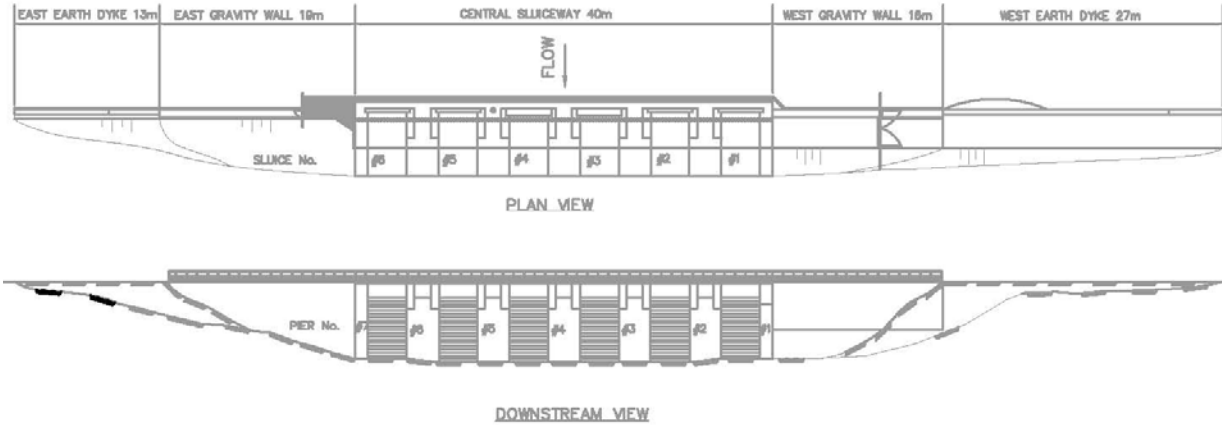
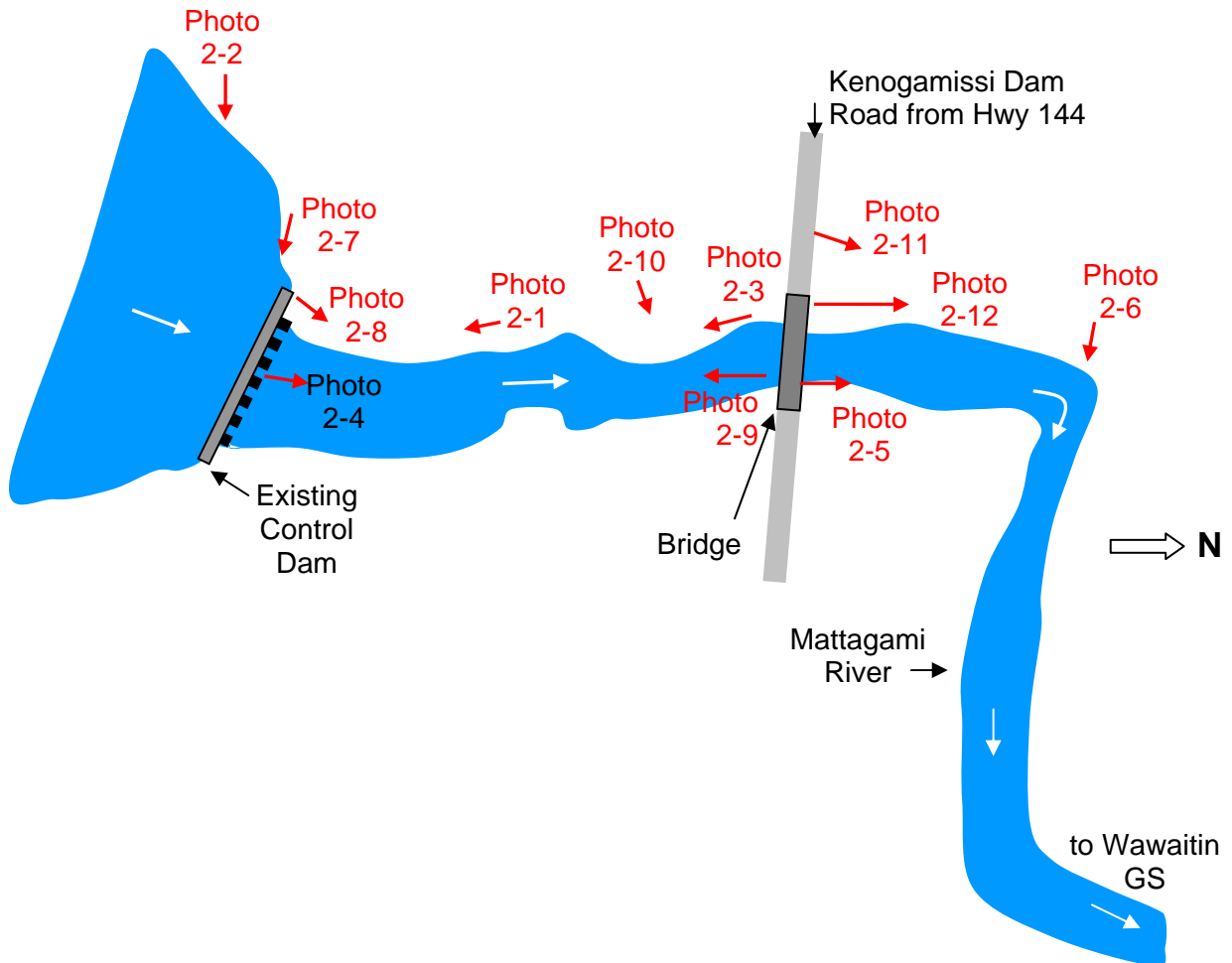


Figure 2.5 shows the existing structures and locations of photographs presented in this project description.

Figure 2.5 Existing Structures and Locations of Photographs 2-1 through 2-12

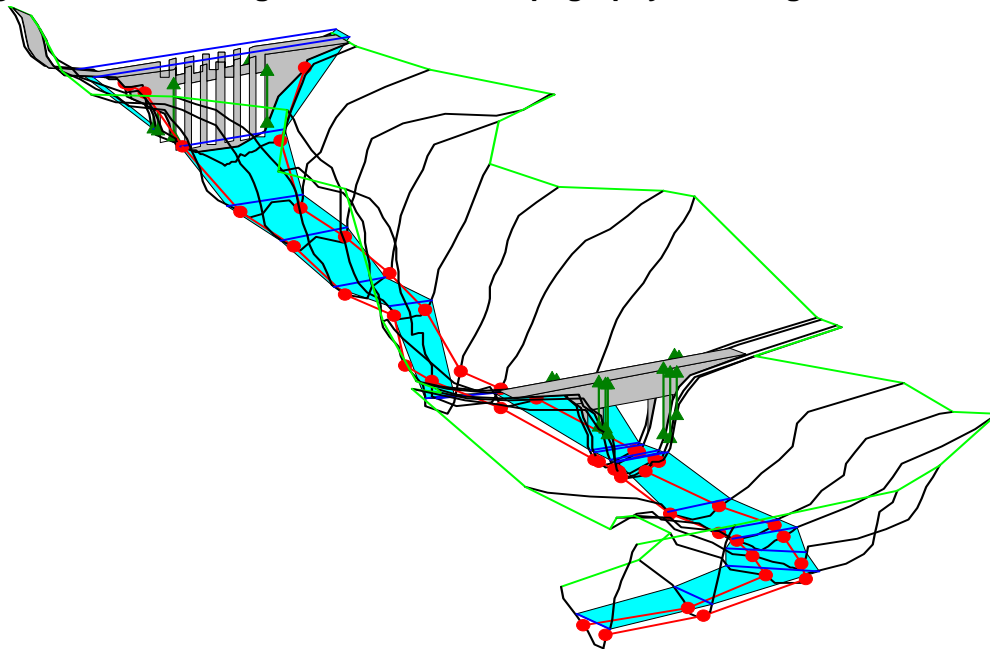


The existing Mattagami Lake Dam was constructed immediately upstream of the Kenogamissi Falls. A primary forest access road and a bailey bridge (owned by Tembec) is located about 150 metres downstream of the dam. The west river bank between the dam and the bridge is relatively steep, while the east river bank has a gentle slope. Downstream of the road and bridge, a creek merges into the river from the west side. The area between the road and the creek is relatively flat and will accommodate the future powerhouse and switchyard.

The slope of the river bed from downstream of the dam to the bridge is relatively steep with an elevation variation of about 12 metres. A series of bedrock outcrops between the control dam and the bridge are visible during low flows.

The Mattagami River in this location generally runs from south to north. Water flows northward from Mattagami Lake through the control dam and turns 90 degrees about 50 metres downstream of the bridge to the east and runs about 550 metres before merging into Kenogamissi Lake. The existing structures and general topography around the Mattagami Lake Dam are illustrated in Figure 2.6. The slopes in this area are typically covered with adequate soil overburden and vegetated with mature trees and undergrowth.

Figure 2.6 Existing Structures and Topography of Mattagami River Section



Photograph 2-2 Mattagami Lake Control Dam, Mattagami Lake and Safety Boom



**Photograph 2-3 Mattagami River from Tembec Bailey Bridge to Dam
(Looking Upstream)**



**Photograph 2-4 Mattagami Lake Control Dam to Bailey Bridge
(Looking Downstream and North)**



**Photograph 2-5 Widened Area of Mattagami River Just Downstream of Bailey Bridge
and Turning 90 Degrees to the East**



Photograph 2-6 View of the 90 Degree Turn in the River from Further Downstream

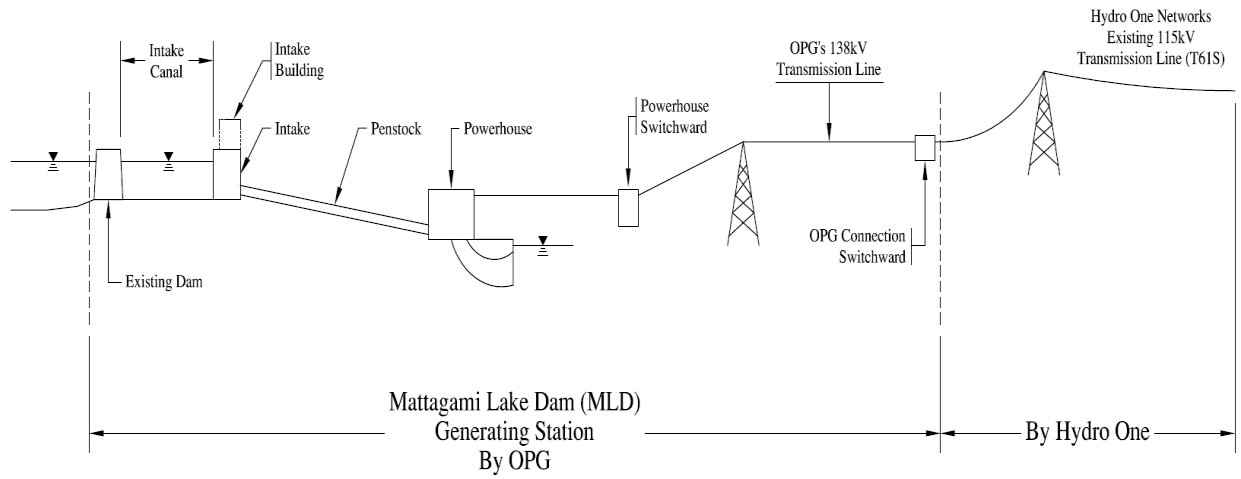


2.3.2 Proposed Undertaking

Preliminary assessments conducted by OPG indicate there is a potential for a small hydroelectric development at this site, with its operation consistent with how the River is currently managed. While several options were examined, the Proposed Undertaking is a single-unit generating station (GS) having an installed capacity of 5 to 7 MW, with an average gross head of about 16 metres and design flow of about 40-47 cubic metres per second (cms) pending on the final plant capacity.

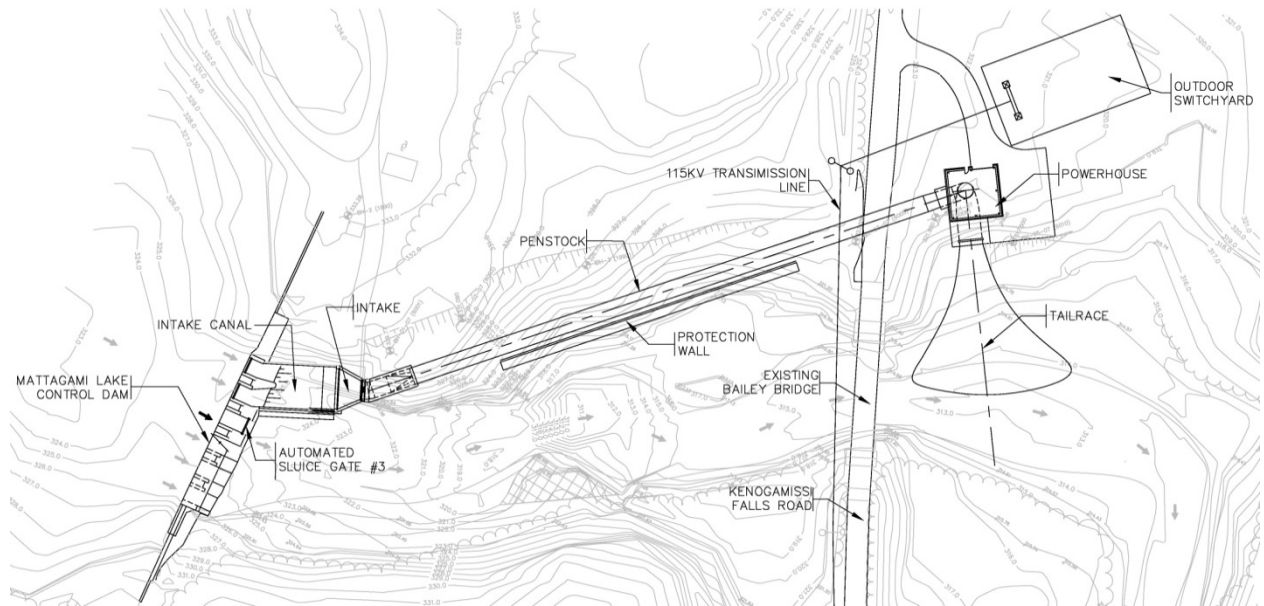
The Proposed Undertaking will include an intake canal, intake structure, penstock, powerhouse with a tailrace channel, powerhouse switchyard, 3 km 115 kilovolts (kV) transmission line, and a connection switchyard near the existing Hydro One 115 kilovolts (kV) Transmission line (T61S). The major components noted above are shown in the following sketch:

Figure 2-7 Scheme of Mattagami Lake Dam GS



The preliminary concept of the Proposed Undertaking is depicted below.

Figure 2.8 Plan View of Conceptual Design



Intake Canal and Intake

The new intake will be located downstream of the west end of the sluiceway to utilize the existing first two sluices. The intake channel will have an approximate footprint of 12 metres by 25 metres, with a maximum depth of approximately 12 metres. A new automated sluice gate will be installed downstream of Sluice #3 to facilitate the remote operation of the dam.

The existing piers #1 and #3 need to be extended downstream approximately 12 metres to connect to the new intake structure. It is OPG's intention to utilize the existing stoplogs at Sluice #1, #2 and #3 as the upstream cofferdam for construction of the new intake structure and the new automated sluice gate at sluice #3. Sluices #1, #2 and #3 will be shut down and sealed during the construction period. If the stoplogs cannot be completely sealed, an alternative means such as the use of membranes can be installed to manage leakage through those stoplogs. The area immediately downstream is expected to be dry because the riverbed in that area is at a higher elevation. The remaining three sluices (#4 to #6) will be utilized to pass any necessary flow discharge in order to optimize site safety. As an additional safety measure, a board system will be installed at the water side of the new intake during the construction period. This will protect the construction pit from spillover or backwater from other sluices. There will be rock blast and concrete placement for the intake construction. All the work will be done in dry conditions in compliance with applicable guidelines, standards and regulatory requirements. A sluiceway, emergency gate, headgate and a set of trashracks will be installed after the concrete work. The remains of the old timber dam shown in Photo 2.7 will be removed to streamline the flows approaching the new intake.

The discharge capacity of Sluices #3 - #6 will be 351 cms (close to the Inflow Design Flood (IDF) of 361 cms for 100 years). As a further Dam Safety measure, the new intake will also include a stop log sluice with an additional discharge capacity of 130 cms, which brings the total discharge capacity to 481 cms and greater than the 1,000 year IDF of 479 cms.

Photograph 2-7 Dam and Intake Structure

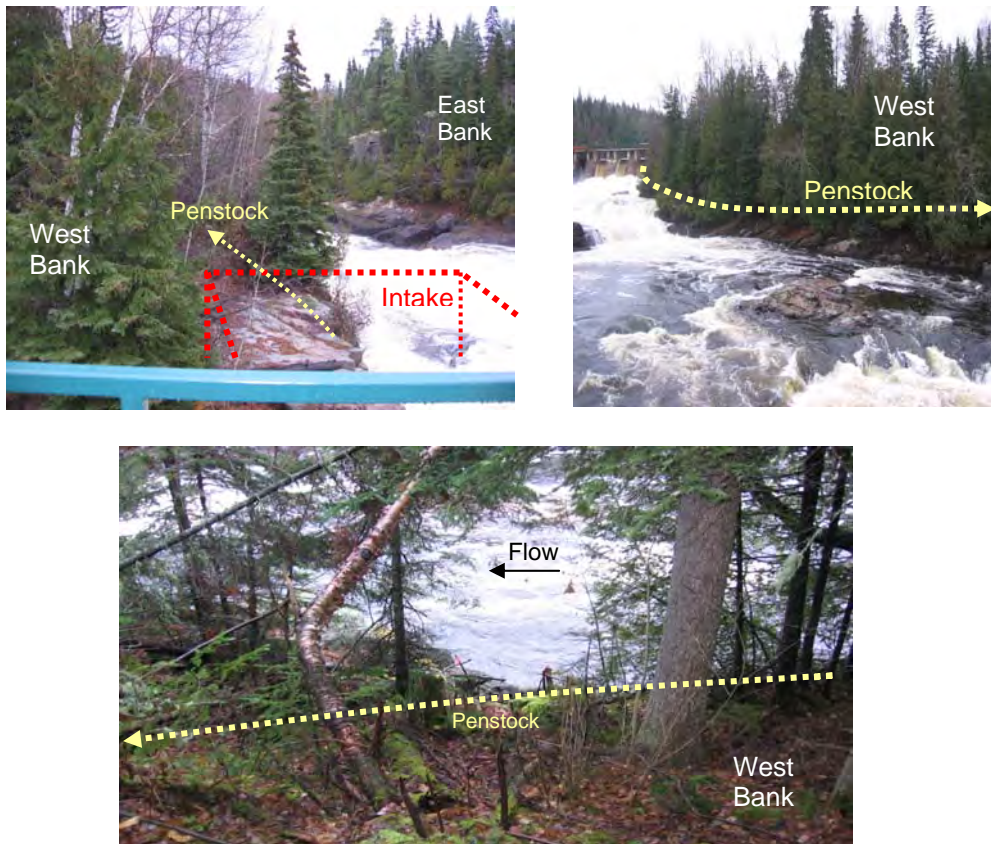


Penstock

A steel penstock with a diameter of about 4 metres and a length of 150 metres will then convey water along the western bank of the river and run under the existing road to a powerhouse, which would be located in the vicinity north of the existing Bailey bridge on the western bank of the river (Photographs 2-8, 2-9, 2-10).

The steel penstock will be placed on concrete saddles. The overburden and rock excavation will be undertaken in dry conditions. There will be no in-water blasting and all rock blasting will follow DFO Guidelines.

Photograph 2-8, 2-9, 2-10 General Location of Penstock on Western Shoreline



Powerhouse, Tailrace Channel and Powerhouse Switchyard

There will be a switchyard adjacent to the powerhouse to accommodate a main power transformer and associated structures and devices. The powerhouse switchyard will be approximately 20 metres by 35 metres. A vehicle parking lot will be located north of the powerhouse with a footprint of approximately 15 metres by 20 metres.

Photograph 2-11 Proposed Location of Powerhouse



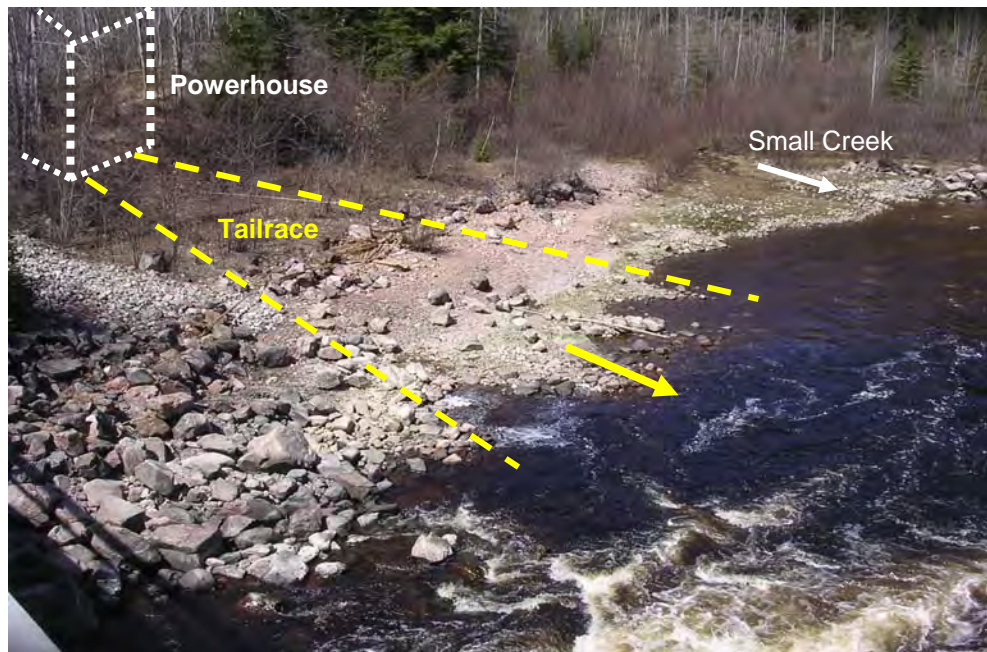
The powerhouse will accommodate a single Kaplan turbine unit. Several similar units have already been installed and successfully operated in Canada. Based on their track record, it is anticipated that this type of unit will most efficiently harvest the water power available at this site. The water from the turbine will be first discharged into the tailrace channel then into the river. The tailrace channel will flare out in order to reduce the exit velocities to acceptable levels (Photograph 2-12).

While final engineering is not completed yet, the powerhouse superstructure is likely to be a prefabricated steel building with metal-clad surface finish. The superstructure's approximate dimensions are 15 x 17 x 12 metres (W x L x H). About 17 metres deep excavation will be required in order to construct the powerhouse concrete substructure and tailrace channel.

The powerhouse and part of the tailrace channel will be constructed in dry conditions inside a cofferdam located along the west shoreline. The cofferdam will be designed and constructed to safely resist the flood design criteria for the construction period. The cofferdam will be removed after the first phase construction of the powerhouse and installation of the tailrace sectional gates. The tailrace channel will be completed and the riverbed will be reshaped during the low flow period when the control dam can be shut down allowing only leakage flow. The potential shoreline that may be reduced due to the cofferdam construction is estimated at 150 m². Approximately 500 m² of shoreline area may need to be reshaped. See the Aquatic TSD for further information.

All equipment associated with the generating station operation will be installed in the second phase of the powerhouse construction along with the powerhouse switchyard.

Photograph 2-12 Location of Proposed Powerhouse and Tailrace



Transmission Line and Connection Switchyard

The proposed 3 km 115 kilovolts (kV) transmission line will run from the powerhouse switchyard to the connection switchyard near the existing Hydro One 115 kV Transmission line (T61S) (Photograph 2-13) running from Timmins Transformer Station to the Shiningtree Distributing Station. The connection switchyard will contain a motorized disconnect switch and associated structures and devices.

The final tap line from the connection switchyard to the existing Hydro One 115 kV Transmission line (T61S) will be constructed by Hydro One. The transmission line will be built to the CAN/CSA-C22.3 No. 1-06 standard.

Photograph 2-13 Existing Hydro One Transmission Line



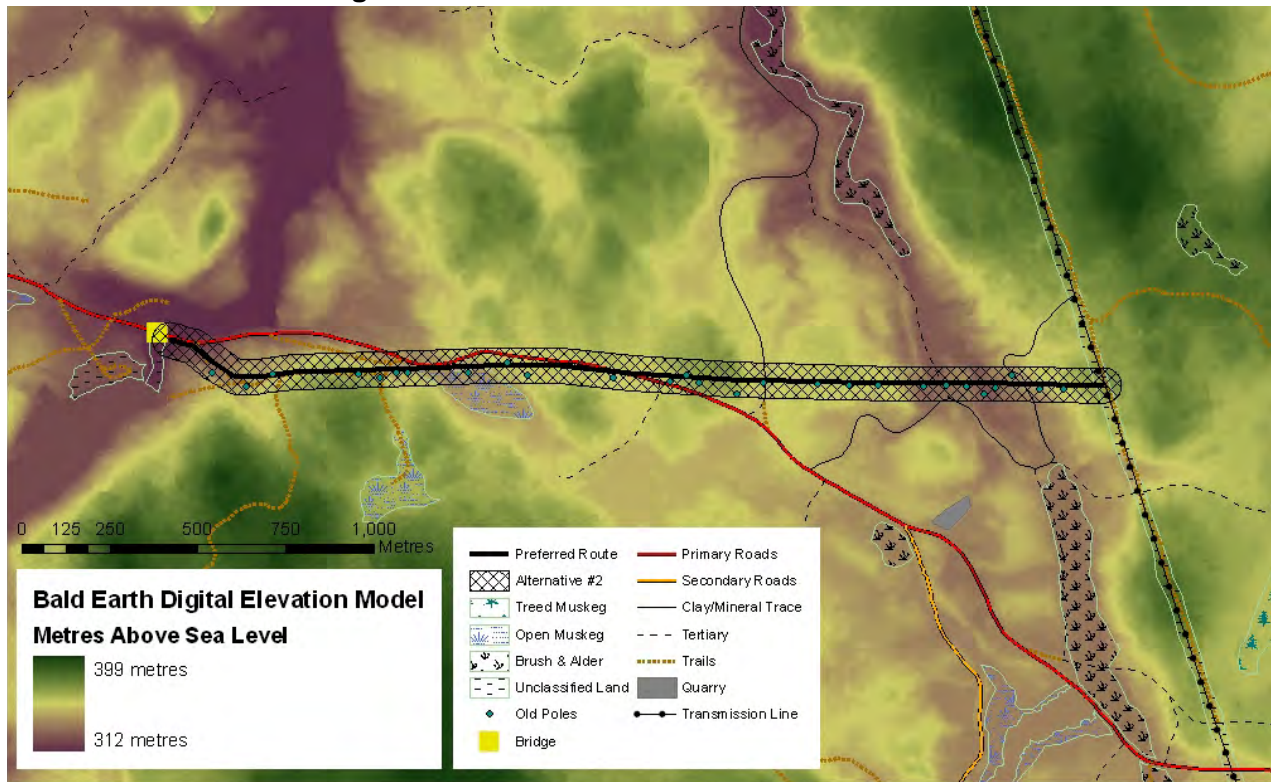
The proposed transmission line will be a 115 kV single or double wooden pole transmission line. A single wooden pole line is shown in the photograph below and the proposed line would resemble this design (Photograph 2-14) or a double wooden pole type of similar height.

Photograph 2-14 Proposed Hydro Transmission Line Style



A preferred transmission corridor has been identified and is depicted in Figure 2.9. This corridor follows an old utility line. This corridor (right-of-way) is approximately 3 km long and will be about 40-45 metres in width.

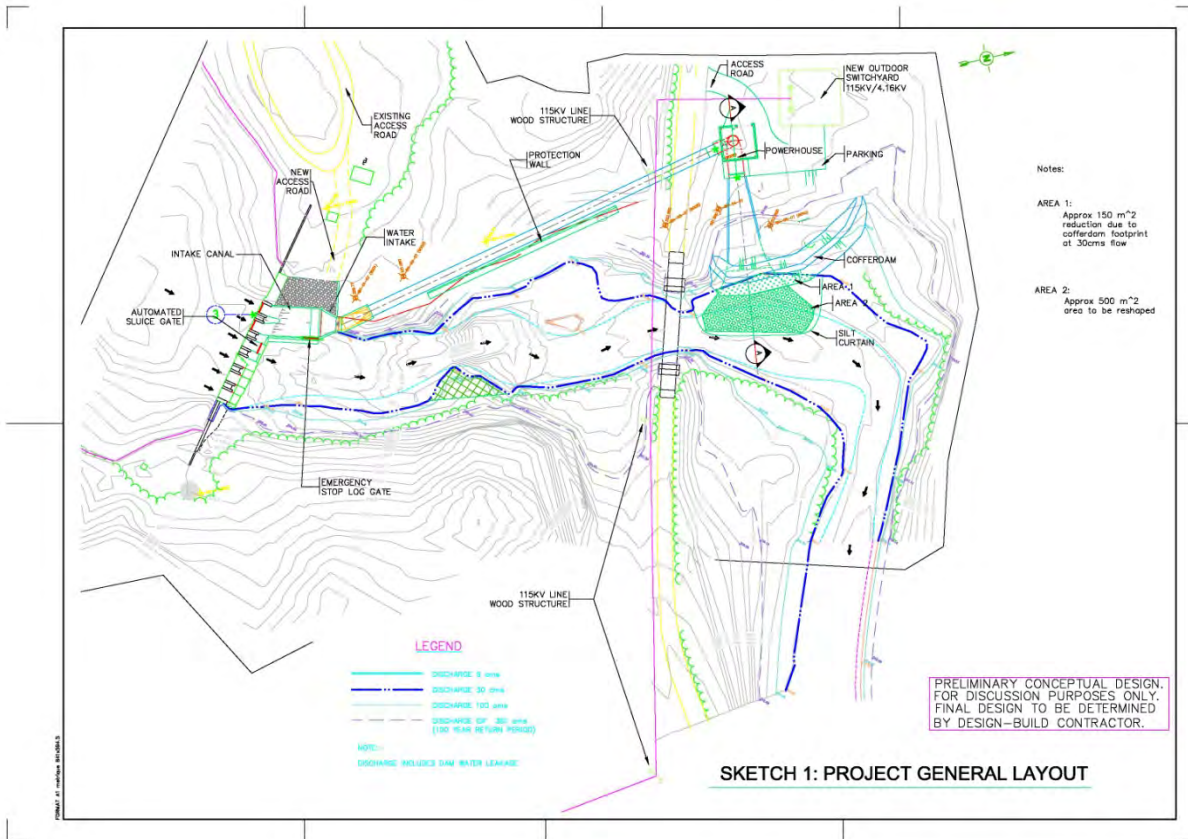
Figure 2.9 Preferred Transmission Route



2.3.3 Proposed Tailrace Cofferdam Construction

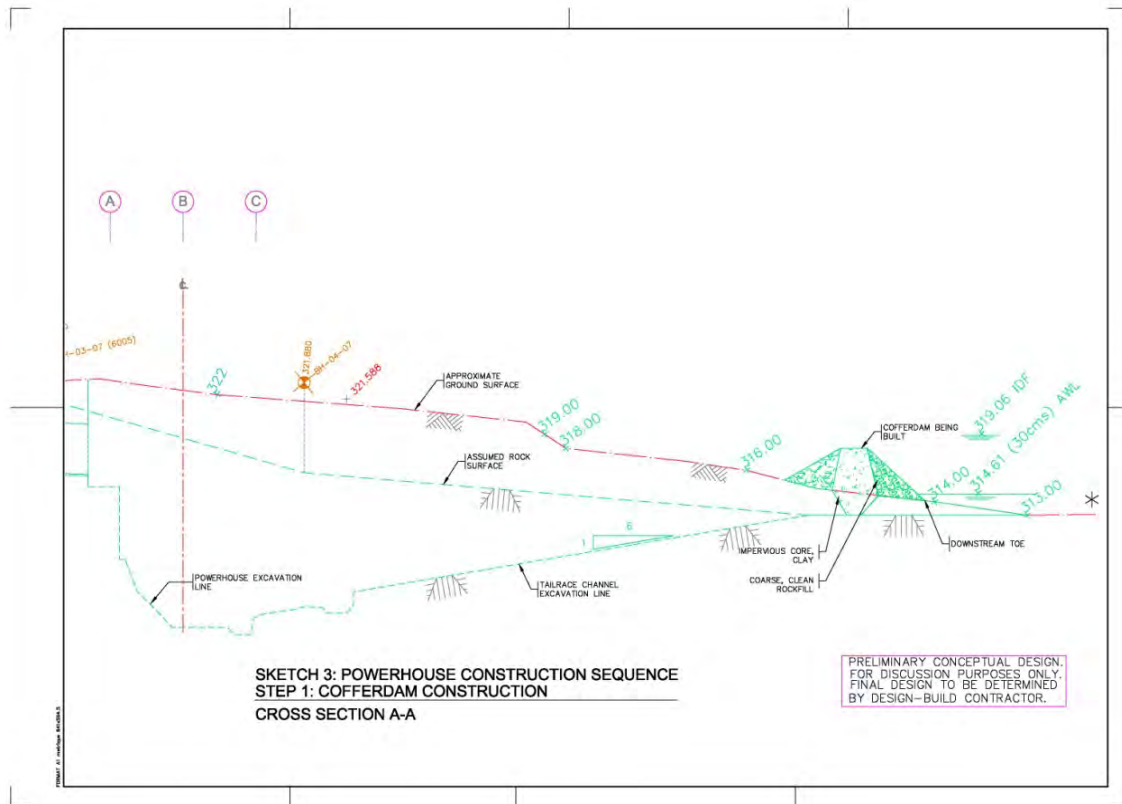
The construction methods of the tailrace cofferdam presented here outline the basic principles that will be used to minimize the environmental impact. Components of the Department of Fisheries and Oceans (DFO) Risk Management Framework were used to assess the proposed tailrace cofferdam construction and were discussed with Connie Smith at a meeting in the Sudbury DFO offices on November 13, 2008. Generally, the powerhouse and part of the tailrace channel will be constructed in dry conditions inside a cofferdam located along the west shoreline.

Figure 2.10 Sketch 1: Project General Layout



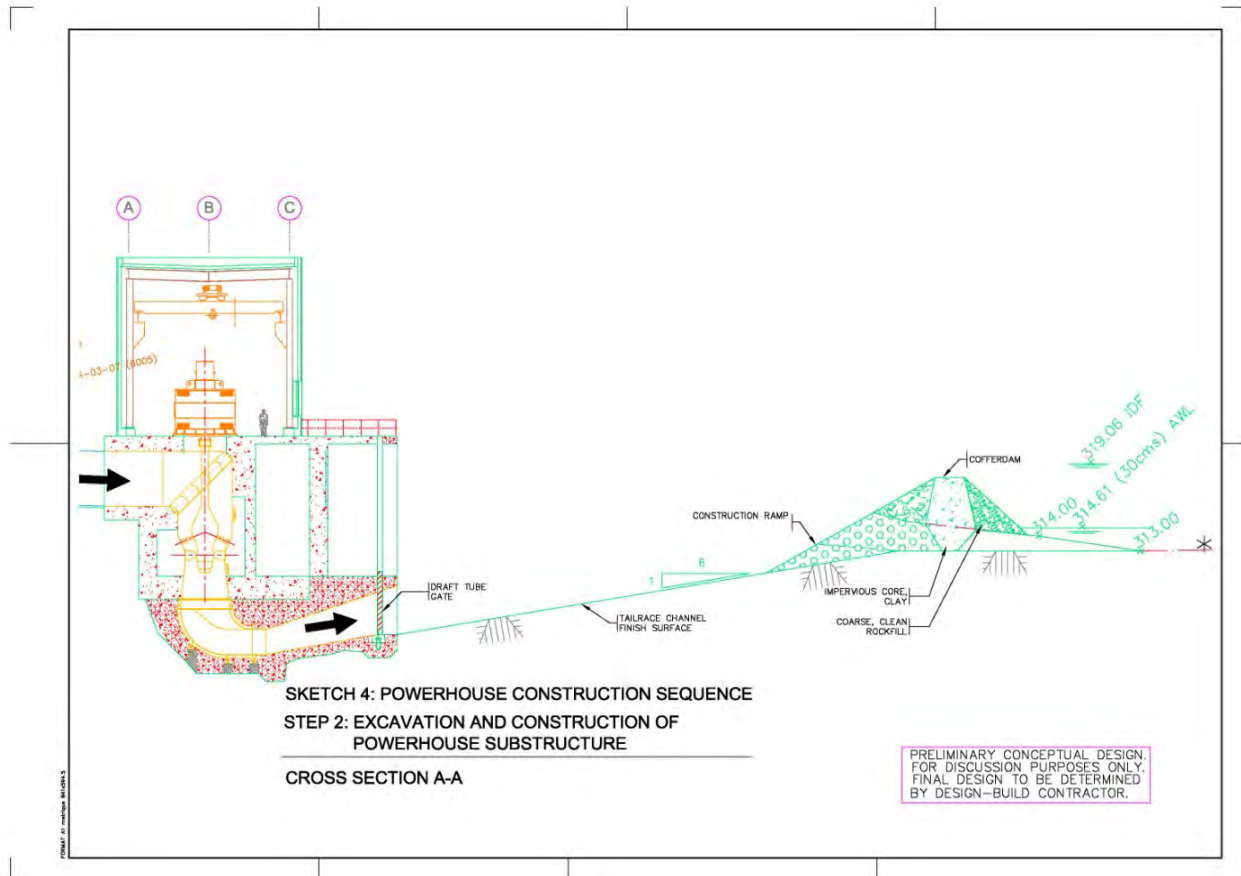
The tailrace cofferdam will be constructed along the west shore of the river, downstream from the road bridge. The construction will occur in the dry over a period of 3 to 4 weeks during the low flow period, when the existing Mattagami Lake Control Dam can be shut down with only leakage flow to the downstream river. No in-water work will occur in the tailrace area during the spawning or incubation periods of walleye or lake whitefish (i.e. the cofferdam construction should normally be done between June 20 and September 15). The cofferdam's toe on the river side will be placed roughly to just below the waterline associated with the average annual flow of 30 cms, and at that water level, the wetted habitat area would be reduced by approximately 150 m². The cofferdam will stay in place for about 2 years and be designed according to the latest Ontario Dam Safety Guidelines. The habitat area, that will temporarily be unavailable to fish during this period, is not spawning habitat for lake whitefish or walleye.

Figure 2.11 Sketch 3: Powerhouse Construction Sequence – Step 1 Cofferdam Construction



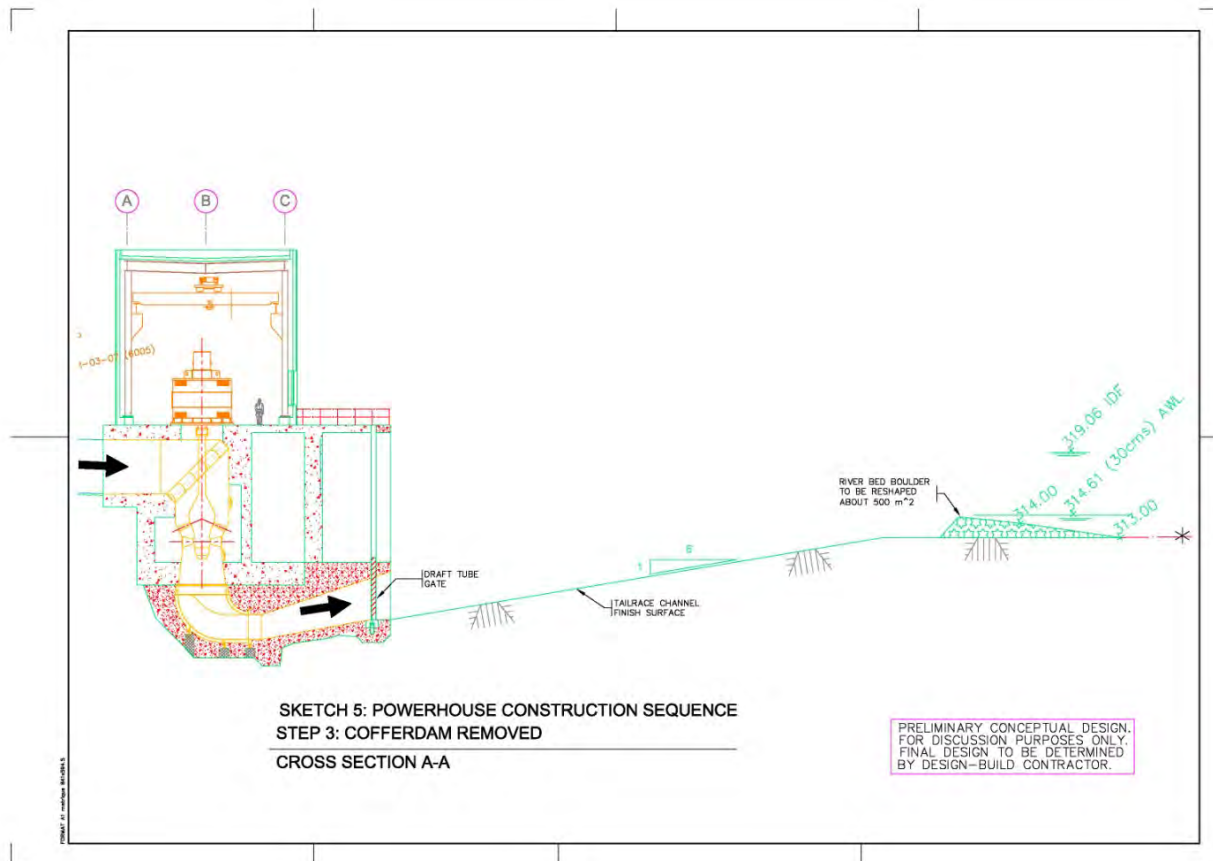
During the excavation and initial construction of the powerhouse and part of the tailrace channel, the excavation pit will need to be maintained in a dry condition. Surface water and leakages will be collected and pumped from the pit to a settling pond or a filter bag, or a combination of both, to remove as much suspended material as possible from the discharge water before it re-enters the river. Contouring and shaping of the tailrace channel will be conducted in the dry behind the cofferdam to the extent possible. Once the powerhouse is advanced to the point that its outer shell within the pit is finished and watertight, and the draft tube gates can be sealed, the cofferdam can be removed.

Figure 2.12 Sketch 4: Powerhouse Construction Sequence – Step 2 Excavation and Construction of Powerhouse Substructure



The cofferdam will be removed during the traditional low flow period, and during the accepted in-water work window (i.e. June 20 to September 15) as indicated earlier. The existing Mattagami Lake Control Dam will be closed, allowing only leakage during the 2 to 3 week duration of this work. This should result in water levels that are low enough, or nearly so, for the cofferdam to be removed in the dry (Figure 2.13). As the cofferdam is removed, the contouring and shaping of the tailrace can be extended outward as much as possible in the dry.

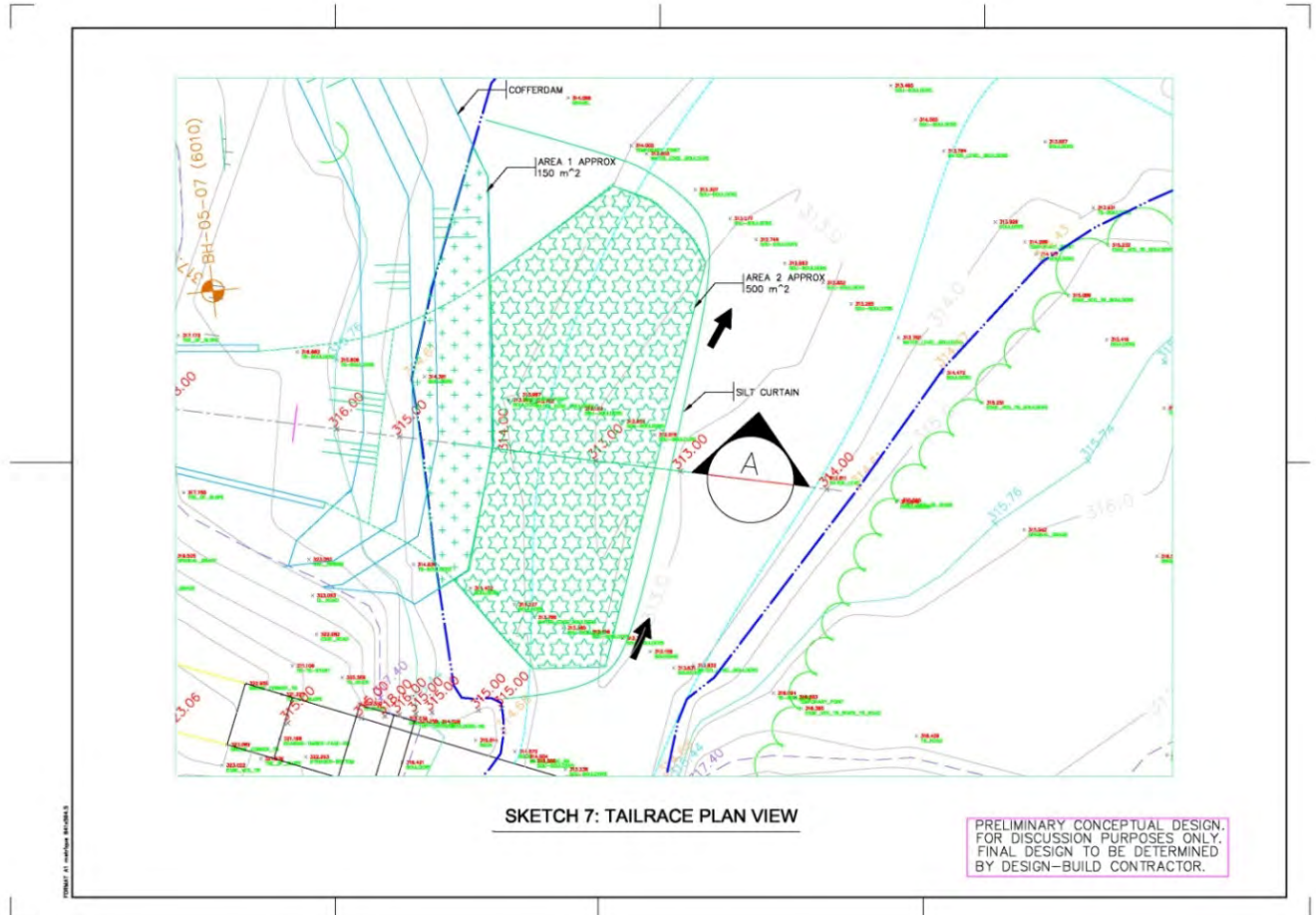
Figure 2.13 Sketch 5: Powerhouse Construction Sequence – Step 3: Cofferdam Removed



The tailrace extension into the river will require the re-contouring of approximately 500 m² of riverbed to allow for the efficient flow of water exiting the tailrace. Figure 2.14 is a plan view of the tailrace with cofferdam, showing the estimated extent of the tailrace contouring and shaping that will be required to smooth the transition between the tailrace to the river. At the point in time when work in the wetted portion of the river cannot be avoided, a silt curtain system will be installed to enclose the tailrace footprint area. For such a small amount of excavation within relatively clean granular substrates, a silt curtain system, rather than a second cofferdam, will be the best choice to minimize impacts to the surrounding habitats. Utilizing a new cofferdam, rather than a silt curtain, would extend the area of direct impact to include the base of the cofferdam, possibly resulting in a doubling of the area of riverbed disturbed, and increasing the duration of that disturbance. Within the area contained by the silt curtain system, the tailrace can be deepened and extended to blend with the contours of the surrounding riverbed. Backhoe bucket movement speed can be adjusted to minimize the suspension of material when warranted. The native riverbed material will be used to re-contour the in-water area as shown in Figure 2.14, with the coarser materials (cobble/small boulder) placed along the edge and sloped sides of the tailrace to provide potential spawning areas for walleye, and the finer materials (sand/gravel) placed in the deeper central portions of the tailrace to provide potential spawning areas for lake whitefish. Once the tailrace construction is complete, and all potentially erodible

areas are stabilized and fine suspended material is cleaned-up, the tailrace silt curtain will be removed.

Figure 2.14 Sketch 7: Tailrace Plan View



3.0 BASELINE AQUATIC ENVIRONMENT CONDITIONS

3.1 DESCRIPTION OF THE STUDY AREAS

The Proposed Undertaking is located on the Upper Mattagami River, in the short section of Mattagami River between Mattagami Lake and Kenogamissi Lake at the Mattagami Lake Dam. The site location is shown on Figures 2-1, 2-2 and 2-3.

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

Regional Study Area

The regional setting is generally defined by the Mattagami River watershed (see Figure 3-1). The regional setting provides for the baseline description of this watershed and the associated general land and water uses affecting the aquatic environment.

Local Study Area

The local study area extends from Mattagami Lake, located immediately upstream of the Mattagami Lake Dam, to Kenogamissi Lake, located approximately 700 metres downstream of the Mattagami Lake Dam (Figure 3-2).

3.2 STUDY APPROACH

The baseline setting for the aquatic environment within the regional study area was prepared based on literature review, observations and information /discussions with relevant regulators and biologists with expertise in this area. Environmental baseline conditions have been summarized by Sears (1992) and OPG *et al.* (2006). This information was augmented and updated by data requested from the Ministry of Natural Resources (MNR), the Ontario Ministry of the Environment (MOE) and Mattagami Region Conservation Authority (MRCA). The baseline aquatic environment information for the local study area was gathered through focused field investigations and discussions with local resource users and MNR personnel.

3.2.1 Field Assessment Methods

Field assessment methods are comprised of (i) an initial and ongoing exchange of environmental and fisheries information related to the study site with the MNR, (ii) obtaining flow and water temperature information from OPG, (iii) discussions of fisheries conditions with local fishers, and (iv) field investigations targeting specific fisheries events such as walleye spawning, or environmental components such as habitat investigations. Prior to the start of field work for this project, background information regarding walleye (*Sander vitreus*) and lake whitefish (*Coregonus clupeaformis*) spawning in the study area, as well as information for other fish species of interest, was requested from the Timmins District Office of the MNR, and from the

Mattagami First Nation (MFN). Ongoing discussions and requests for information with MNR biologists and resource personnel have occurred over the multi-year field assessment program to aid in the timing of field activities and the interpretation of observations. Local fishers were also contacted on a number of occasions to monitor whitefish spawning activity. Additional field observations of water temperature and river flow during April, May, October, and November over the multi-year field assessment program were provided by OPG staff to aid in determining the timing for the spawning investigations and to assess field safety conditions.

The 2006 field investigations for this project were conducted by C. Portt and Associates staff on May 2 and 3 (G. Coker, J. Reid), June 21 (C. Portt, G. Coker, J. Reid), October 17 and 18 (G. Coker, J. Reid), November 20 (G. Coker) and December 11 (G. Coker). The 2007 field investigations were conducted by G. Coker and J. Reid on May 2, August 28, and November 9 and 10. In 2008 field investigations were conducted on May 8 and 9 (G. Coker, J. Reid), August 6 (G. Coker), September 8-11 (G. Coker), and November 21 (G. Coker, J. Reid). In 2009 field investigations were conducted by G. Coker and J. Reid on May 11 and 12, August 27, and October 29. In 2010 only the walleye spawning assessment has been conducted (April 19 and 20) at the time of this writing. During the walleye spawning investigations in May of 2006, 2007, 2008, 2009 and 2010, the Mattagami River between the Mattagami Lake Dam and Kenogamissi Lake was examined during daylight hours in order to identify safety hazards, access routes, and potential walleye spawning habitat. 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. Where possible, estimates of the number of walleye were made for discrete sections of river.

Fish habitat was investigated and mapped on June 21 and December 11, 2006. On June 21, a Garmin GPS 12 Global Positioning System (GPS) unit was used in conjunction with direct observations and measurements to map fish habitat and substrate type within the study area near-field. On December 11, 2006, flow through the Mattagami Lake Dam was curtailed so that a surveying contractor could conduct a detailed topographic survey of the study area near-field. During a field investigation undertaken over September 8–11, 2008, to determine an appropriate minimum flow downstream of the proposed GS (Appendix C), river substrates downstream from the road bridge to Kenogamissi Lake were mapped in detail using total station and GPS. Granular substrates were classed using a modified Wentworth (1922) scale, where sand and gravel were combined into a single class (0.0625 – 64 millimetres), cobble and small boulders were combined into a single class (65 – 500 millimetres), and a class for large boulders (>0.5 m) was added. It was thought that this would be a more relevant classification scheme considering the habitat types within the study area, in which sand was always found mixed with gravel, and where most areas with cobble-sized substrate also included a large and sometimes dominant proportion of smaller boulders. The wetted perimeter was also surveyed at this time, at the river flows 1.2, 2.5, 3.2, and 4.5 cubic metres per second. Digital photographs were taken at strategic geo-referenced locations to further characterize habitat and record specific observations. Referenced photographs are provided in (Appendix A).

Fish were collected by electrofishing in wadeable areas on June 21, 2006, using a Halltech Model HT 2000 backpack electrofisher, and on August 28, 2007, using a Smith-Root Model 12 backpack electrofisher. Additional fish community information was gathered during spawning investigations, through discussions with local fishers, and while mapping habitat.

Lake whitefish spawning field investigations were conducted in 2006, 2007, 2008 and 2009. In 2006, field investigations occurred on October 17 and 18, November 20 and December 11, with night observations occurring on October 18 and November 20. On December 11, 2006, a short-term (approximately 4 hours) flow reduction was undertaken to allow a surveying contractor (Global Surveying) to conduct a detailed topographic survey of the near-field study area. The reduced flow also provided an opportunity for the fisheries biologist (G. Coker) to conduct more effective observations for whitefish and to search for whitefish eggs. The search for whitefish eggs was undertaken by vigorously disturbing the cobble substrate down to the cobble/gravel sub-pavement by kicking and removing larger rocks by hand. During this process an upwelling current was created by the rapid movement of feet and a dipnet, and the material that was washed up out of the interstitial spaces and suspended was collected with a fine mesh dipnet (21 centimetres net mouth; 0.5 millimetres mesh). The area disturbed at each location ranged from approximately 0.6 – 1 metres in diameter, depending on the substrate characteristics.

Field observations for lake whitefish spawning in 2007 were conducted during daylight hours on November 9 and 10, and at night on November 9, using an underwater video camera system. The camera was tied to a buoy and allowed to float downstream on a long transmission cable, while a stationary observer watched the monitor. Approximately six camera deployments and retrievals occurred at each location. The length of cable between the buoy and the camera was adjusted to best match the water depth within each area examined. Using this method the entire length of river from the bridge downstream to below the second pool, as well as at the river mouth, was examined for whitefish. The same method was used to conduct field observations for lake whitefish on November 21, 2008, and October 29, 2009, however, some of the more turbulent rapids were not examined in 2009 because of the fear that the video camera would not survive being washed through the rapids.

Hydraulic modeling of flows from the proposed tailrace was undertaken by SCP-BPR Inc. using the MODELEUR software (Appendix B). Water level and flow measurements conducted on September 19 and December 11, 2006, were used to calibrate the model.

Figure 3.1 Mattagami River Watershed Generating Stations and Dams

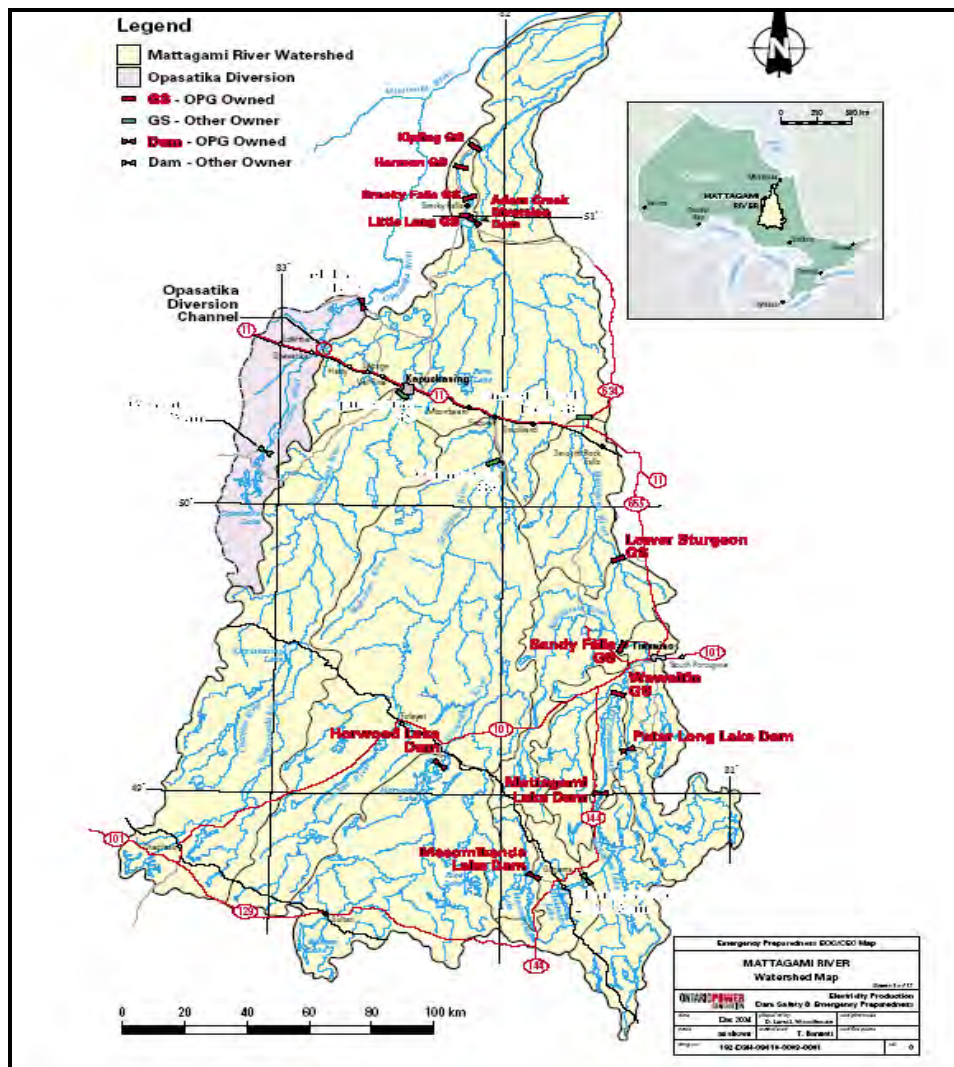


Figure 3.2 Local Study Area



3.3 REGIONAL STUDY AREA

3.3.1 Hydrology

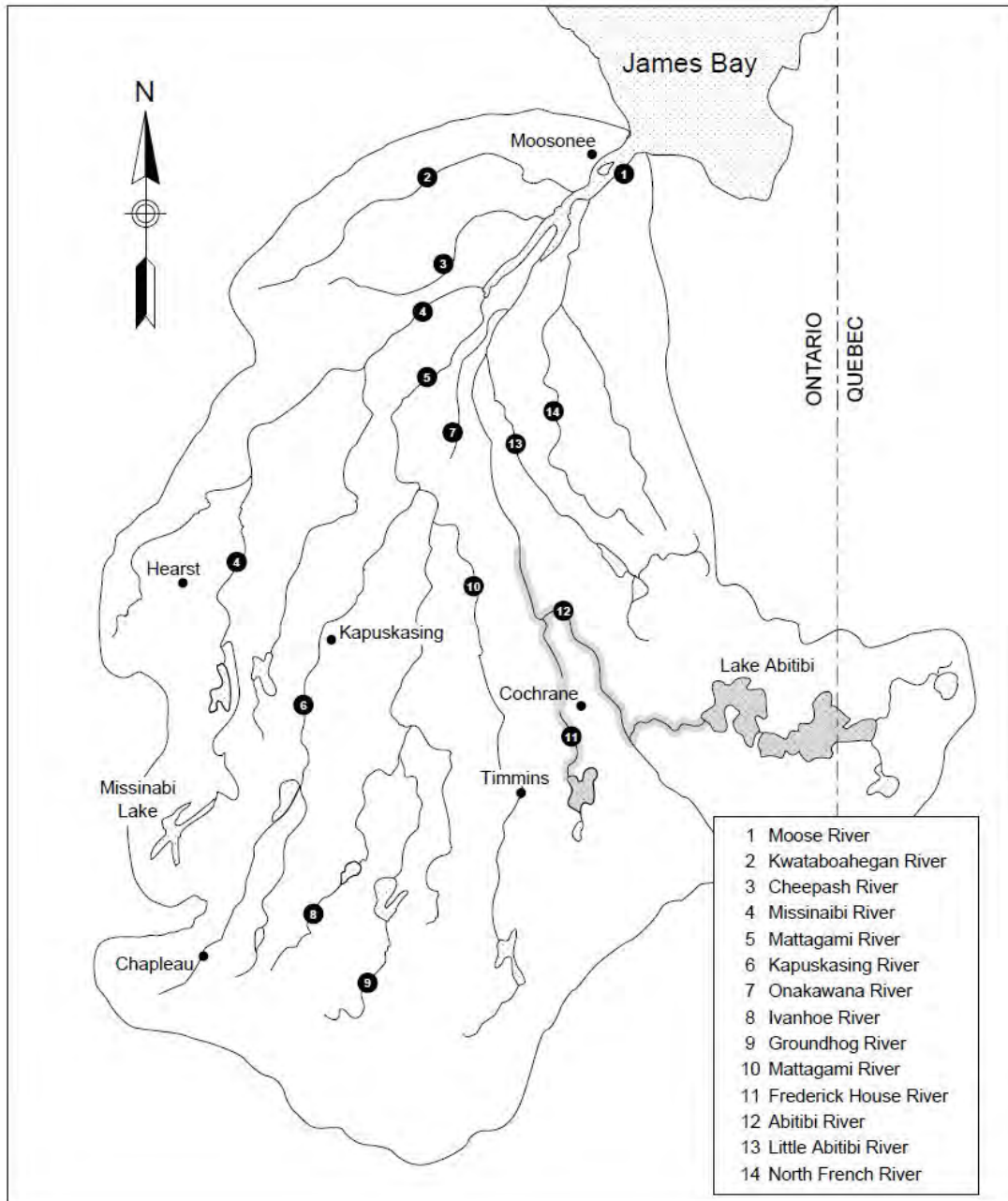
The Mattagami River is located within the Moose River drainage basin of the Hudson Bay Drainage System (Figure 3-3). The Moose River drainage basin drains approximately 109,000 square kilometres traversing three physiographic regions (see Figure 3-4): the Canadian Shield, the Great Clay Belt and the Hudson Bay Lowlands (Brousseau and Goodchild, 1989).

The Mattagami River extends approximately 418 kilometres from its headwaters at Mesomikenda Lake, draining other major tributaries such as the Groundhog River, Grassy River, Kapuskasing River, Ivanhoe River, Makami River, Remi River, Opatatika River, Hull Creek and Lost River to its confluence with the Moose River (OPG *et al.*, 2006). The Mattagami River and its tributaries drain approximately 35,612 square kilometres.

Based on historical hydrological data, the greatest streamflow occurs during the spring freshet in April, May and June with the lowest flows occurring generally during the summer near Timmins, and the winter at Smooth Rock Falls (see Table 3.1). Maximum, mean and minimum daily discharges of the upper Mattagami River near Timmins are depicted in Figure 3-5. Extreme maximum and minimum monthly flows near Timmins were 295 cubic metres per second in May 1979 and 17.9 cubic metres per second in September 1991, respectively.

Extreme maximum and minimum daily flows at this same location were 539 cubic metres per second on 21 May 1996 and 9.69 cubic metres per second on 14 August 1992, respectively.

Figure 3.3 Moose River Drainage Basin



Seyler 1997

Figure 3.4 Major Physiographic Regions of the Moose River Basin

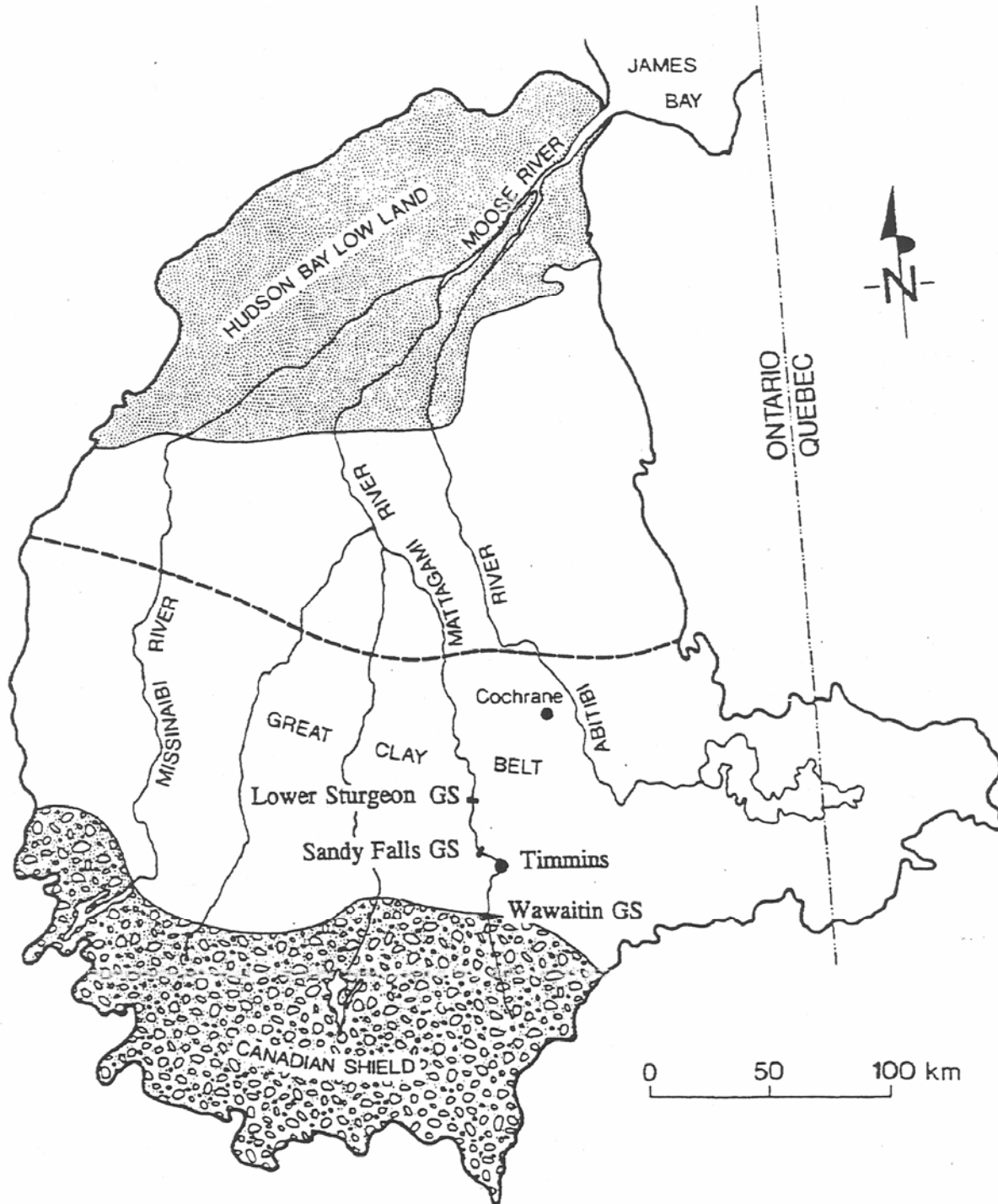


Table 3.1 Monthly and Annual Mean Discharges (cms) of the Mattagami River¹

Location	Period of Record	Jan.	March	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Near Timmins ²	1969 - 1997	63.5	66.2	138	90.9	49.7	36.5	35.4	42.7	50.4	55.3	64.6
At Smooth Rock Falls ³	1920 - 1997	54.8	62.1	320	160	96.4	64.5	76.8	98.3	92.6	66.4	111

¹ Source: http://www.wsc.ec.gc.ca/staflo/index_e.cfm?cname=flow_monthly.cfm

² Location: 48°24'15"N; 81°26'54"W; drainage area of 5,540 square kilometres.

³ Location: 49°16'4"N; 81°38'30"W; drainage area of 10,000 square kilometres.

Figure 3.5 Maximum and Minimum Daily Discharge (cubic metres per second) for the Mattagami River Near Timmins (1969-1997)



3.3.2 Morphology and Bathymetry

On the Canadian Shield, the upper Mattagami River has irregular gradients and is typically less than 100 metres wide, except where there are in-stream lakes such as Lake Mattagami and Lake Kenogamissi (Seyler 1997). The river channel is tightly contained, with bedrock outcrops common and manifested as extensive riffle and rapid areas. Inflowing tributaries are generally small.

3.3.3 Water Quality

Due to its good water quality, the Mattagami River is the source of the Timmins potable water supply. Tables 3.2, 3.3 and 3.4 present water quality data for the Mattagami River at the Highway No. 101 bridge in Timmins, at the Timmins Waterworks Plant intake and downstream of the Timmins Sewage Treatment Plant (STP), respectively. The mean concentrations of all applicable parameters were below the Provincial Water Quality Objectives (PWQOs) and Guidelines (PWQGs), with the following exceptions:

- aluminum exceeded the PWQO at the Highway No. 101 bridge (however, it is unlikely that the aluminum analyses were based on clay-free samples as required for comparison with the PWQO);
- total phosphorus exceeded the interim PWQO in 1975 at the Waterworks Plant intake, as well as for three of the four sampling years downstream of the Timmins STP; and
- fecal coliform and total coliform exceeded the previous PWQGs (MOE 1984), which have been replaced by a PWQO for *Escherichia coli* (MOEE 1994), downstream of the STP.

The Proposed Undertaking will have no adverse impact on water quantity or water quality.

Table 3.2 Mattagami River Water Quality at Highway No. 101 Bridge (Riverside Dr.), Timmins

Parameter	Concentration (mg/L) unless otherwise indicated)							PWQO ³
	1987-1992 ¹	1994 ²			1995 ²			
	Mean	Mean	Min.	Max.	Mean	Min.	Max.	
Dissolved Oxygen	9.39(22) ⁴	10.1(7)	7.5	12.0	9.7(10)	8.0	11.5	See below ⁵
Alkalinity	42.2(23)	39(10)	27	43	51(10)	30	150	-
Conductivity (umhos/cm)	110(24)	89(10)	64	100	92(9)	73	106	-
Hardness	50(2)	45(10)	35	50	50(9)	37	59	-
pH (units)	7.6(24)	7.7(10)	7.5	7.8	7.7(10)	7.5	7.8	6.5-8.5
Particulate (Non-filterable) Residue	3.0(14)	<4.2(10)	<1.0	9.0	<5.8(10)	<1.0	25	-
Turbidity	2.54(18)	-	-	-	-	-	-	-
Total Reactive Ammonia	0.02(23)	<0.02(10)	<0.01	<0.04	<0.021(10)	<0.01	0.06	-
Unfiltered Reactive Nitrite	-	-	-	-	<0.004(9)	<0.002	0.011	-
Unfiltered Reactive Nitrate	-	-	-	-	0.054(9)	<0.014	0.094	-
Filtered Total Reactive Nitrates	-	0.07(10)	<0.02	0.24	0.10(10)	<0.16	0.50	-
Total Kjeldahl Nitrogen	0.488(24)	0.39(10)	0.32	0.51	0.447(10)	0.317	0.790	-
Reactive Phosphate	-	-	-	-	<0.003(9)	<0.001	0.006	-
Total Phosphorus	0.012(24)	0.012(10)	0.006	0.023	0.016(10)	0.008	0.051	0.03 ⁶
Sulphate	6.37(24)	4.8(10)	4.1	6.5	4.6(8)	3.55	6.62	-
Cyanide	<0.001(21)	-	-	-	-	-	-	-
Phenols (µg/L)	0.2(8)	-	-	-	-	-	-	5
Calcium	-	-	-	-	22(9)	11	85	-
Chloride	1.5(9)	-	-	-	-	-	-	-
Magnesium	-	-	-	-	5.7(9)	2.4	26	-
Sodium	1.60(1)	-	-	-	-	-	-	-

Table 3.2 Mattagami River Water Quality at Highway No. 101 Bridge (Riverside Dr.), Timmins (Cont'd)

Parameter	Concentration (mg/L) unless otherwise indicated)							PWQO ³
	1987-1992 ¹	1994 ²			1995 ²			
	Mean	Mean	Min.	Max.	Mean	Min.	Max.	
Aluminum (µg/L)	110(4)	-	-	-	183(10)	82	460	75 ^{6,7}
Arsenic (µg/L)	<1.0(15)	-	-	-	-	-	-	100
Cadmium (µg/L)	-	-	-	-	<0.22(10)	<0.20	<0.31	0.2
Chromium (µg/L)	-	-	-	-	<0.6(10)	<0.20	1.8	100
Cobalt (µg/L)	-	-	-	-	<0.85(10)	<0.5	4	0.6
Copper (µg/L)	2.0(19)	<1.4(10)	<0.06	<2.3	<3.3(10)	<0.95	17	5
Iron (µg/L)	200(19)	234(10)	130	430	241(10)	120	450	300
Lead (µg/L)	3(15)	<2.1(10)	<1.0	<4.0	<0.29(10)	<2.0	<10.0	10
Manganese (µg/L)	-	-	-	-	21(9)	12	32	-
Molybdenum (µg/L)	-	-	-	-	<0.6(10)	<0.2	3.4	10 ⁸
Nickel (µg/L)	1(1)	<1.2(10)	<1.0	<2.0	<5.6(10)	<1.0	46	25
Zinc (µg/L)	4(15)	<1.9(10)	<1.0	<3.0	<4.5(10)	<1.0	20	30

¹ Source: Sears (1992).

⁵ For warmwater biota: 7 mg/L at 0°C, 6 mg/L at 5°C, 5 mg/L at 10°C and 15°C, 4 mg/L at 20°C and 25°C.

² Source: S. Sunderani, MOE, 2006, pers. comm.

⁶ Interim PWQO.

³ PWQO = Provincial Water Quality Objective (MOEE, 1994).

⁷ At pH >6.5 to 9.0, the Interim PWQO is 75 mg/L based on total aluminum measured in clay-free samples.

⁴ Number in brackets is the number of samples analyzed.

Table 3.3 Mattagami River Water Quality at Timmins Waterworks Plant Intake¹

Parameter	Concentration (mg/L) unless otherwise indicated)												PWQO ²
	1974			1975			1976			1977			
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	
Fecal Coliform (no./100 mL)	98(11) ³	0	700	20(11)	0	130	7(12)	0	37	<110(12)	<40	920	100/100 ⁴
Total Coliform (no./1,000 mL)	659(11)	5	3,000	431(11)	0	3,500	387(12)	0	4,000	<534(12)	<200	4,400	1,000/100 ⁴
Dissolved Oxygen	9.5(11)	5.0	13.0	10.1(12)	7.0	14.0	9.3(12)	3.0	11.0	6.9(11)	5.0	9.0	See below
Biological Oxygen Demand (5-day)	0.9(11)	0.2	2.0	1.1(12)	0.4	2.8	1.6(12)	0.2	1.0	1.1(11)	0.4	3.0	-
Acidity	4.1(11)	2.0	10.0	3.2(11)	1.0	6.0	4.1(12)	1.0	16.0	2.3(12)	1.0	4.0	-
Alkalinity	40(11)	32	56	39(11)	28	59	41(12)	25	59	62(12)	26	258	-
Conductivity (µmhos/cm)	99(11)	78	143	110(12)	82	215	127(12)	70	335	113(12)	74	250	-
Hardness	47(11)	36	80	51(11)	37	97	50(12)	35	76	52(12)	31	121	-
pH (units)	7.3(11)	6.5	7.9	7.4(11)	7.1	7.8	7.73(12)	7.40	8.10	7.61(11)	7.15	8.26	6.5-8.5
Colour (Hazen colour unit)	30(11)	0.3	60	42(11)	15	65	39(12)	30	60	50(11)	40	70	-
Filtered Residue	66(110)	51	120	75(11)	52	140	100(5)	46	218	-	-	-	-
Particulate (Non-filterable) Residue	<12(11)	0	20	20(10)	1	128	5(11)	1	17	32(12)	1.2	152	-
Total Residue	77(11)	61	110	103(11)	56	300	95(10)	65	219	105(12)	1.2	152	-
Turbidity (FTU)	2.4(11)	1.1	6.3	3.1(12)	1.0	8.0	1.8(12)	0.9	3.0	7.1	1.4	53	-
Total Reactive Ammonia	0.02(110)	<0.01	0.09	0.04(12)	<0.01	0.21	0.020(12)	<0.002	0.092	0.026(12)	0.004	0.080	-
Filtered Reactive Nitrite	0.006(11)	0.003	0.015	0.006(12)	0.002	0.026	0.003(12)	0.001	0.006	0.003(12)	0.001	0.010	-

Table 3.3 Mattagami River Water Quality at Timmins Waterworks Plant Intake¹ (Cont'd)

Parameter	Concentration (milligrams per litre (mg/L) unless otherwise indicated)												PWQO ²
	1974			1975			1976			1977			
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	
Filtered Reactive Nitrate	0.04(11)	<0.01	0.14	0.29(12)	<0.01	1.80	0.061(12)	<0.005	0.204	0.079(12)	<0.005	0.490	-
Total Kjeldahl Nitrogen	0.42(11)	0.32	0.64	0.47(12)	0.31	0.85	0.30(12)	0.14	0.41	0.51(12)	0.24	1.30	-
Reactive Phosphate	0.004(11)	0.001	0.010	0.009(12)	0.002	0.031	0.003(12)	0.001	0.009	0.003(12)	0.001	0.010	-
Total Phosphorus	0.027(11)	0.008	0.088	0.043(12)	0.007	0.120	0.012(12)	0.004	0.018	0.018(11)	0.010	0.034	0.03 ⁶
Calcium	-	-	-	-	-	-	14(7)	11	20	17.4(5)	9.2	36.0	-
Chloride	1.2(11)	1.0	2.0	3.8(12)	1.0	24.0	1.9(12)	0.6	10.0	1.4(12)	1.0	3.8	-
Iron	0.64(11)	0.2	2.0	0.83(11)	0.15	5.7	0.21(12)	0.05	0.36	0.93(12)	0.12	7.22	0.3
Magnesium	-	-	-	-	-	-	3.2(7)	2.5	4.5	3.7(5)	2.0	7.5	-

¹ Source: S. Sunderani, MOE, 2006, pers. comm.

² PWQO = Provincial Water Quality Objective (MOEE, 1994).

³ Number in brackets is the number of samples analyzed.

⁴ Previous Provincial Water Quality Guideline (MOE, 1984).

⁵ For warmwater biota: 7 mg/L at 0°C, 6 mg/L at 5°C, 5 mg/L at 10°C and 15°C, 4 mg/L at 20°C and 25°C.

⁶ Interim PWQO.

Table 3.4 Mattagami River Water Quality, Downstream of Timmins STP¹

Parameter	Concentration (milligrams per litre (mg/L) unless otherwise indicated)												PWQO2
	1978			1979			1980			1981			
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	
Fecal Coliform (no./100 mL)	1,385(11)3	<40	12,000	-	-	-	-	-	-	-	-	-	100/1004
Total Coliform (no./1,000 mL)	8,689(11)	200	80,000	-	-	-	-	-	-	-	-	-	1,000/1004
Dissolved Oxygen	5.9(12)	3.0	11.0	7.2(10)	5.0	11.0	8.8(16)	4.0	14.1	9.8(16)	7.1	15.0	See below5
Biological Oxygen Demand (5-day)	1.0(10)	0.4	1.5	0.5(3)	0.2	1.0	0.6(14)	0.2	1.0	-	-	-	
Alkalinity	-	-	-	-	-	-	-	-	-	41(14)	35	50	-
Conductivity(umhos/cm)	106(11)	91	120	99(11)	78	124	106(16)	90	157	103(15)	86	118	-
pH (units)	-	-	-	-	-	-	7.58(14)	7.25	7.80	-	-	-	6.5-8.5
Filtered Residue	67(9)	59	78	65(11)	51	81	69(16)	59	102	-	-	-	-
Particulate (Non-filterable) Residue	5(11)	1	15	18(11)	2	104	3.5(16)	2	5	-	-	-	-
Total Residue	73(11)	63	85	83(11)	54	163	72(16)	62	106	-	-	-	-
Turbidity (FTU)	2.4(10)	1.5	3.5	3.9(11)	1.2	14	2.2(16)	1.3	3.2	1.5(16)	0.50	3.0	-
Total Reactive Ammonia	0.077(10)	0.008	0.138	0.086(11)	0.010	0.252	0.055(16)	0.022	0.102	0.051(15)	0.004	0.246	-
Filtered Reactive Nitrite	0.006(10)	0.002	0.023	0.005(11)	0.002	0.012	0.004(16)	0.002	0.008	0.012(15)	0.001	0.350	-
Filtered Reactive Nitrate	0.109(10)	0.415	0.015	0.146(11)	0.016	0.813	0.063(16)	0.003	0.462	0.122(15)	0.002	0.360	-
Filtered Total Reactive Nitrates	-	-	-	-	-	-	-	-	-	0.134(14)	0.040	0.365	-
Total Kjeldahl Nitrogen	0.52(10)	0.42	0.59	0.57(11)	0.24	1.64	0.40(16)	0.30	0.80	0.47(15)	0.30	0.72	-
Reactive Phosphate	0.014(10)	0.003	0.028	0.011(11)	0.002	0.022	0.010(16)	0.001	0.029	0.020(15)	0.001	0.005	-
Total Phosphorus	0.035(11)	0.026	0.053	0.041(11)	0.022	0.125	0.025(16)	0.009	0.068	0.039(15)	0.014	0.063	0.036
Chloride	1.65(11)	1.20	2.70	1.96(11)	1.20	3.35	1.45(16)	0.95	5.60	1.55(16)	1.15	3.30	-
Phenols (micrograms per litre (µg/L))	-	-	-	-	-	-	-	-	-	<1.1(14)	<1.0	2.0	56

Table 3.4 Mattagami River Water Quality, Downstream of Timmins STP¹ (Cont'd)

Parameter	Concentration (milligrams per litre (mg/L) unless otherwise indicated)												PWQO2
	1978			1979			1980			1981			
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	
Arsenic (µg/L)	-	-	-	-	-	-	<1(13)	<1	<1	-	-	-	100
Cadmium (µg/L)	-	-	-	-	-	-	<4(12)	<0.1	<5	-	-	-	0.2
Copper (µg/L)	-	-	-	-	-	-	<10(13)	<1	50	2(15)	<1	6	5
Lead (µg/L)	-	-	-	-	-	-	<22(13)	<1	<30	5(15)	<3	29	20
Nickel (µg/L)	-	-	-	-	-	-	<15(13)	<2	4	-	-	-	25
Zinc (µg/L)	-	-	-	-	-	-	<10(13)	1	<10	4(15)	<1	17	30

¹ Source: S. Sunderani, MOE, 2006, pers. comm.

² PWQO = Provincial Water Quality Objective (MOEE, 1994).

³ Number in brackets is the number of samples analyzed.

⁴ Previous Provincial Water Quality Guideline (MOE, 1984).

⁵ For warmwater biota: 7 mg/L at 0°C, 6 mg/L at 5°C, 5 mg/L at 10°C and 15°C, 4 mg/L at 20°C and 25°C.

⁶ Interim PWQO.

3.3.4 Sediments

Sediments in the Mattagami River within the Great Clay Belt can be expected to be predominantly silt and clay, particularly in the in-stream lakes and slower moving sections of the river. The Mattagami Lake Dam is situated within the Canadian Shield portion of the Mattagami River, and river substrate has very little silt and clay. Based on the good water quality of the Upper Mattagami River and the predominantly coarse substrates in the vicinity of the Mattagami Lake Dam, the substrates can be expected to have low concentrations of contaminants.

3.3.5 Aquatic Vegetation

Three aquatic plant species considered to be significant by the MNR were listed in the Mattagami River Watershed Management Plan (Table 3.5). None of these species are considered to be endangered, threatened or of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2006) or the Committee on the Status of Species at Risk in Ontario (COSSARO) (MNR 2006). Examination of the MNR Natural Heritage Information Centre (NHIC 2006) database indicated that there were no records of these three species within a 5 kilometre radius of the site of the Proposed Undertaking. Similarly, based on the *Species at Risk Act* (SARA) Schedule 1 Species at Risk Web Mapping Application (Environment Canada CWS 2004) database, no aquatic vegetation species at risk have documented occurrences overlapping the local study area of the Proposed Undertaking.

Table 3.5 Significant Aquatic Plant Species Recorded in the Mattagami River Watershed¹

Common Name	Scientific Name	Habitat Requirements	Provincial Rank ²
Yellow dryas	<i>Dryas drummondii</i>	Calcareous cliffs, talus and river-gravels	S1
Roundleaf monkey-flower	<i>Mimulus glabratus</i>	Swamps, shores and shallow water along streams adjacent to open, meadow-like areas	S1
Creeping rush	<i>Juncus subtilis</i>	Margins and shores of ponds and streams	S3

¹ Source: OPG *et al.* (2006).

² NHIC (2006): S1 = extremely rare in Ontario, usually five or fewer occurrences in the province or very few remaining individuals and often especially vulnerable to extirpation; S3 = rare to uncommon in Ontario, usually between 20 and 100 occurrences, but with a large number of individuals in some populations and may be susceptible to large-scale disturbances.

3.3.6 Plankton

There are two algal communities in most lotic (fast river) 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). The epilithic type consists of benthic algae attached to rocks. The epiphytic type is attached larger filamentous algae, bryophytes (mosses) and aquatic macrophytes. The epipelagic type 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). Zooplankton species recorded in the Mattagami River are presented in Table 3.6.

Table 3.4 Zooplankton Species Recorded in the Mattagami River¹

Taxon
Cl. Cladorera
F. Bosminidae
<i>Bosmina longirostris</i>
<i>Eubosmina tubicens</i>
F. Chydoridae
<i>Eurycercus lamellatus</i>
F. Daphnidae
<i>Ceriodaphnia reticulata</i>
<i>Daphnia</i>
<i>D. pulex</i>
<i>D. rosea</i>
<i>Simocephalus serrulatus</i>
<i>S. vetulus</i>
F. Leptodoridae
<i>Leptodora kindti</i>
F. Polyphemidae
<i>Polyphemus pediculus</i>
F. Sididae
<i>Latona setifera</i>
<i>Sida crystallina</i>
Cl. Copepoda
F. Cyclopidae
<i>Diacyclops nanus</i>
<i>Eucyclops serrulatus</i>
<i>Macrocyclus fuscus</i>

¹ Fiset (1995).

3.3.7 Fisheries Resources

Seyler (1997) listed the species that occur in the Mattagami River (Table 3.7). Seyler (1997) indicated that longnose sucker, lake sturgeon, shorthead redhorse, and goldeye do not occur in the vicinity of the Mattagami Lake Dam. Of the species listed in Table 3.7, only lake sturgeon, greater redhorse and goldeye are tracked by the Natural Heritage Information Centre (March 31, 2009). All three are provincially ranked S3 and considered rare to uncommon in Ontario (http://nhic.mnr.gov.on.ca/nhic_.cfm). However, the record of a greater redhorse in the Mattagami River system is probably incorrect; it is most likely the result of misidentification of shorthead redhorse. Fishes in the genus *Moxostoma* are notoriously difficult to identify, even for an expert, and confirmed specimens of the greater redhorse are only known from the Ottawa and St. Lawrence River systems, as well as Lakes Ontario, Erie, and Huron (http://nhic.mnr.gov.on.ca/nhic_.cfm). Except for lake sturgeon which is listed as “Special Concern”, none of the fish that occur in the Mattagami River (Table 3.7) are presently considered at-risk federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (http://nhic.mnr.gov.on.ca/nhic_.cfm). Lake sturgeon is also the only fish included in the Species at Risk in Ontario (SARO) list, where it is considered “Special Concern”. Species listed as “Special Concern”, either in the COSEWIC or SARO lists, do not presently have legal protection under the federal *Species at Risk Act* (SARA) or the provincial *Endangered Species Act* (ESA 2007), respectively.

Table 3.5 Fish Species of the Mattagami River

Common name	Scientific name	Mattagami River ¹	Mattagami Lake ²	Kenogamissi Lake ²	Comments	Conservation rank (Ontario)
lake sturgeon	<i>Acipenser fulvescens</i>	✓			lower reaches only	S3 – rare to uncommon
brook trout	<i>Salvelinus fontinalis</i>	✓			certain tributaries	
lake whitefish	<i>Coregonus clupeaformis</i>	✓	✓	✓		
cisco	<i>Coregonus artedii</i>	✓	✓	✓		
northern pike	<i>Esox lucius</i>	✓	✓	✓		
goldeye	<i>Hiodon alosoides</i>	✓			lower reaches only	S3 – rare to uncommon
longnose sucker	<i>Catostomus catostomus</i>	✓				
common white sucker	<i>Catostomus commersonii</i>	✓	✓	✓		
greater redhorse	<i>Moxostoma valenciennesi</i>		✓		Probably <i>M. macrolepidotum</i>	
redhorse	<i>Moxostoma</i> sp.	✓			Probably <i>M. macrolepidotum</i>	
lake chub	<i>Couesius plumbeus</i>	✓				
golden shiner	<i>Notemigonus crysoleucas</i>	✓				
emerald shiner	<i>Notropis atherinoides</i>	✓				
common shiner	<i>Luxilus cornutus</i>	✓				
blacknose shiner	<i>Notropis heterolepis</i>	✓				
spottail shiner	<i>Notropis hudsonius</i>	✓	✓	✓		
fathead minnow	<i>Pimephales promelas</i>	✓				
bluntnose minnow	<i>Pimephales notatus</i>			✓		
longnose dace	<i>Rhinichthys cataractae</i>	✓				
fallfish	<i>Semotilus corporalis</i>	✓			lower reaches only	
pearl dace	<i>Margariscus margarita</i>	✓				
northern redbelly dace	<i>Phoxinus eos</i>		✓			
burbot	<i>Lota lota</i>	✓	✓	✓		
brook stickleback	<i>Culaea inconstans</i>	✓				
ninespine stickleback	<i>Pungitius pungitius</i>	✓				
stickleback	Gasterosteidae			✓		
trout-perch	<i>Percopsis omiscomaycus</i>	✓		✓		
smallmouth bass	<i>Micropterus dolomieu</i>	✓	✓	✓	upper reaches only	
yellow perch	<i>Perca flavescens</i>	✓	✓	✓		
walleye	<i>Sander vitreus</i>	✓	✓	✓		
johnny darter	<i>Etheostoma nigrum</i>	✓				
logperch	<i>Percina caprodes</i>	✓	✓	✓		
mottled sculpin	<i>Cottus bairdii</i>	✓				
sculpin	<i>Cottus</i> sp.		✓	✓		

¹Riverine fish species of the Mattagami River (modified from Table 1 In Seyler, 1997).²OPG et al, 2006.

3.4 LOCAL STUDY AREA

3.4.1 Existing Aquatic Habitat

The results of the habitat surveys conducted on June 21 and December 11, 2006, are illustrated in Figure 3-6, and the results of the habitat survey conducted on September 8 – 11, 2008, are illustrated in Figure 3-7. In the vicinity of the dam, Mattagami Lake slopes down quickly from the shoreline to a depth of approximately 8 metres. Mattagami Lake water levels are controlled by the Mattagami Lake Dam, in accordance with the Mattagami River System Water Management Plan (OPG *et al* 2006), resulting in a drawdown of lake levels over the winter to provide spring flood protection for Timmins (Appendix A: Compare Photographs 1 and 2; Figure 3-8). Photograph 2 (Appendix A; Figure 3-8) shows the mainly sand substrate of this portion of Mattagami Lake. Immediately upstream of the dam are the remains of an old rock-filled crib structure that extends a short distance from each shore (Appendix A: Photograph 3), and there is an area of rock rubble along the shore at both ends of the dam (Appendix A: Photograph 4). While the remains of the crib structure provides some habitat structure in an area dominated by sand substrates, it is unlikely that it provides critical habitat for any fish species residing in Mattagami Lake, due to its configuration, its location within the lake, and the fact that it is exposed to air during the late winter drawdown of Mattagami Lake. Other lake habitats dominated by sand in the vicinity of the control dam, are also unlikely to provide critical habitat for any fish species residing in Mattagami Lake, due to the common nature of the habitat, the fine sand substrate, and the late winter drawdown of the lake.

Between the Mattagami Lake Dam and the road bridge (Figure 3-9: Area A), the Mattagami River is a steep series of rock chutes and rapids, with primarily bedrock substrate (Figures 3-6 and 3-7; Appendix A: Photographs 5, 6 and 7). The bedrock substrate and swift flows limit productivity in this area. Though some fish reside in the deep bedrock pool located half way between the dam and the bridge (Figures 3-9 and 3-7; Appendix A: Photograph 6), it is unlikely that fish can move upstream of the pool, nor is it likely that significant fish reproduction occurs within Area A.

Downstream of the bridge, for a distance of approximately 550 metres to Kenogamissi Lake, the Mattagami River is a series of rapids with interspersed reaches of slower, deeper water (Figure 3-9). After passing beneath the bridge (Appendix A: Photograph 7) the river widens and deepens somewhat providing an area of slower water before turning to the east (Figures 3-6 and 3-8: Area B; Appendix A: Photograph 8). This wide area (Appendix A: Photograph 8) has a variety of depths (Figure 3-6), substrates (Figure 3-7), and flow velocities and, based on our observations, is the upstream limit of the walleye and lake whitefish spawning runs. Whitefish during their spawning run were abundant in this pool on November 9 and 10, 2007, and a small number of whitefish eggs were found at the downstream edge of this pool during an intensive search for eggs on December 11, 2006.

Figure 3.6 Bathymetry and Topography in the Vicinity MLD. The Water Edge on June 21 and on May 2 (Walleye Spawning) was estimated from Photographs, while the Water Edge on December 11 was Determined by Total Station

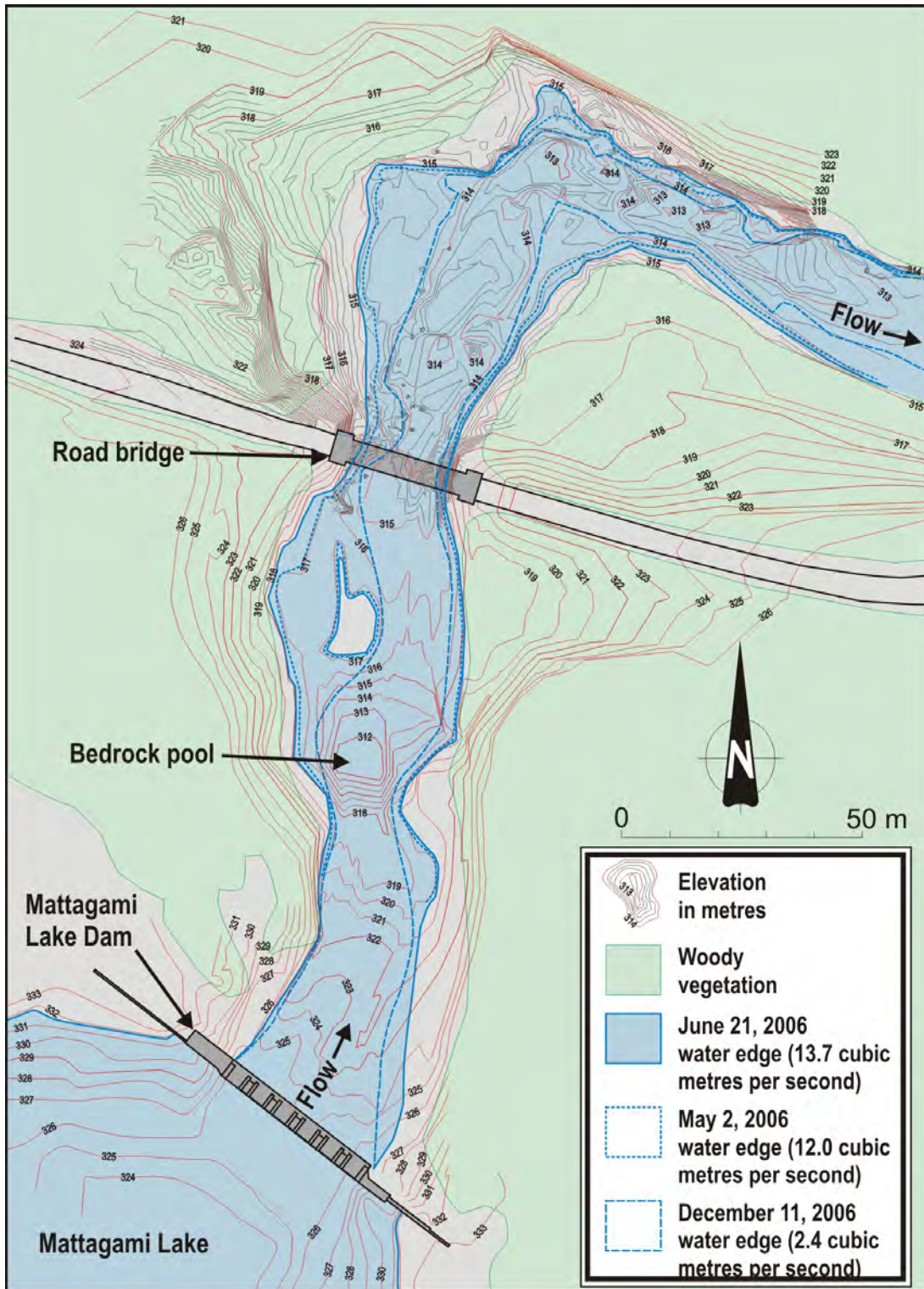


Figure 3.7 Substrate Type in the Vicinity of the Proposed Undertaking, downstream to Kenogamissi Lake. The Water Edge at four measured Riverflows was determined by Total Station (Global Surveying)

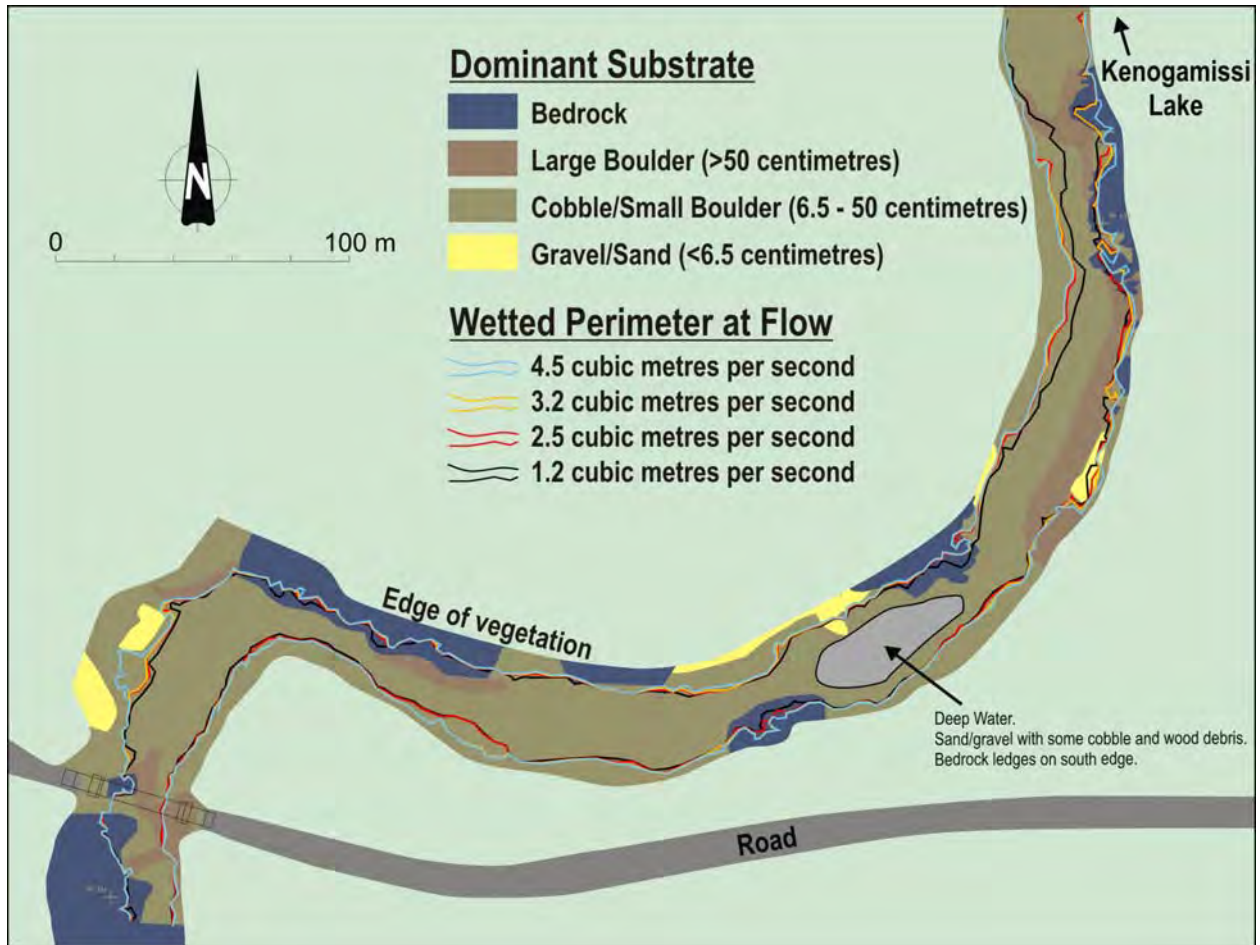


Figure 3.8 Photograph Locations and Watercourse Sections Referenced in this Report

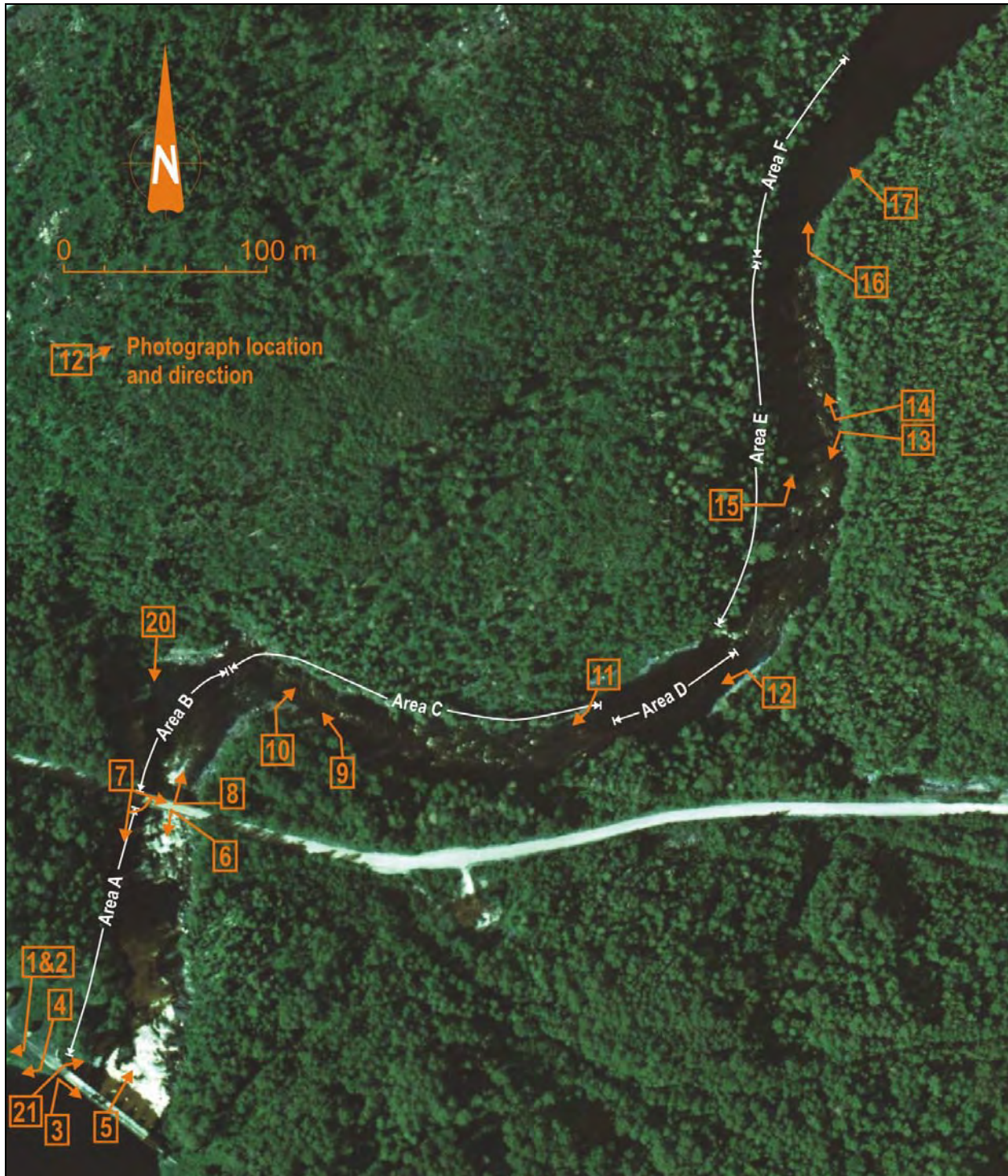


Figure 3.9 Project Study Area from Mattagami Lake to Kenogamissi Lake, Showing the Main Site Features, the Location and Basic Layout of the Proposed Undertaking, Watercourse Sections Referenced in this Report, and the Location of Photographs of the Small Watercourse Flowing from the West



The high bedrock slope along the north side of the river within the upstream end of Area C (Figures 3-9 and 3-7) directs the river to the east. Through the upstream two thirds of Area C the substrate is mostly bedrock in the north half, and mostly boulder and cobble in the south half of the channel (Figures 3-9 and 3-7; Appendix A: Photographs 9 and 10). The boulders and cobble through Area C provide good walleye spawning habitat. In the downstream one third of Area C the bedrock recedes to the north bank of the river, leaving cobble and boulder through most of the channel (Appendix A: Photograph 11).

Area D (Figures 3-9 and 3-8) is a deep pool with slower flow velocity (Appendix A: Photograph 12), that has mostly cobble and boulder substrate with some bedrock along the south side of the river, cobble and gravel along the north side, and sand, gravel and cobble with some bedrock ledges within the deep portion of the pool (Figures 3-7 and 3-9). The maximum depth of this pool is approximately 4 metres. Whitefish during their spawning run were abundant in this pool on November 10, 2007, and some were also observed here on September 29, 2009, during their spawning run. Whitefish eggs were found to be most abundant at the downstream edge of this pool, of the locations examined during an intensive search for eggs on December 11, 2006.

Area E (Figures 3-9 and 3-8) consists of long rapids that have a high proportion of bedrock and boulders in the east half of the channel, and mainly cobble substrate with a few small boulders on the west side of the channel (Figure 3-7); Appendix A: Photographs 13 and 14). Flow velocity also appears to be somewhat greater in the east side of the Area E channel than in riffle areas along the west side of Area E or in the riffles of Areas C and D. Bedrock and boulders are not suitable substrates for walleye spawning, and combined with the higher water velocities, it is not surprising that walleye are not generally observed spawning in the eastern side of the Area E channel (Figures 3-10, 3-11, 3-12, 3-13). However, many spawning walleye are usually observed on the west side of the channel in Area E (Figures 3-10, 3-11, 3-12, 3-13), where the slower flow velocities, shallow water, and cobble substrates (Appendix A: Photograph 15) provide good spawning habitat.

In Area F (Figure 3-9), at the transition between lotic and lentic habitats, flow velocity slows and substrates within the east side of the channel appear to be mainly cobble with coarse gravel and a few boulders (Appendix A: Photographs 16 and 17). Combined with the approximately 1 metre water depth in Area F, this location provides good walleye spawning habitat.

A small watercourse drains from the west into Area B, approximately 30 metres to the north of the proposed powerhouse location (Figure 3-9). The watercourse is approximately 0.3 - 0.5 metres wide with predominantly sand substrate (Appendix A: Photograph 18 - refer to Figure 3-9 for location), and is often incised (Appendix A: Photograph 19 - refer to Figure 3-9 for location). A small culvert conveys it beneath the forest access road in the vicinity of the OPG access lane for the Mattagami Lake Dam, which has a drop of 0.2 metre at the downstream end, effectively blocking any upstream movement of fish beyond this point (Figure 3-9). Approximately 200 metres of this watercourse, downstream of the culvert, was electrofished on August 28, 2007, but no fish were captured. However, it is possible that some small fishes may occasionally or seasonally utilize the lower reaches of this watercourse.

3.4.2 Fish Community

The section of the Mattagami River downstream of the Mattagami Lake Dam is known as an important walleye and lake whitefish spawning area for populations of those fishes in Kenogamissi Lake and more fully discussed in sections 3.4.3 and 3.4.4. To the best of MNR's knowledge, the flowing water between the Mattagami Lake Dam and Kenogamissi Lake is the only available spawning habitat for the walleye population of Kenogamissi Lake (J. Mucha, Biologist, MNR, Timmins. Personal communication, May 2, 2006). The MNR has monitored walleye spawning at this site and MNR and OPG collaborate to maximize walleye spawning success. MNR alerts OPG to the beginning of the walleye spawning period. The minimum flow implemented for walleye spawning at MLD might vary between 12-15 cms from year to year, depending on the observed and anticipated flow conditions each year, as per the current MRSWMP (2006). A recreational dipnet fishery is permitted for lake whitefish during that species' spawning run in the fall.

Electrofishing on June 21, 2006, downstream of the bridge in Area B and in the upstream end of Area C (Figure 3-9) for a total of 742 electroseconds (duration that the electrofishing unit was emitting an electrical charge to the water), captured 2 longnose dace, 1 yellow perch, 1 burbot, and 1 logperch. This same area was electrofished again on August 28, 2007, for a total of 1,295 seconds, capturing 12 yellow perch, 4 smallmouth bass, 40 logperch, 12 longnose dace, 2 mottled sculpin, 1 mimic shiner (*Notropis volucellus*), and 1 lake chub. Also on August 28, 2007, the small watercourse draining from the west into Area B was electrofished (Figure 3-9), but no fish were captured. During an intensive search for lake whitefish eggs on December 11, 2006, many burbot, longnose dace, and logperch, as well as 1 yellow perch, were observed in the shallow water.

3.4.3 Walleye Spawning

Background

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 metres deep (Smith, 1985), and in velocities from 0.3-1.0 metres per second (McMahon *et al*, 1984). 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).

Observations

On May 2, 2006, the water temperature downstream of the Mattagami Lake Dam was 9.9°C in the early afternoon. By May 3 at 3:40 pm, the water temperature had risen to 12.3°C. On the evening of May 2, after nightfall, approximately 100 spawning walleye were observed at various locations within Areas B and C (Figure 3-10).

The water temperature downstream of the Mattagami Lake Dam was 7.7°C at 6:00 pm on May 2, 2007. Later that evening, after nightfall, approximately 328 walleye were observed in a

number of locations throughout Areas B, C, D, E and F, wherever habitat was suitable for spawning (Figure 3-10).

River flow was higher than usual during the spring melt of 2008, with values of approximately 150 cubic metres per second at the start of the walleye spawning period. MNR determined that OPG should consider the spawning run to be underway on May 8, 2008. Consequently, OPG reduced the flow from the Mattagami Lake Dam to approximately 15 cubic metres per second on the morning of May 8. On May 8, 2008, the water temperature downstream of the Mattagami Lake Dam was 8.2°C in the early evening. By the evening of May 9, 2008, the water temperature had risen to 8.5°C. No walleye were observed in Areas B and C on May 8, 2008, but six walleye were observed widely scattered throughout these two areas on May 9 (Figure 3-11). One walleye was observed in Area D on May 9, 2008. Though Area E provides an extensive area of walleye spawning habitat along the west side of the river where about 150 walleye were observed in 2007, in 2008 only twenty walleye were observed here on May 8, and again on May 9 (Figure 3-11). Area F is where the river habitat transitions to lake habitat, and provides a relatively large area of walleye spawning habitat. Twenty-seven walleye were observed in Area F on May 8, and twelve were observed here on May 9, 2008 (Figure 3-11), which contrasts with the 84 walleye observed here in 2007. It is speculated that the cooler than average spring in 2008 may have delayed the walleye spawning by a few days. This, combined with the higher than usual river flow leading up to the start of walleye spawning, may have resulted in less favourable spawning habitat conditions in the river. It is likely that in 2008 much of the walleye spawning occurred within Area F or slightly downstream in Kenogamissi Lake.

In 2009 the water temperature downstream of the Mattagami Lake Dam was 7.3°C in the early evening on May 11, and approximately 290 walleye on their spawning run were observed after nightfall in Areas B, C, D, E and F (Figure 3-12). By the evening of May 12, 2009, the water temperature had risen to 8.9°C, and after nightfall that evening approximately 239 walleye were observed (Figure 3-12).

In 2010 the water temperature downstream of the Mattagami Lake Dam was 7.3°C in the early evening on April 19, and approximately 135 walleye on their spawning run were observed after nightfall (Figure 3-13). On the evening of April 20, 2010, the water temperature was still 7.3°C, and after nightfall that evening approximately 162 walleye were observed (Figure 3-13). Riverflow was low in 2010, due to an exceptionally dry and warm spring, necessitating MNR and OPG agreeing to discharge only 5-6 cubic metres per second during the walleye spawning and incubation period (Louis Verville, OPG. Personal Communication, June 25, 2010), rather than the minimum of 12 – 15 cubic metres per second specified in the Mattagami River Water Management Plan (OPG *et al.*, 2006).

At the time of the 2006, 2007, 2008 and 2009 spawning observations, the flow released from the Mattagami Lake Control Dam was approximately 12-15 cubic metres per second, based on OPG records. The observed pattern of spawning locations within this portion of the Mattagami River is a function of the river morphology and its effect upon depth, water velocity, and substrate type. In this portion of the Mattagami River, the streambed at the outside of the bends

(where water velocities are higher) is composed mainly of bedrock and larger boulders, and the streambed at the inside of the bends (where water velocities are lower) is composed mainly of cobble material. This is illustrated in Photographs 9, 10, 13 and 15 (Appendix A). During the walleye spawning period in spring, river flow is such that the water velocity is too high for walleye spawning along the outside of the bends, but is suitable for spawning along the inside of the bends. This pattern of velocity and substrate results in the best spawning habitats being located in the inside of the bends, as illustrated by the observations of spawning fish (Figures 3-10, 3-11, 3-12 and 3-13). Exceptions to this general location pattern were observed at the downstream end of the two pools (Areas B and D) where the deeper water in the pools slowed velocity enough to provide some localized spawning habitat on the outside of the bend. The numbers of spawning walleye, as well as the pattern of spawning locations, were not appreciably different in 2010, despite the lower than usual flow of 5 cubic metres per second released from the Mattagami Lake Control Dam (compare Figure 3-13 with Figures 3-10 and 3-12). The primary impact of lower flows in 2010 upon the walleye spawning run, was to the broad and shallow spawning habitat along the west side of Area E, where a reduction in the available spawning area is reflected in the lower numbers of spawning fish observed. The lower than usual flows in 2010 appeared to have little impact upon other walleye spawning locations within the study area.

Most of Area A (Figure 3-10), between the dam and the road bridge is very steep and, thus, is inaccessible to walleye, and the bedrock substrate there does not provide spawning habitat (Figure 3-7; Appendix A: Photographs 5 and 6). No walleye have ever been observed in the portion of Area A, immediately upstream from the road bridge, where walleye access may be possible and substrate is not entirely bedrock (Figure 3-7; Appendix A: Photograph 7), during the spawning observations conducted in 2006, 2007, 2008, 2009 and 2010.

Figure 3.10 River Reaches Examined and Number of Walleye Observed During the 2006 and 2007 Walleye Spawning Investigations. The Numbers Represent the Number of Walleye Observed in the Adjacent Area Outlined in Yellow, and Pertain to 2007 Unless Otherwise Indicated

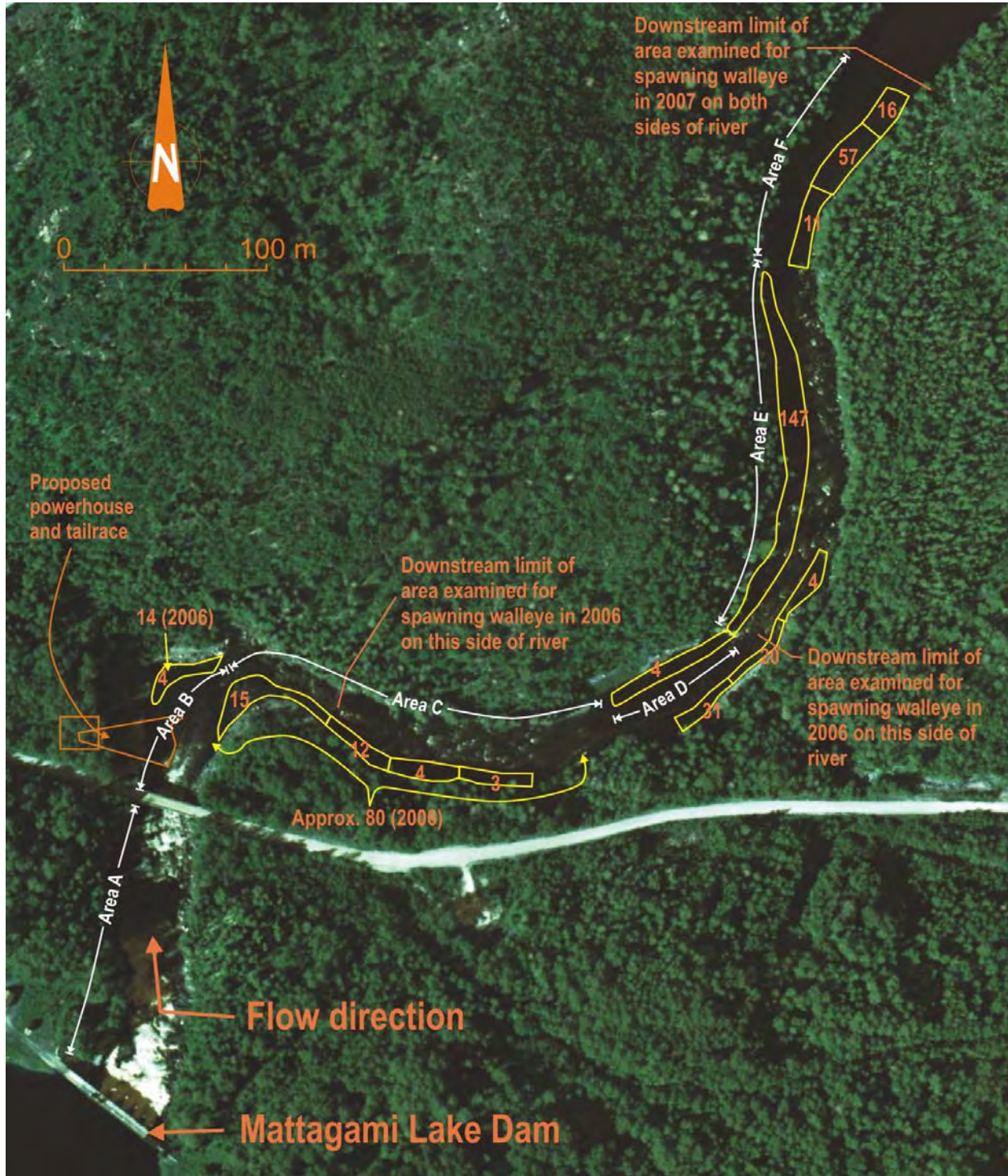


Figure 3.11 River Reaches Examined and Number of Walleye Observed During the 2008 Walleye Spawning Investigations. The number of walleye observed on May 8/9, 2008, are indicated for those areas where fish were found

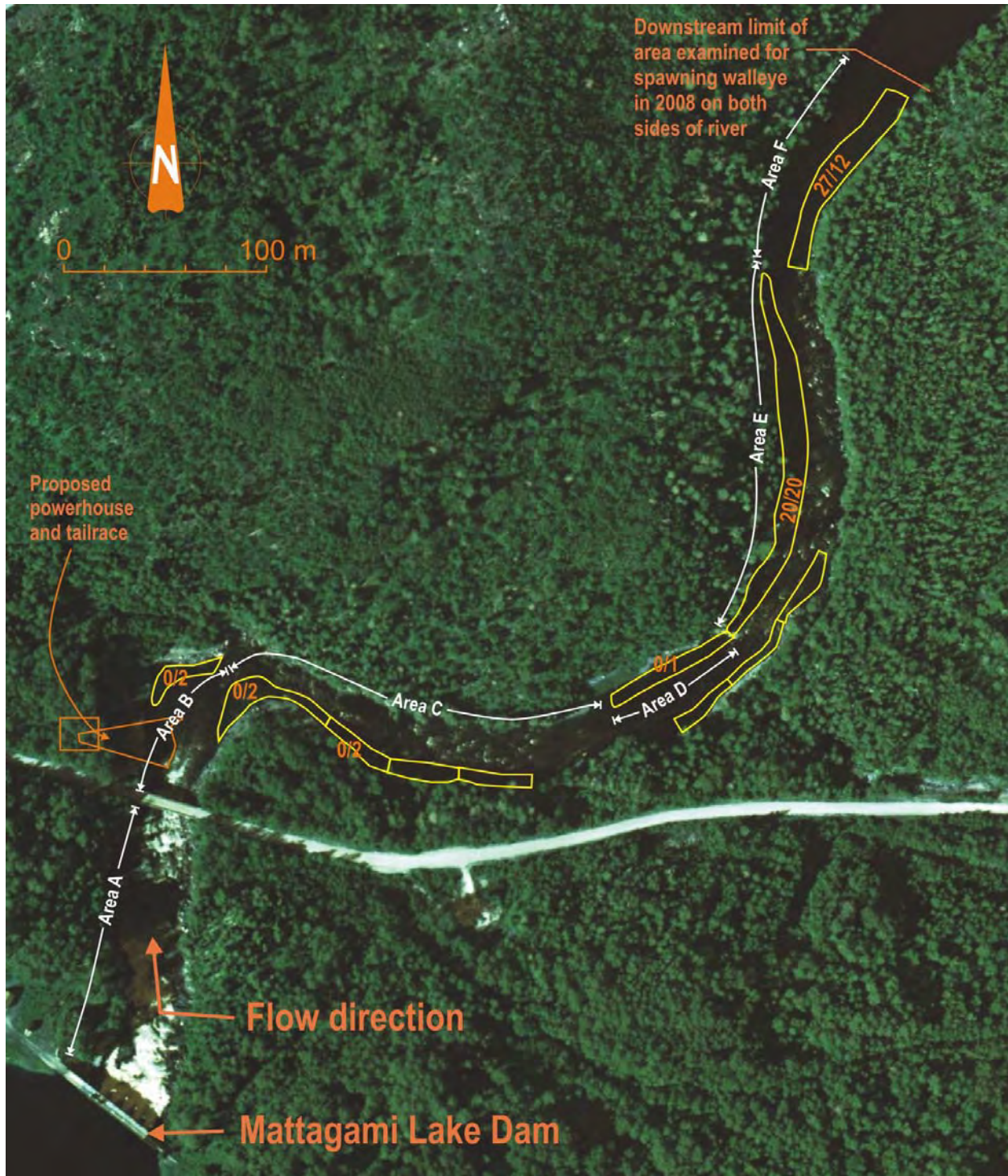


Figure 3.12 River Reaches Examined and Number of Walleye Observed During the 2009 Walleye Spawning Investigations. The number of walleye observed on May 11/12, 2009, are indicated for those areas where fish were found.

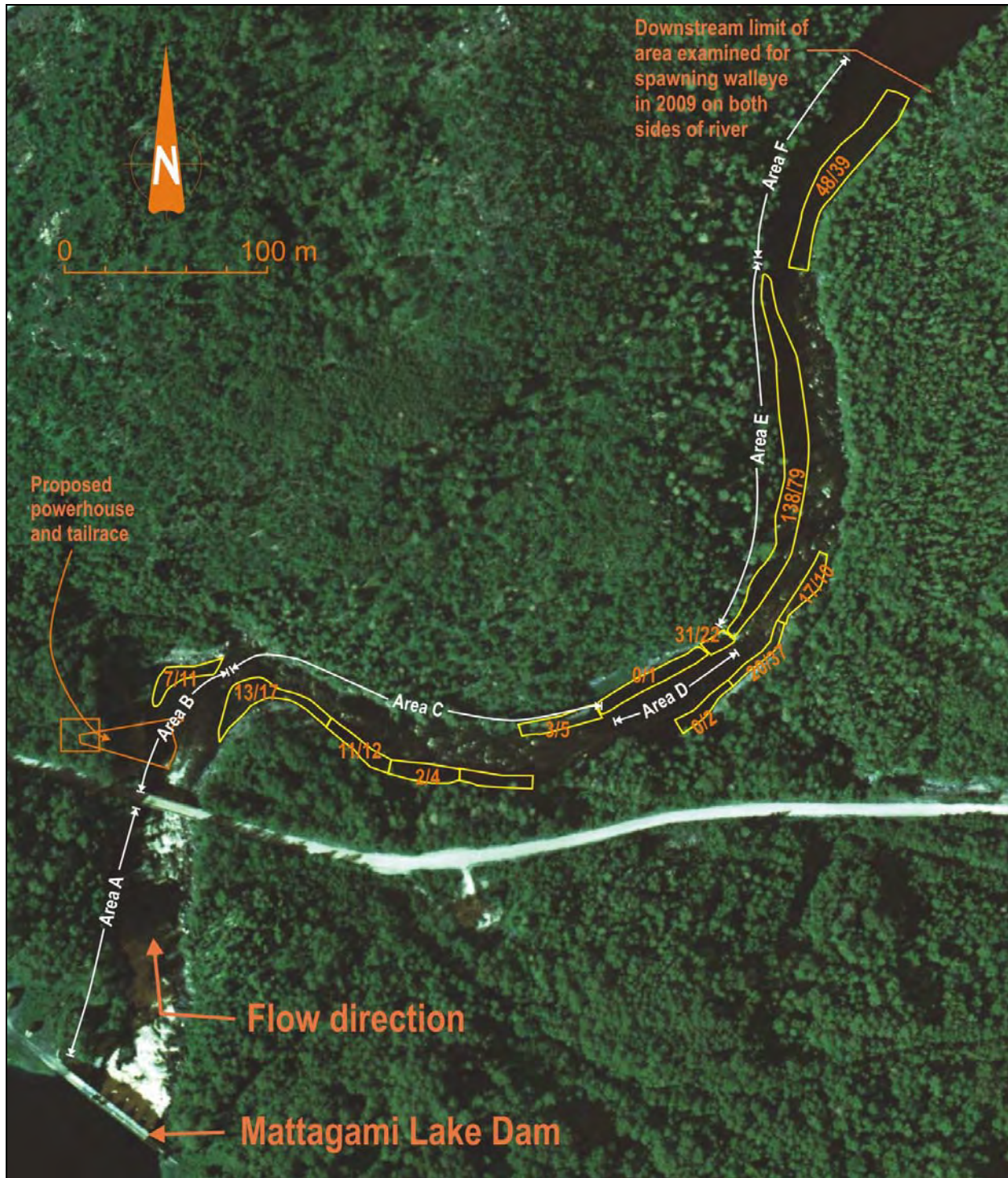


Figure 3.13 River Reaches Examined and Number of Walleye Observed During the 2010 Walleye Spawning Investigations. The number of walleye observed on April 19/20, 2010, are indicated for those areas where fish were found.



3.4.4 Lake Whitefish Spawning

Background

Lake whitefish in Canada typically spawn from late September to December, at temperatures less than 7.8°C (Scott and Crossman, 1973). Scott and Crossman (1973) and Coad *et al* (1995) report that spawning usually occurs in water less than 7.8 metres deep, while Becker (1983) gives a range from 2 to 18 metres. Substrate type varies widely, and some populations spawn in rivers, while others spawn in lakes (Becker, 1983; Coad *et al*, 1995; Scott and Crossman, 1973). Becker (1983) and Coad *et al* (1995) state that female whitefish rise to the surface while emitting spawn, accompanied by one or two males discharging milt. The broadcast eggs settle to the bottom and receive no parental care (Becker, 1983; Coad *et al*, 1995). The eggs are 2.95 ± 0.01 millimetres in diameter, and hatch during the early spring (Becker, 1983).

On October 18, 2006, two dipnetters were fishing downstream of the road bridge on the west side of the river (Appendix A: Photograph 20). On this day they had not captured any fish, but they had captured a couple of fish a few days earlier. A discussion with the dipnetters revealed that they have fished this location every year for approximately the past twenty years. They stated that fishing begins around the middle of October and continues, sometimes, into December. They, as well as others, fish in two locations where the water is slower and deeper than most places downstream of the bridge (Figure 3-8: Area B and Area D; Appendix A: Photographs 8 and 12). They did not think that whitefish migrate farther upstream than the bridge. Of the two fishing locations, the farther downstream location is best, but it is more difficult to access, which is why they usually stay near the bridge. Subsequent telephone conversations with one of the dipnetters on November 1, 14 and 19, 2006, revealed that they only captured a few fish over the entire fishing period in 2006, and that they only captured a few fish in 2005 also. Previous years had higher catches, with daily catches of up to 75 fish possible during some years.

On November 9, 2007, two dipnetters, different than those observed in 2006, were fishing at the lower whitefish spawning pool (Figure 3-14: Area D). They had only captured one fish thus far that day, but stated that 2007 had been a very good year for fishing and the fishers were capturing 15 - 25 fish per person per visit. While we were on-site, the fishers moved to the upper whitefish spawning pool (Figure 3-14: Area B) and captured six whitefish within about 15 minutes. They stated that the lower pool (Area D) was generally a better place to catch fish than the upper pool (Area B), but it could vary from day to day. The six fish captured appeared to be at the end of their spawning run, and the fishers remarked that likely only a few days of worthwhile fishing remained.

The fishers were contacted after the close of the 2008 lake whitefish season, and they reported that fishing had been very poor from the start of spawning in late October to almost the end of November. Near the end of November the weather became unseasonably warm, and then fishing suddenly improved for a few days before ending for the year at the end of November. They also noticed an unusually low number of eggs in the fish.

In 2009, the group of local fishers that have been contacted every year since 2006 could not be contacted. However, contact was made with another fisher on November 2, 2009, first contacted in 2008, who assists his father who holds the commercial whitefish netting licence on Kenogamissi Lake. He stated that he caught very few fish in his father's gill nets that are set in Kenogamissi Lake near the mouth of the Mattagami River. He also stated that the dipnet fishers that operate in the two pools of the Mattagami River, downstream of the road bridge (Figure 3-15), had caught very few fish in total. C. Portt and Associates staff (G. Coker, J. Reid) also examined the area around these two pools on October 29, 2009, and found no evidence of fish cleaning, though there were four recent wooden tripod structures that are part of the dipnetting equipment.

Figure 3.14 Lake Whitefish Spawning Locations Between the Mattagami Lake Dam and Kenogamissi Lake. The Areas Examined for Whitefish Eggs in 2006, and the Sections of River Examined for Spawning Whitefish with an Underwater Video in 2007 and 2008, are shown

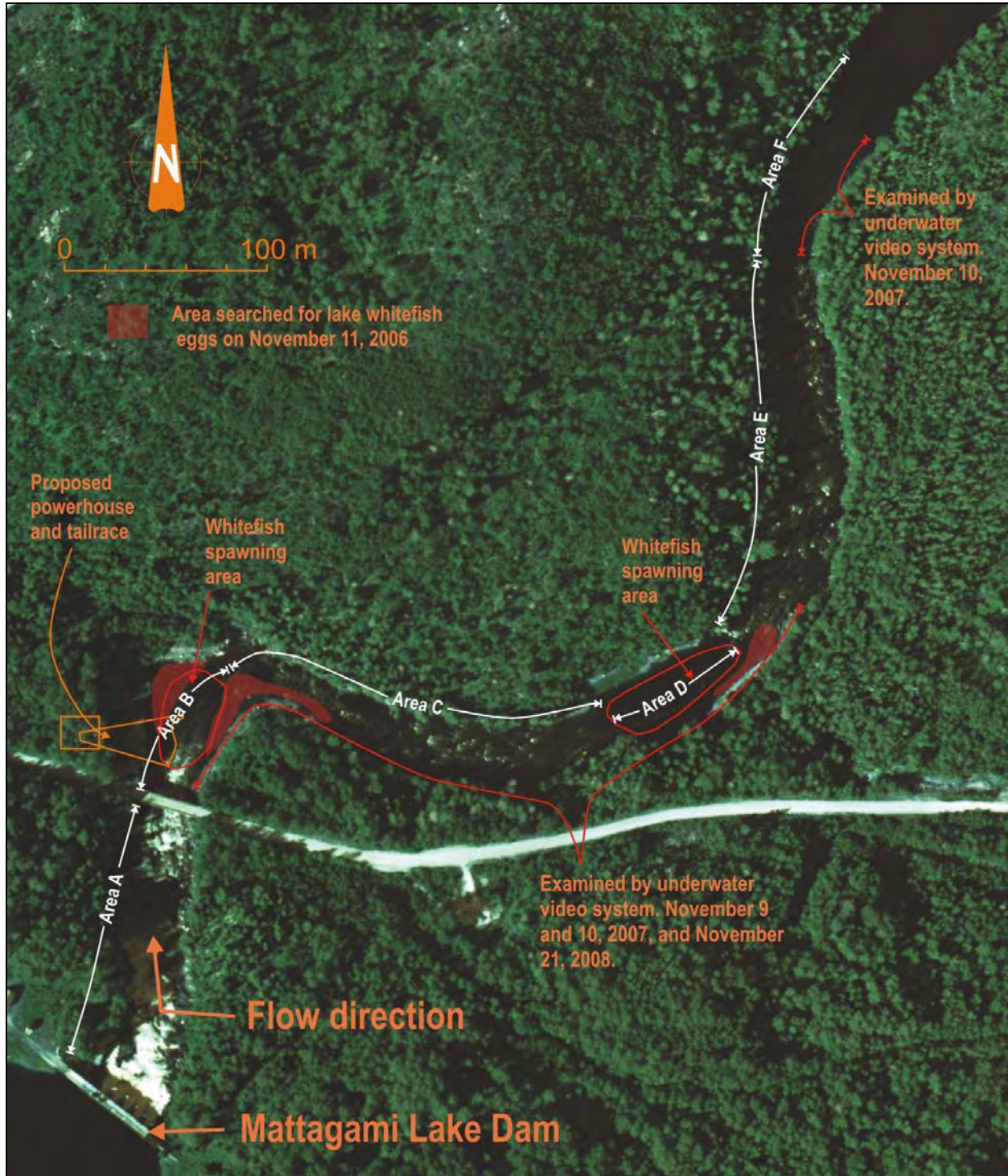
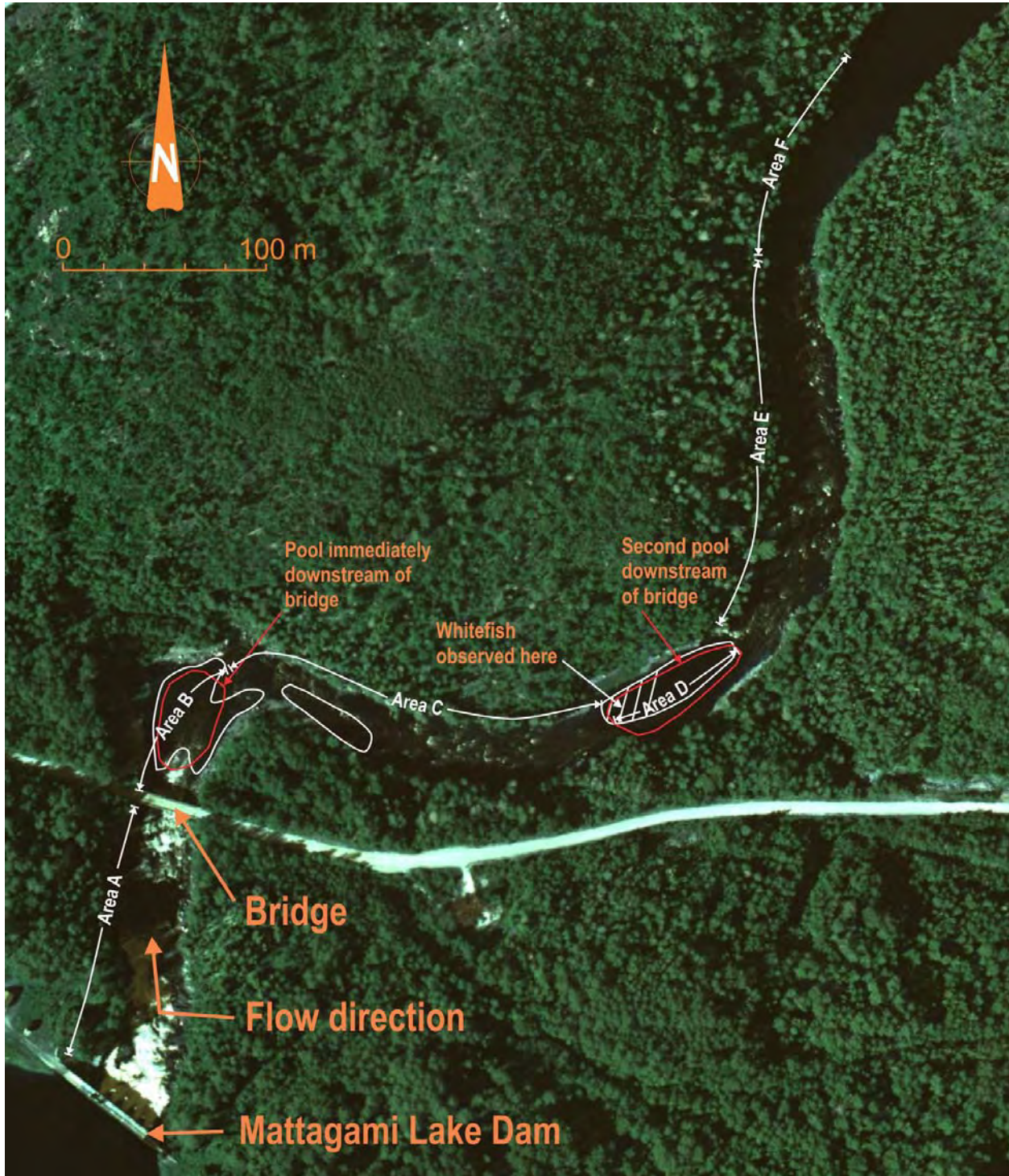


Figure 3.15 Lake Whitefish Spawning Locations Between the Mattagami Lake Dam and Kenogamissi Lake. The Areas Examined for Spawning Whitefish with an Underwater Video in 2009 are delineated in white, and the area where lake whitefish were observed is denoted by white hatching



Observations

Observations were made in 2006 for spawning whitefish throughout Areas B, C and D, as well as a short distance upstream of the bridge into Area A, on October 17 (day only), October 18 (day and night), November 20 (4:00 - 5:55 pm), and December 11 (day only). On October 17 and 18, 2006, the water temperature downstream of the Mattagami Lake Dam was 8.3°C, and on November 20, 2006, it was 2.0°C. The December 11 observations occurred during a short-term (approximately 4 hours) flow reduction, so instream visibility was excellent. No whitefish were observed on any of these occasions.

Fish eggs, presumed to be whitefish eggs based on size, colour, and the fact that whitefish are the only known fall spawner present, were collected during the planned flow reduction on December 11, 2006. Along the west side of Area B (Figure 3-14), 1 live (clear) egg was collected in 30 collection attempts. Along the east side and the downstream edge of Area B, 1 dead (opaque) egg was collected in 13 collection attempts. Along the downstream edge of Area D, 4 live eggs and 1 dead egg were collected in 6 collection attempts. All eggs collected in Area D were collected in the 2 deepest and farthest offshore collection attempts, and where subsequent removal of rocks revealed additional eggs that could be observed.

Whitefish spawning observations in 2007 were conducted in Areas B, C, D, the upstream end of Area E, and in Area F, on November 9 and 10, using an underwater video camera attached to a buoy (Figure 3-14). Whitefish were only observed in the deep water of the two pools or in the shallow faster flowing water at the downstream end of the pools (Figure 3-14: Areas B and D). The same locations, except for Area F, were examined on November 21, 2008, when the water temperature was 2.7°C, but no fish were observed.

Whitefish spawning observations in 2009 were conducted in Areas B, C, D, the upstream end of Area E on October 29, also using an underwater video camera attached to a buoy, however, the more turbulent and shallow rapids were not examined out of concern that the video camera would not survive (Figure 3-15). Whitefish were only observed in deep water within the upstream end of the pool in Area D (Figure 3-15).

3.4.5 Summary of Existing Conditions

The fish community in the vicinity of the Proposed Undertaking reflects the relatively simple community structure that is typical of many of the rivers in the Hudson Bay drainage, as well as the mainly shallow riffle habitat, with occasional deeper areas, that is present in this section of Mattagami River. The small fishes captured here are typical for this location and habitat. Logperch and longnose dace are common species inhabiting riffle habitat in riverine situations. Yellow perch are more common in Kenogamissi Lake, but some likely inhabit the slower flowing habitats that occur in Areas B and D. Though usually found in the deeper waters of lakes and larger rivers as adults in summer, young burbot are often found along rocky shores (Scott and Crossman, 1973), and, when present, are often electrofished from the interstitial spaces of cobble or rip-rap in rivers or larger streams (G. Coker, personal observation). Walleye and lake

whitefish are also part of the fish community during their respective spawning runs, and during the incubation and hatching period as embryos and fry.

The Mattagami River, from downstream of the road bridge to Kenogamissi Lake, is an important spawning area for the walleye population of Kenogamissi Lake. Our observations within Area B, with regard to the habitat utilized by spawning walleye, are consistent with observations undertaken by MNR (J. Mucha, Biologist, MNR, Timmins. Personal communication, November 21, 2006). During the 2007 walleye spawning season, when the entire length of river between the Mattagami Lake Dam and Kenogamissi Lake was examined, walleye were observed nearly everywhere that suitable substrate and velocities occurred downstream of the bridge in Areas B to F (Figures 3-10 to 3-13).

The Mattagami River, downstream of the road bridge to Kenogamissi Lake, apparently contains at least two spawning areas for the lake whitefish population of Kenogamissi Lake. Discussions with the whitefish dipnetters, as well as the results of the egg collections undertaken on December 11, 2006, and underwater video observations of lake whitefish during their 2007 and 2009 spawning run, suggest that the spawning habitat in Area D is utilized more than that in Area B (Figures 3-14 and 3-15). This may be the case because Area D has a larger area of deep water and a greater maximum depth than Area B, as well as slower flow velocities. These characteristics may make Area D better whitefish spawning habitat than Area B, based on the descriptions of spawning habitat and behaviour in Scott and Crossman (1973), Coad *et al* (1995) and Becker (1983). Given that lake whitefish prefer deeper water for spawning than what is generally found throughout this section of river, and that they also will readily spawn in lakes, it is possible that this section of river is not the only spawning area for the Kenogamissi Lake population.

4.0 IMPACT ASSESSMENT AND MITIGATIVE MEASURES

The available environmental baseline information and site-specific aquatic habitat and fisheries survey findings provided the basis for an assessment of potential construction and operational effects on the aquatic environment. The significance of potential impacts is based on their magnitude, duration and extent after the implementation of recommended mitigative measures. The following sections detail the potential impacts and mitigating measures that directly affect fish and fish habitat, and provide an analysis of the residual impacts for the different phases and components of the Proposed Undertaking.

4.1 POTENTIAL CONSTRUCTION IMPACTS AND ASSOCIATED MITIGATION

4.1.1 Water Quality

Erosion and Sediment Control

Erosion and sediment control will be an integral component of the construction planning process. All personnel involved with the proposed works will be briefed on erosion and sediment control including engineers, contractors, inspectors and environmental staff.

Sediment and erosion control measures should be implemented as required prior to work and maintained during the work phase, to prevent entry of sediment into the water. This should include sediment removal from water pumped from within the work areas such as the powerhouse foundation area, draft pit and tailrace excavation. It should also include the use of silt curtains or cofferdams, if appropriate, during any in-water work to prevent deleterious substances from entering fish habitat. Dredged material should be disposed of on land above the high water level and suitably contained/stabilized to prevent the dredged material from re-entering the water.

In general, the following guidelines will be applied in the development of the Erosion and Sediment Control Plan:

- fitting of proposed works to the terrain;
- timing of grading and construction activities to minimize soil exposure;
- retention of existing vegetation where feasible;
- restriction of the use of heavy construction equipment to within the approved work areas to minimize soil disturbance and vegetation destruction;
- storage of striped soil at upland locations;
- implementation of erosion control measures, e.g., rip rap berms underlain by filter geotextile, straw bales used as filters, silt fencing along the shoreline and/or mulching for interim stabilization;
- diversion of runoff away from exposed areas;
- minimization of the length and steepness of slopes;
- maintenance of low runoff velocities;

- design of drainage works, such as ditches and outfalls, to handle concentrated runoff;
- retention of sediment on site;
- routine inspection and maintenance of erosion and sediment control measures; and,
- re-vegetation of disturbed areas by seeding and/or planting of native species following construction as soon as seasonal conditions permit.

As indicated in the Terrestrial Environment Technical Support Document, site-specific Erosion and Sediment Control Plans, addressing the areas around the new powerhouse and its ancillary infrastructures, as well as the construction laydown and assembly areas, will be prepared and implemented during construction. The site-specific Erosion and Sediment Control Plan will be part of a broader Environmental Management Plan.

With the implementation of a site-specific Erosion and Sediment Control Plan, the potential effects of soil erosion and turbidity generation will be minimized or obviated.

Management and Control of Hazardous Material, Construction Wastes, and Accidental Spills

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, debris etc.) from entering the water. Incidental spills of oil, gas, diesel fuel and other liquids to the environment could occur 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 should be followed to minimize contamination of the natural environment, e.g., placement of fuel tanks and generators on plastic sheets bermed around the edges, and use of suitable hydrocarbon absorbent material for cleanup and approved landfill or other disposal. Any spills with the potential to create an impact to the environment should be reported to the MOE as required by provincial spills legislation. Interim sanitary waste collection and availability of treatment facilities should be arranged for the duration of the construction period. All construction waste, washwater and wastewater should be disposed of in accordance with regulatory requirements.

There is a potential for accidental loss of cement during surface application. Any dripped cement should be recovered from the river bottom for suitable disposal prior to temporary cofferdam removal. All trash and other solid debris should also be collected for appropriate disposal.

A Hazardous Materials Management Plan, Waste Management Plan and a Spills Emergency Preparedness and Response Plan will be developed 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.

Use of Explosives

Blasting will likely be required to facilitate new powerhouse and/or ancillary infrastructure construction for the Proposed Undertaking. Explosives used in construction will be closely controlled, with their use restricted to authorized personnel who have been trained in the use of explosives in a manner so as to minimize impacts on the environment. Appropriate government agencies and the local residents will be informed of the blasting schedule in advance of construction, as well as just prior to the detonation program. All necessary permits will be obtained by the Design-Build-Contractor (DBC), who will also comply with all legal requirements in connection with the use, storage and transportation of explosives, including, but not limited to, the *Canada Explosives Act* and the *Transportation of Dangerous Goods Act*. The DBC will be required to retain a consulting engineer with technical expertise in blasting to provide advice on maximum loading of explosives for all blasting, as well as an engineering report indicating recommended charges and blasting methods to be used at specific locations. All blasting will occur in such a way as to be in compliance with federal regulations and directions.

Blasting could have a potential effect on groundwater quality and flow in the immediate vicinity of the blasting operations (Fitchko *et al.*, 1998). Minimization of the physical effects of blasting will be ensured by following the recommendations of the blasting engineer.

Acid Rock Drainage Potential

The available information for the assessment of acid rock drainage potential consists of nine Acid Base Accounting (ABA) analyses of drill core, two of which are splits of a pulp, and two appear to be separate splits of the same drill core interval. The analyses were performed by Geo Lab Inc. of Sherbrooke, Quebec. In addition, there is a geotechnical report by BPR Energie Inc. that documents borehole locations, rock composition, etc. The geotechnical report notes that bedrock in the area tested is granite with felsic and dioritic dikes. This type of rock typically has a low potential for Acid Rock Drainage (ARD) however granite can contain sulphide minerals and have the potential to generate ARD in some areas, and therefore additional analysis in the form of ABA testing is useful.

The ABA results confirm that the granite tested does have a very low sulphide content. Acid Potential (AP), is typically calculated from sulphide sulphur content, but is calculated from total sulphur content for these analyses, which results in a more conservative assessment. The highest sulphide sulphur level in these samples is 0.02%, which is a negligible amount. The BC ML (Metal Leaching) /ARD Guidelines (1997) suggest that below 0.3% sulphide sulphur, there should be no concern with respect to metal leaching/acid rock drainage (ML/ARD), unless the material has elevated metal levels and/or the levels of neutralizing potential (NP) are relatively low. It should be noted that the guidelines are being revised and this cut-off will be dropped from the revised guidelines in favour of a case by case assessment.

Neutralization Potential (NP) levels ranged from low to moderate (6 to 40 kilograms CaCO₃ per tonne). The lower levels of NP in some samples may indicate that these samples have a negligible potential to neutralize acidity, as the NP test typically overestimates NP.

The NP/AP ratio is commonly used to further assess the potential for ARD. The draft BC Guidelines suggest the following ABA screening criteria:

Table 4.1 NP/AP¹ Acid-Base Screening Criteria Recommended in Draft BC Guidelines

Screening Criteria	Potential for ARD	Comments
NP/AP < 1	likely	likely ARD generating unless sulphide minerals are non-reactive
1 <= NP/AP < 2	possible	possibly ARD generating if NP is sufficiently un-reactive or is depleted at a faster rate than sulphides
2 <= NP/AP < 4	low	not potentially ARD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
NP/AP >= 4	none	

1: NP = neutralizing potential, AP = acid potential

All of the samples fall within the “none” category, confirming that there is little potential for ARD.

4.1.2 Aquatic Habitat

General Considerations

Timing of In-water Work

In-water construction activities should be timed to avoid the spawning and incubation period of spring spawning fishes such as walleye, which typically excludes in-water work from April 1 to June 20.

In-water construction activities should be timed to avoid the spawning and incubation period of lake whitefish. The DFO guidelines suggest September 15 to May 15 for all of northeastern Ontario (Fisheries and Oceans Canada, 2010), but based upon the lake whitefish spawning investigations at the Mattagami Lake Dam, it is believed that spawning within the Mattagami River at this location does not commence until well after October 1, usually during the second half of October.

Use of Explosives

Blasting should adhere to the Fisheries and Oceans Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (http://www.dfo-mpo.gc.ca/canwaters-eauxcan/infocentre/guidelines-conseils/guides/explosguide/chap3_e.asp#GUIDELINES).

Sediments

After construction, substrate type and quality will be similar to that currently in place. The potential use of fragmented rock generated by blasting activities for fish habitat enhancement and/or use for nearshore/shoreline erosion protection will be discussed with DFO. Otherwise, the excess rock will be removed from the dewatered areas behind the temporary cofferdam for suitable upland disposal.

Plankton

Plankton populations will not be affected by the project.

Benthic Macroinvertebrates

A few construction activities may have a temporary 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 in the areas to be excavated consists primarily of boulder, cobble, gravel and/or sand over bedrock, or bedrock. The placement of rock fill over this type of similar substrate will minimize any detrimental effect on the benthic macroinvertebrate communities.

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 activity 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 communities associated with a naturally variable, high energy environment. The benthic organisms are adapted to the high-energy, unstable conditions, and have life cycles that allow them to better withstand these stresses (Hirsch *et al.*, 1978).

Site-specific Fish Habitat Considerations

Intake channel

Alteration of the existing Mattagami Lake Dam to include an intake channel will not result in any permanent loss of fish habitat. A small area of bedrock riverbed immediately downstream of the two west-most sluice gates will be altered and covered by the intake structure (Figure 3-9). Given the bedrock nature of this small area and its inaccessibility to fish, as well as the fact that it is only wet when water is spilled across it when either of the two western-most sluice gates are open, this is not considered fish habitat (Appendix A: Photograph 21). No in-water work is proposed on the upstream side of the dam, except for the removal of the remains of the crib structure.

Removal of old rock-filled wooden crib structure

With the proposed utilization of the two western-most sluice gates to divert river flow for the proposed GS, an old rock-filled crib structure located immediately upstream of the dam at this location (Figure 3-9; Appendix A: Photograph 3) must be removed to allow the uninhibited flow of water into the GS. This old crib structure will be dismantled and its material removed to an off-site approved disposal area. To maintain the habitat function that was provided by the rock and timber crib, new, similarly sized clean rock material, will be placed in a similar configuration in the vicinity of the floating boom (Appendix A: Photograph 2). To improve the utilization of this habitat by fish, the new habitat should be located in deeper water so that it remains submerged during the late winter drawdown of Mattagami Lake.

These old rock-filled wooden cribs are not large, and are primarily composed of large rocks and old logs, and therefore are not expected to generate much suspended sediments when they are dismantled. Since the surrounding lake substrates are primarily fine, any deposition from the small amount of fine material that may be attached to this wood and rock structure will not significantly impact surrounding habitats. Its removal can be accomplished without the use of a cofferdam, as the installation and subsequent removal of a cofferdam would likely constitute a greater impact than the actual work. However, a silt curtain may be warranted. If this work is undertaken within the in-water construction window for this site (June 20 to September 15), no negative impacts to fish and fish habitat are anticipated.

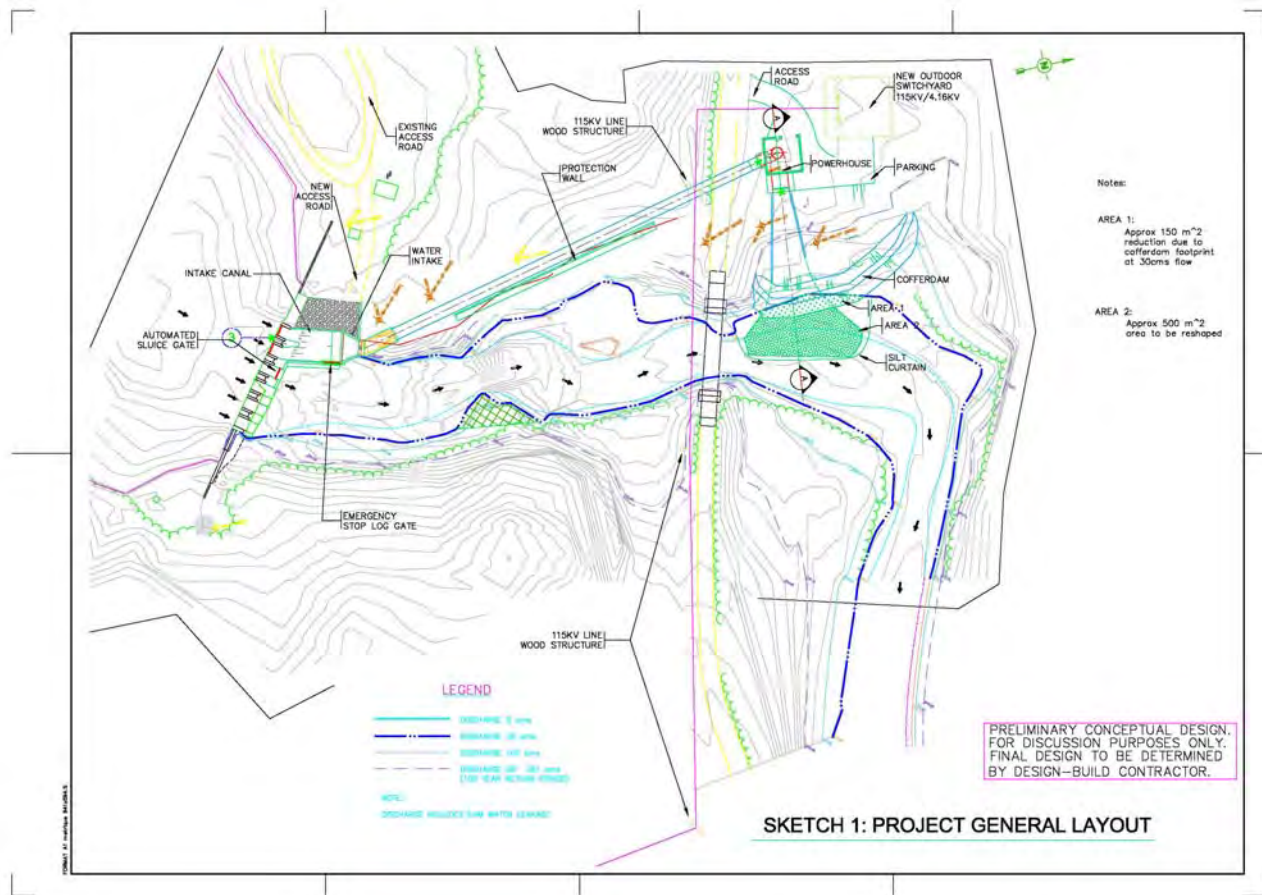
Penstock construction

The penstock and associated protection works will be constructed above the average high water level, and therefore will not impact fish habitat, providing that the appropriate general mitigation measures described at the beginning of Section 4.0 are applied.

Powerhouse and tailrace construction

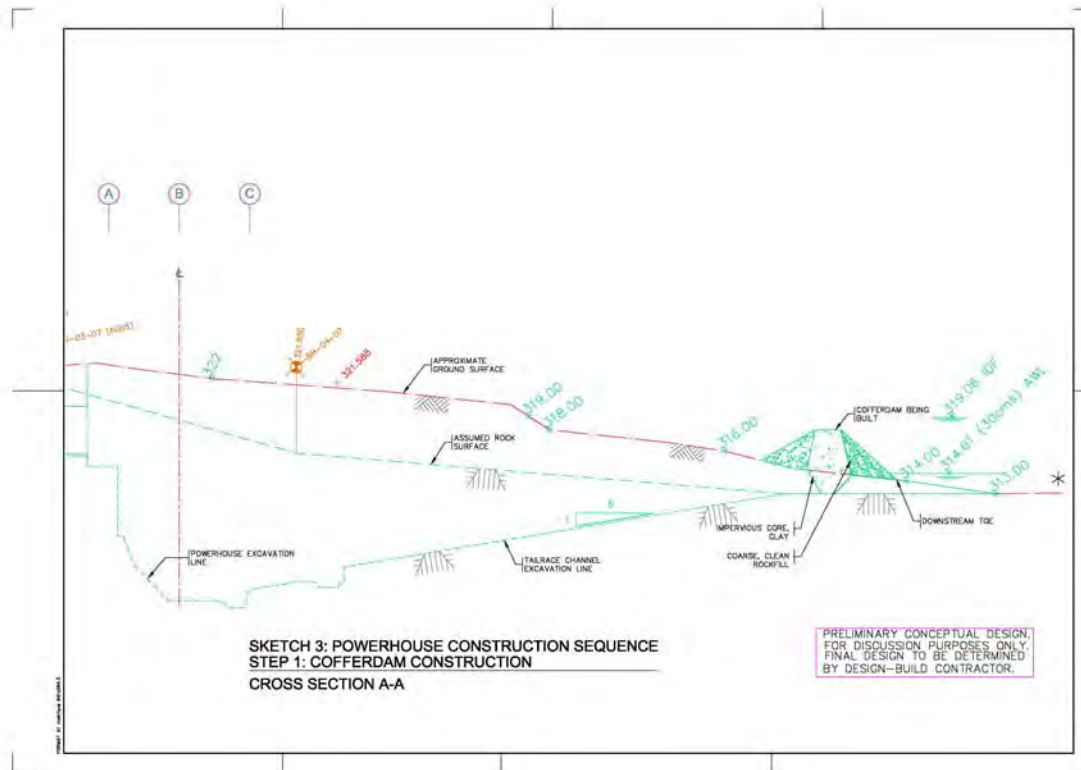
While the construction methods presented here outline the basic principles that will be used to minimize the environmental impact of this work, the final design of the tailrace channel and cofferdam is the contractor's responsibility. The construction methods presented here reflect the components of the DFO Risk Management Framework (Fisheries and Oceans Canada, 2006) and have been discussed with DFO. Generally, the powerhouse and part of the tailrace channel will be constructed in dry conditions inside a cofferdam located along the west shoreline (Appendix A: Photograph 22). The general layout is provided in Figure 4-1.

Figure 4.1 General Project Layout



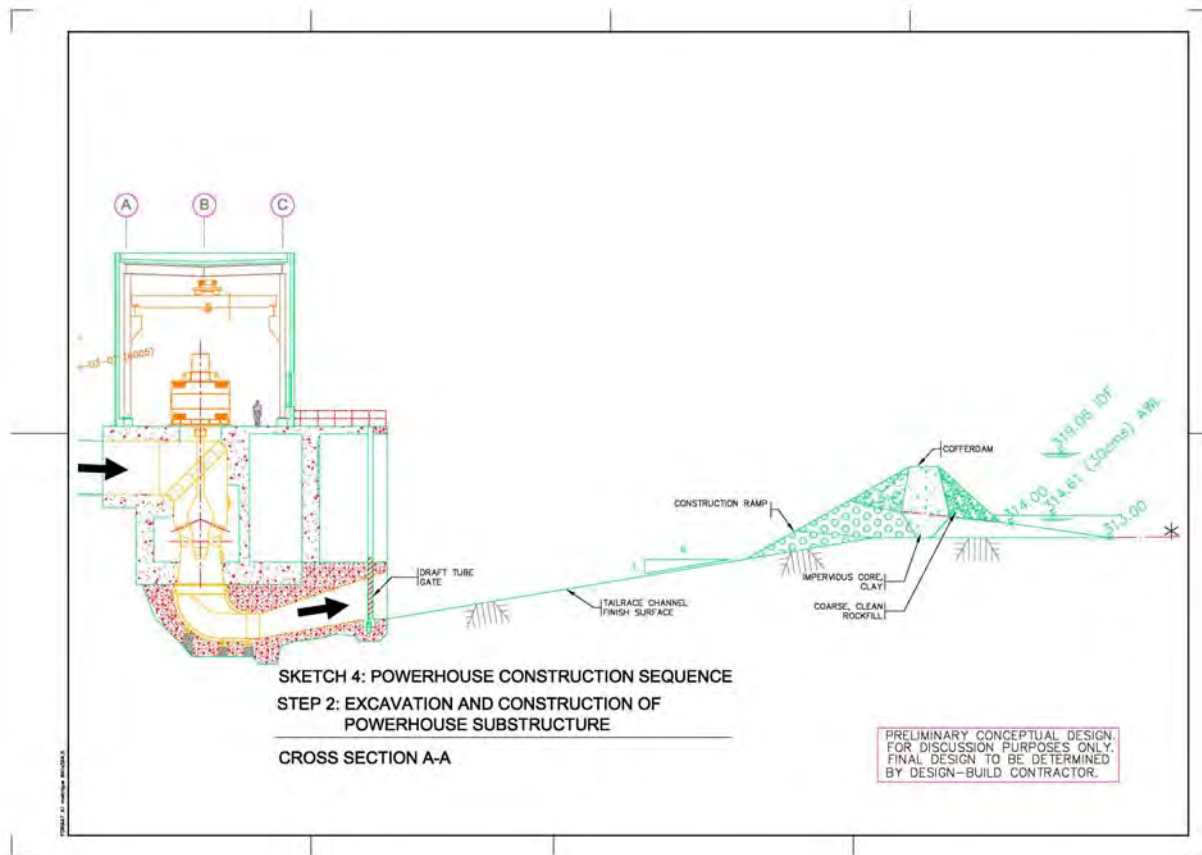
As noted above these are preliminary plans and will be subject to final stamped drawings from the contractor. The powerhouse cofferdam will be constructed along the west shore of the river, downstream from the road bridge (Appendix A: Photograph 22). The construction will occur in the dry over a period of 3 to 4 weeks during the low flow period, when the dam can be shut down (if necessary) with only leakage flow to the downstream river. No in-water work will occur in the tailrace area during the spawning or incubation periods of walleye and lake whitefish (i.e. the work should normally be done between June 20 and September 15). The cofferdam toe on the river side will correspond roughly to just below the waterline associated with the average annual flow of 30 cubic metres per second, and at that water level would reduce the wetted habitat area by approximately 150 square metres. The cofferdam will stay in place for about 2 years, and be designed according to the latest Ontario Dam Safety Guidelines. The habitat area that will temporarily be unavailable to fish during this period, is not spawning habitat for lake whitefish or walleye. The initial cofferdam configuration is shown in Figure 4-2.

Figure 4.2 Initial Cofferdam Location

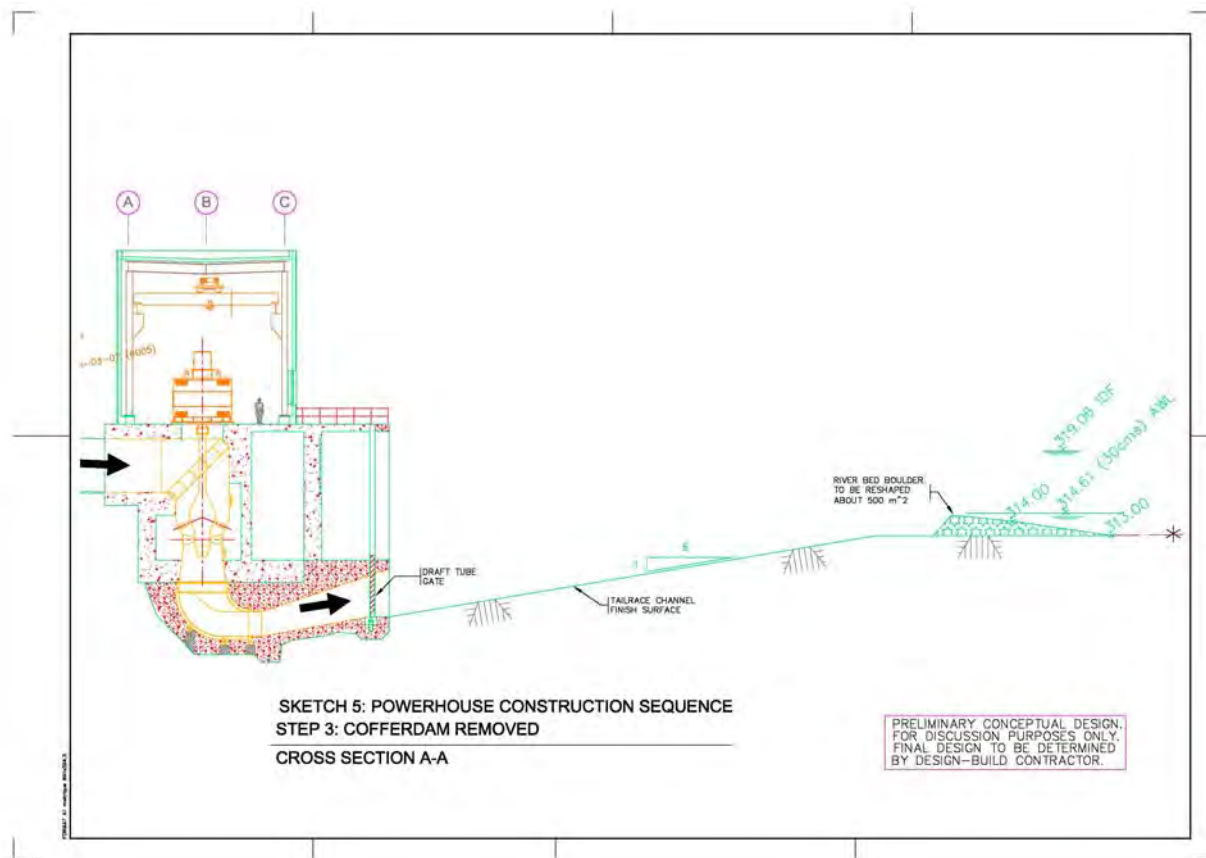


During the excavation and initial construction of the powerhouse and part of the tailrace channel, the excavation pit will need to be maintained in a dry condition. Surface water and leakages will be collected and pumped from the pit to a settling pond or a filter bag, or a combination of both, to remove as much suspended material as possible from the discharge water before it re-enters the river. Contouring and shaping of the tailrace channel will be conducted in the dry behind the cofferdam to the extent possible. Once the powerhouse is advanced to the point that its outer shell within the pit is finished and watertight, and the draft tube gates can be sealed, the cofferdam can be removed. Figure 4-3 shows the construction advanced to the point that the cofferdam can be removed.

Figure 4.3 Work-site Configuration Immediately Prior to Cofferdam Removal



The cofferdam will be removed and the tailrace completed during the traditional low flow period, and during the accepted in water work window (i.e. June 20 to September 15), as indicated earlier. The existing Mattagami Lake Control Dam will be closed, allowing only leakage during the 2 to 3 week duration of this work. This should result in water levels that are low enough for the cofferdam to be removed in the dry (Figure 4-4). As the cofferdam is removed, the contouring and shaping of the tailrace can be extended outward as much as possible in the dry.

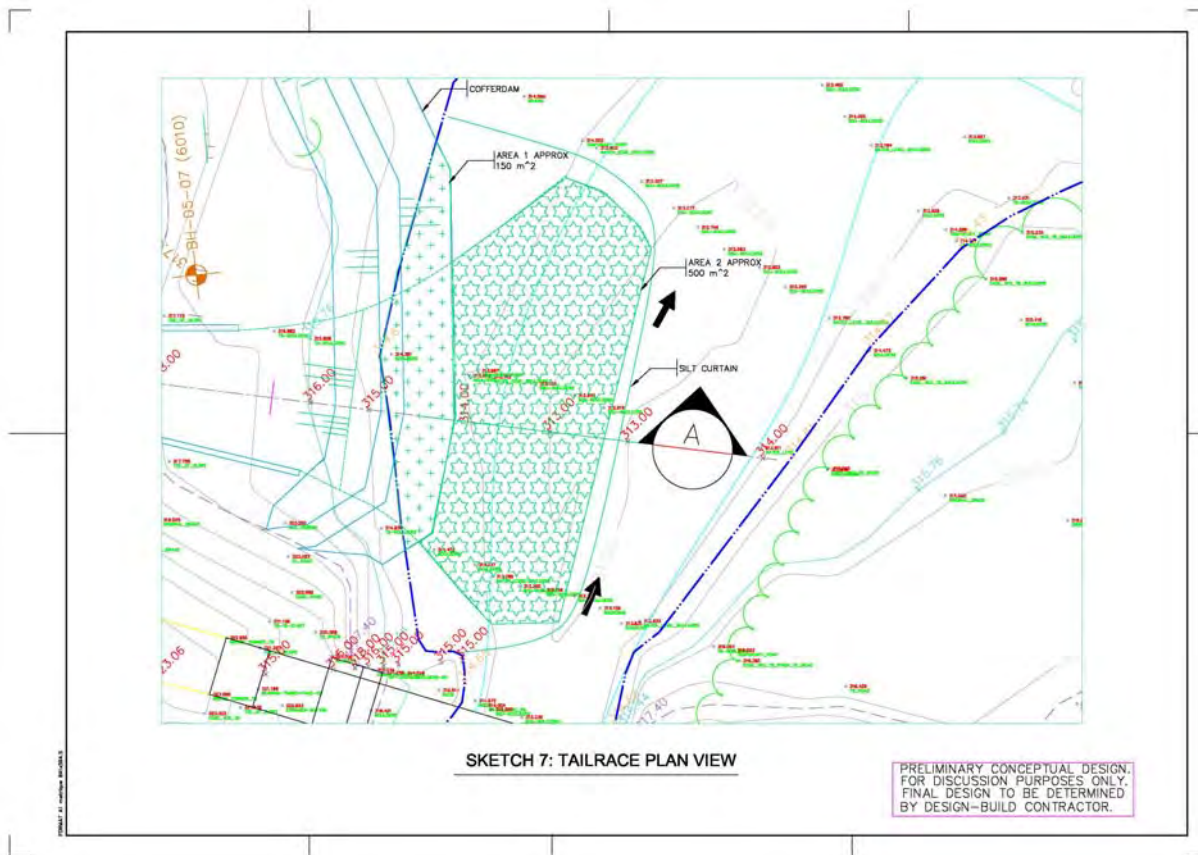
Figure 4.4 Cofferddam Removal and Outward Extension of Tailrace into River

The tailrace extension into the river will require the re-contouring of approximately 500 square metres of riverbed, to allow for the efficient flow of water exiting the tailrace. Figure 4.5 is a plan view of the proposed works, showing the estimated extent of the tailrace contouring and shaping that may be required to smooth the transition between the tailrace to the river. At the point in time when work in the wetted portion of the river cannot be avoided, a silt curtain system will be installed to enclose the tailrace footprint area. For such a small amount of excavation within relatively clean granular substrates, a silt curtain system, rather than a second cofferdam, would be the best choice to minimize impacts to the surrounding habitats. Utilizing a new cofferdam, rather than a silt curtain, would extend the area of direct impact to include the base of the cofferdam, possibly resulting in a doubling of the area of riverbed disturbed, and increasing the duration of that disturbance. Within the area contained by the silt curtain, the tailrace can be deepened and extended to blend with the contours of the surrounding riverbed. Backhoe bucket movement speed can be adjusted to minimize the suspension of material when warranted. The native riverbed material will be used to re-contour the in-water area as shown in Figure 4.5, with the coarser materials (cobble/small boulder) placed along the edge and sloped sides of the tailrace to provide potential spawning areas for walleye, and the finer materials (sand/gravel) placed in the deeper central portions of the tailrace to provide potential spawning areas for lake whitefish. Once the tailrace construction is complete, and all potentially erodible

areas are stabilized and fine suspended material is cleaned-up, the tailrace silt curtain will be removed.

Re-contouring of the riverbed to accommodate the tailrace will not impact substrates used by spawning walleye. Re-contouring will shuffle some of the substrates where lake whitefish apparently spawn, but this is not expected to impact spawning since the overall substrate type will not be changed and lake whitefish spawn over a variety of substrates. Furthermore, as detailed in Section 3.4.4, sufficient water depth appears to be a significant condition for lake whitefish spawning, and the proposed tailrace and associated works are expected to slightly increase the area of deeper habitat in the vicinity of the tailrace (portion of Area B), creating conditions that are more favourable for lake whitefish spawning (see Section 4.2 below).

Figure 4.5 Plan View of the Proposed Tailrace Works



4.2 POTENTIAL OPERATIONAL IMPACTS AND ASSOCIATED MITIGATION

The proposed Undertaking will not substantively change the flow regime of the Mattagami River or the management of water levels within Mattagami Lake or Kenogamissi Lake. Operation of the proposed GS will respect the amended Water Management Plan and users will not detect changes in flow beyond the local study area. The following summarizes the expected impact to

flow once the proposed GS is operational. Historical flows and elevations are included below in Figure 4.6 for reference.

Upstream of Mattagami Lake Dam, flow velocity changes will be limited to within a few metres of the dam. Currently, the velocity gradient occurs across all sluices dependent upon which stoplogs are pulled. Going forward, when the GS is in operation, a velocity gradient will preferentially occur at the proposed intake structure at the west end of the dam. This change is not expected to cause significant impact.

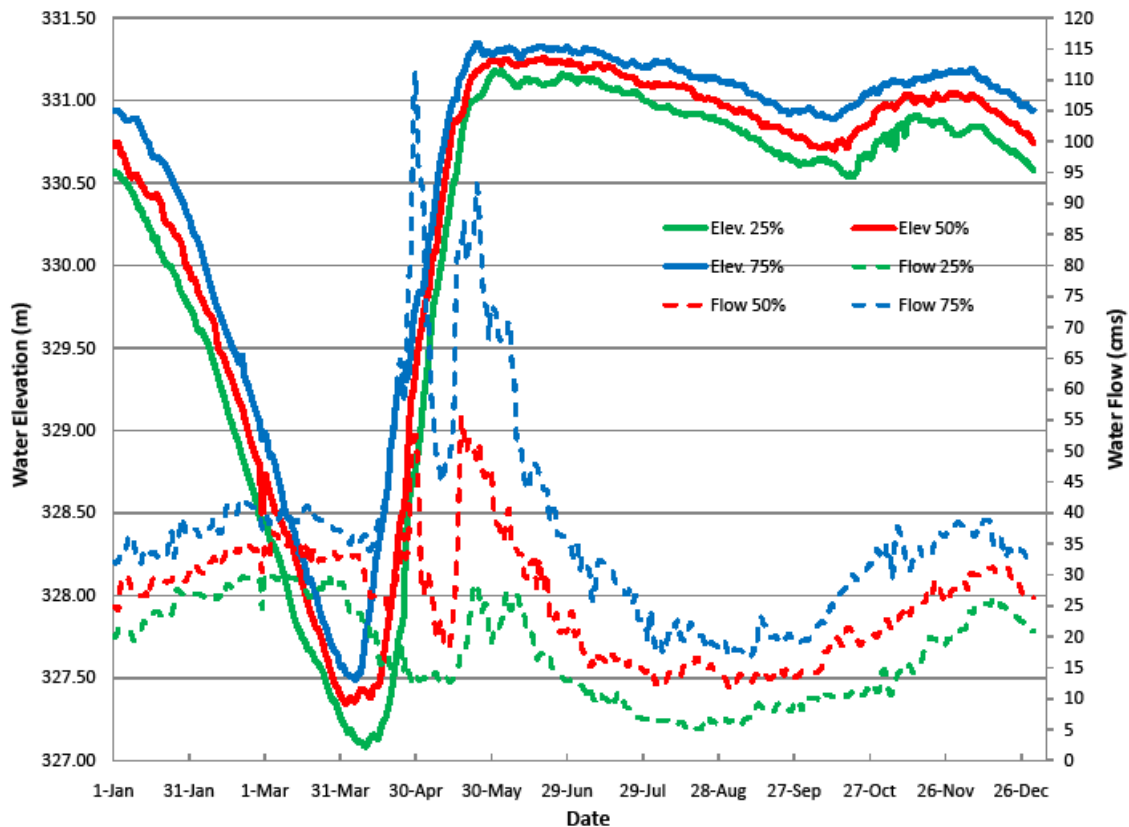
The proposed Undertaking will result in a reduction in flow within the area between the dam and the proposed GS which can be summarized in three scenarios.

1. In scenario one, flows are between the GS minimum rated flow (8-12 cms) and maximum rated flow (47 cms). Under these conditions, water previously passed through the dam will now pass through the intake structure and be diverted through the GS before returning to the river downstream. In order to preserve fish habitat in this area an ecological, or minimum, flow of 0.2 cms will be maintained throughout the year to prevent the area from becoming dewatered;
2. A second scenario is when flows are greater than the GS can utilize, in which case the additional flow will be passed through the dam. This scenario will increase the flows between the dam and GS as compared to scenario one, but total flow will continue to be passed downstream of the GS. Flows exceeding 47 cms are generally only expected during high flow season in early spring;
3. The third scenario occurs when the station is shut down due to insufficient water to run the GS at its minimum rated flow (below 8-12 cms) or from maintenance periods resulting in the facility being shut-down. In order to meet the downstream minimum flow requirement, flow through the dam would be increased to a minimum of 2.8 cms. Based on historical flow data, this scenario is most likely to occur during late summer.

Figure 4.6 below illustrates historical flows and levels for Mattagami Lake Dam between 1979 and 2009. Storage reservoirs were created to provide a means of storing water during high inflow periods, to be used for power generation during low inflow periods. High inflows during the fall are stored and used over the course of the winter when natural inflows are at their lowest. At the end of the winter, when the storages have been drawn down, the reservoirs are replenished by the high spring flows.

These graphs provide historical data for this facility over a number of years (generally 30 years) based on daily average levels and flows graphed on a weekly average. The average level/flows (50% time exceedence) for a given time period, along with 25% of time and 75% of time exceedence bands are also included.

Figure 4.6 Mattagami Lake Dam (1979-2009)



Flow Velocity Changes Immediately Upstream of the Mattagami Lake Dam

Local flow velocities within a few metres of the upstream side of the Mattagami Lake Dam will change from present. Instead of a velocity gradient occurring at any one sluice, series of sluices, or across all sluices, dependent upon which stoplogs are pulled, a velocity gradient will preferentially occur at the proposed intake structure at the west end of the dam. It is not thought that this will cause a significant impact upon local fish habitat or fish communities in Mattagami Lake, and therefore, no mitigation is proposed.

Flow Reduction Between the Dam and the Road Bridge

When the GS is in operation, potentially all flow up to a maximum of about 40 to 47 cubic metres per second would pass through the proposed intake structure and be diverted through the GS. Based upon the known hydrology of this site (Table 4.2), without provision of a minimum flow Area A would likely be dewatered, other than dam leakage, most of the time except for periods in March through June when the river flow is more likely to exceed the GS capacity. Therefore, to maintain the fish habitat found in this stretch of river, an ecological, or minimum, flow, is proposed to be released downstream of the dam.

Table 4.2 Mattagami River Monthly Mean Flow for the Period 1950 to 2006 at Mattagami Lake Dam (OPG Data)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Flow (cms)	28.5	33.1	38.6	42.6	55.1	41.9	22.1	16.6	16.1	20.3	25.4	29.0	30.8

Habitat within Area A is not thought to contribute significantly to local fish production, or provide spawning habitat for downstream fish populations, since it is almost entirely bedrock with high flow velocity (Appendix A: Photographs 5, 6 and 21). However, a deep bedrock pool located 40 metres upstream of the road bridge (Figures 3-9 and 3-6; Appendix A: Photograph 6), provides non-critical and low productivity fish habitat.

As part of a study undertaken in 2008 in support of this project (Appendix C), it was determined that to maintain the viability of fish habitat in the “bedrock pool” located 40 metres upstream of the bridge, an ecological flow of 0.2 cubic metres per second must be provided to maintain water quality as well as a maximum water depth of 11 centimetres at the outlet of the pool (See Transect S-3 in Photograph 1-4 of Appendix C) to provide habitat connectivity with downstream aquatic habitats. To simplify compliance measurement and reporting, the minimum water level in the bedrock pool that corresponds with these conditions will be maintained and measured by OPG. If winter conditions (e.g. ice cover in bedrock pool) result in the inability of the water level gauge to accurately provide water levels, OPG staff will periodically assess the outlet depth by other means to ensure that the maximum depth of 11 centimetres is maintained at Transect S-3. As part of the final design of the redeveloped structure, there will be an arrangement for providing the minimum flow, other than leakage from the dam.

OPG has also committed to undertaking an effectiveness monitoring program of the post-construction functionality of the bedrock pool (see Section 4.3 below).

A minor amendment to the Water Management Plan is anticipated to accommodate the minimum flow requirements described above. Further information on this can be found in the Public and Agency Consultation Technical Support Document.

Changes in flow pattern in the vicinity of the proposed tailrace

The discharge from the proposed tailrace will change the velocity and orientation of the existing flow patterns in portions of Area B (Figure 3-9; Appendix A: Photographs 8 and 22). Area B contains approximately 6% of the spawning habitat for walleye and something less than 50% of the spawning habitat for lake whitefish that occurs between the Mattagami Lake Dam and Kenogamissi Lake. Downstream of Area B (Figure 3-9), flow velocity and volume will not differ between pre- and post-development (Figures 4-7 to 4-14), and therefore effects upon spawning habitat in these areas will not occur.

To mitigate the potential impacts to the walleye spawning in Area B (Figures 3-10, 3-11, 3-12 and 3-13), flow modeling was conducted (Appendix B) and the tailrace orientation was adjusted accordingly to minimize the changes in flow velocity within known areas of walleye spawning

habitat. The modelling results for two flow rates, at the tailrace orientation that has the least affect upon flow velocity in known walleye spawning locations, are presented in Figures 4-7 and 4-15. A comparison of Figure 4-7 to 4-10 with the spawning locations shown in Figures 3-10 to 3-13, suggest that the proposed tailrace will have little effect upon walleye spawning habitat conditions.

Lake whitefish are known to spawn over a variety of substrates, compared to the relatively narrow range of substrate size for walleye. Also, lake whitefish prefer deeper water for spawning than walleye, possibly with a minimum depth of approximately 2 metres (Becker, 1983), and are known to spawn in both lake and riverine habitats. Therefore, it appears that lake whitefish do not have the same narrow range of spawning habitat requirements as walleye, and are likely less susceptible to habitat change. Since the construction or the operation of the GS will not eliminate any of the existing habitat types within Area B, but will only shift their locations, it is thought that the proposed changes in flow pattern within Area B will not have a negative impact upon lake whitefish spawning. Also, it is possible that spawning habitat for lake whitefish within Area B may slightly improve post-construction, as the proposed tailrace is expected to slightly increase the area of deeper habitat in Area B, and create a deeper area with low velocity water between the tailrace outflow and the upstream road bridge (Figures 4-11 and 4-14), creating conditions that are more commonly found in portions of Area D.

Figure 4.7 Flow Velocities in Area B and the Upstream Portion of Area C Under Existing Conditions at a River Flow of 14 cms

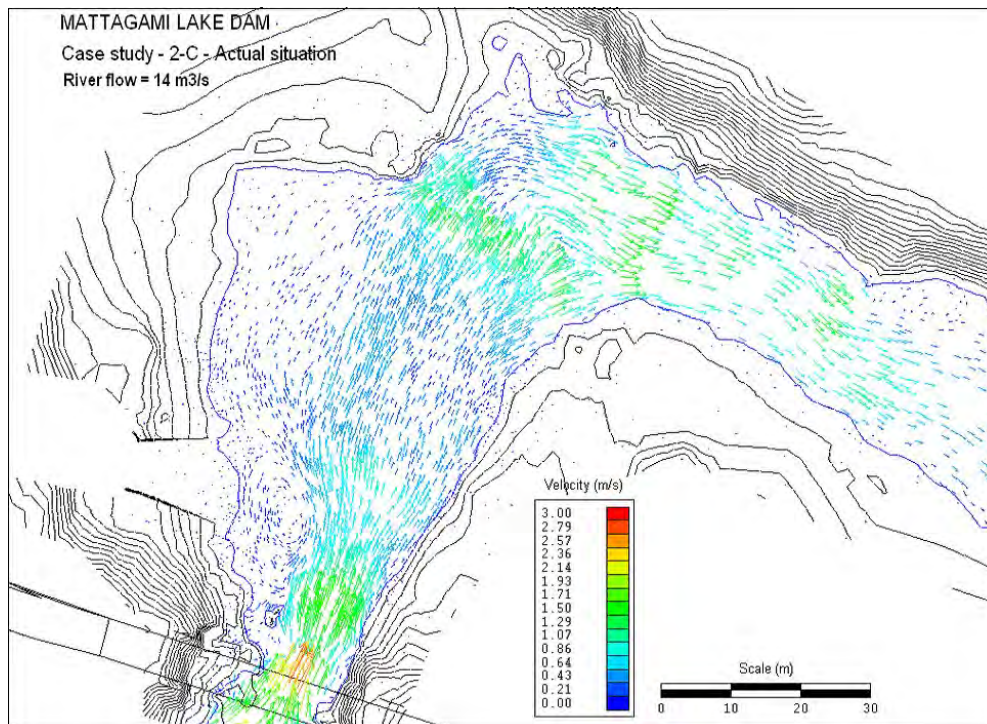


Figure 4.8 Flow Velocities in Area B and the Upstream Portion of Area C Under the Proposed GS Operating Conditions at a River Flow of 14 cms

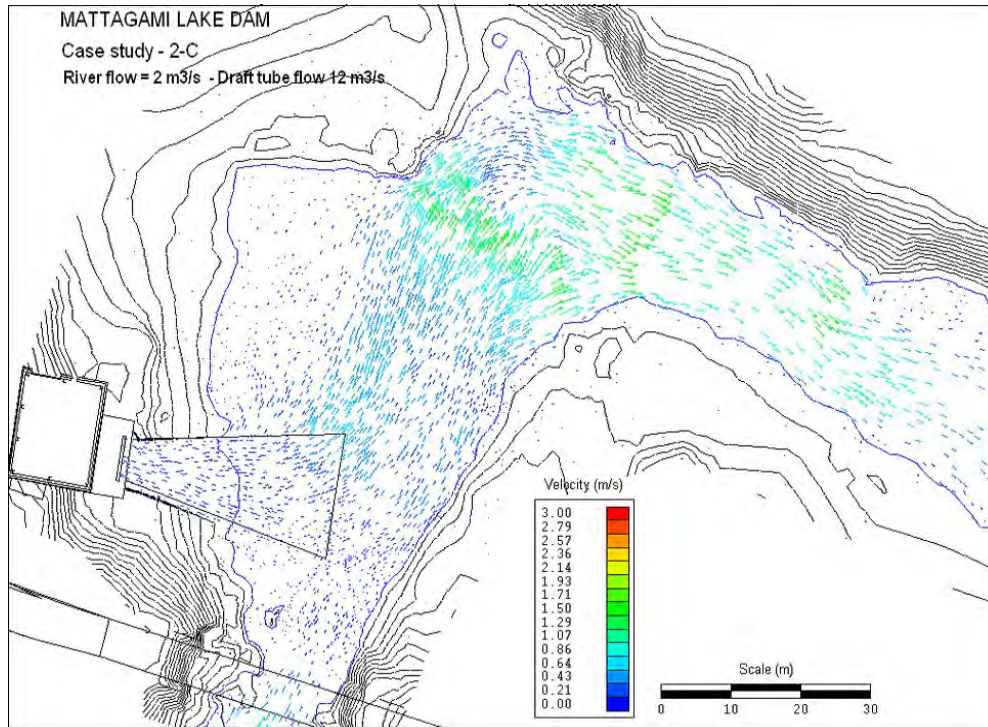


Figure 4.9 Areas Where Typical Walleye Spawning Velocities Occur in Area B and the Upstream Portion of Area C Under Existing Conditions at a River Flow of 14 cms

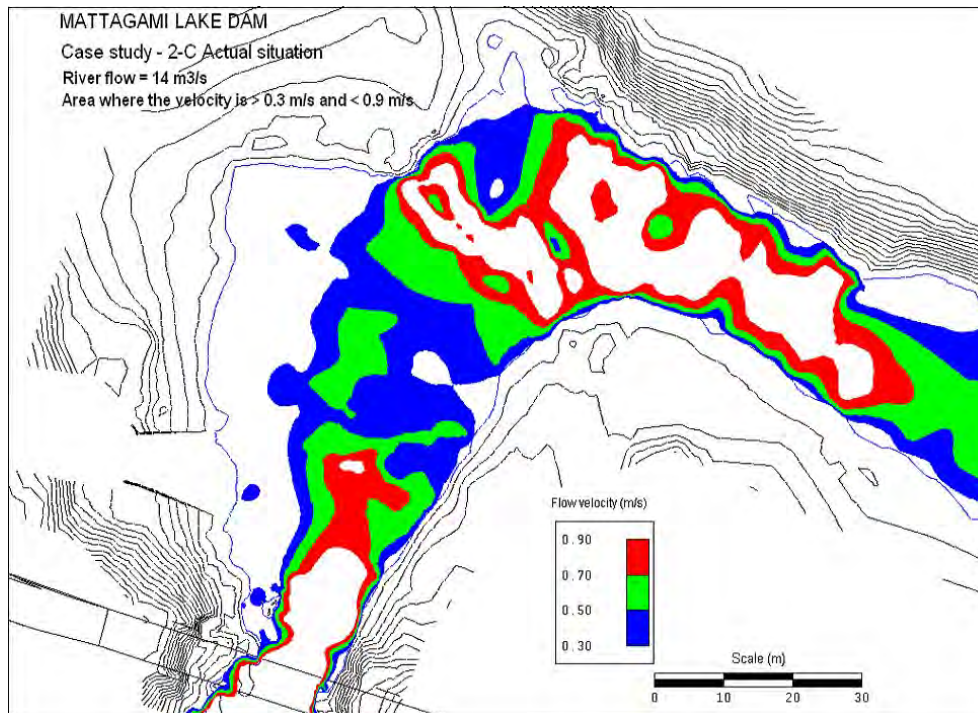


Figure 4.10 Areas Where Typical Walleye Spawning Velocities will Occur in Area B and the Upstream Portion of Area C Under the Proposed GS Operating Conditions at a River Flow of 14 cms

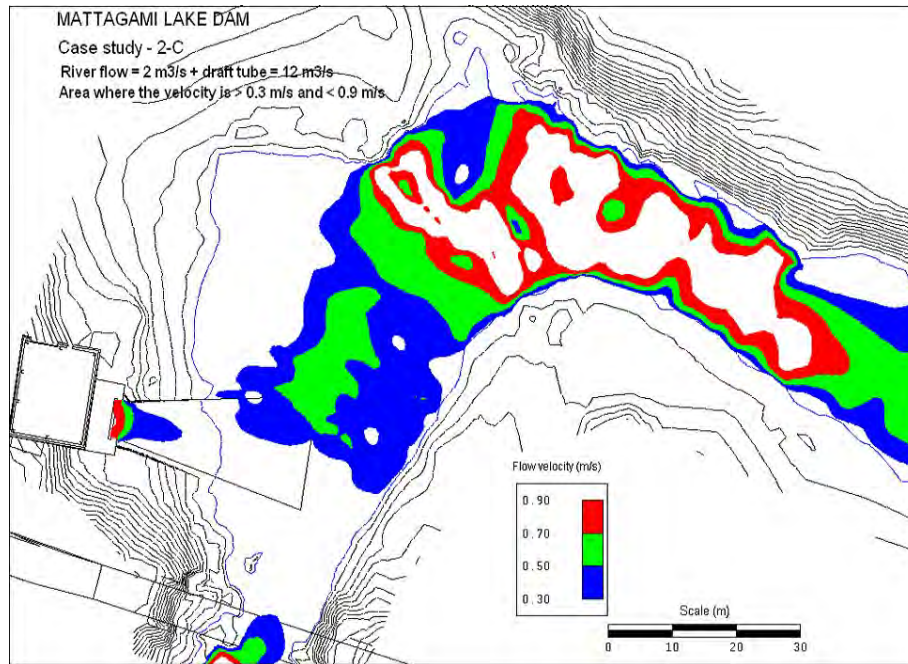


Figure 4.11 Flow Velocities in Area B and the Upstream Portion of Area C Under Existing Conditions at a River Flow of 39 cubic metres per second

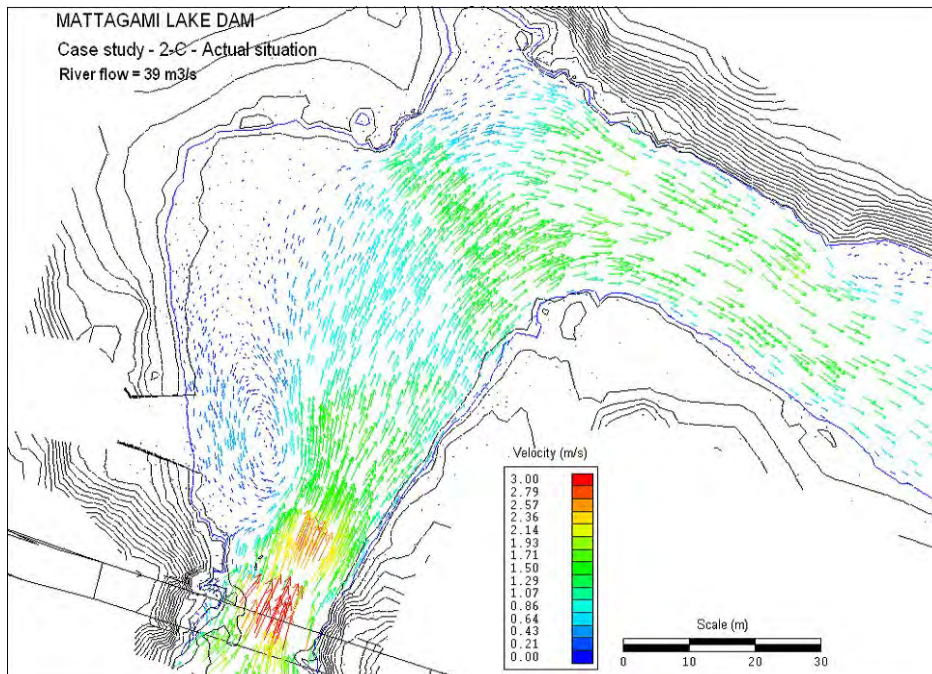


Figure 4.12 Flow Velocities in Area B and the Upstream Portion of Area C Under the Proposed GS Operating Conditions at a River Flow of 39 cms

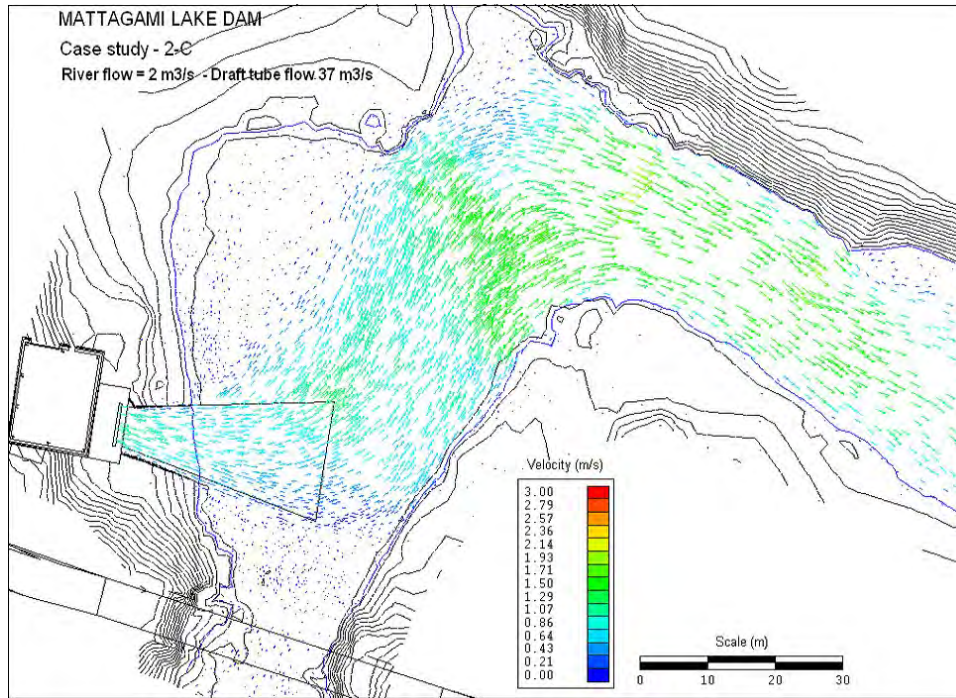


Figure 4.13 Areas Where Typical Walleye Spawning Velocities Occur in Area B and the Upstream Portion of Area C Under Existing Conditions at a River Flow of 39 cms

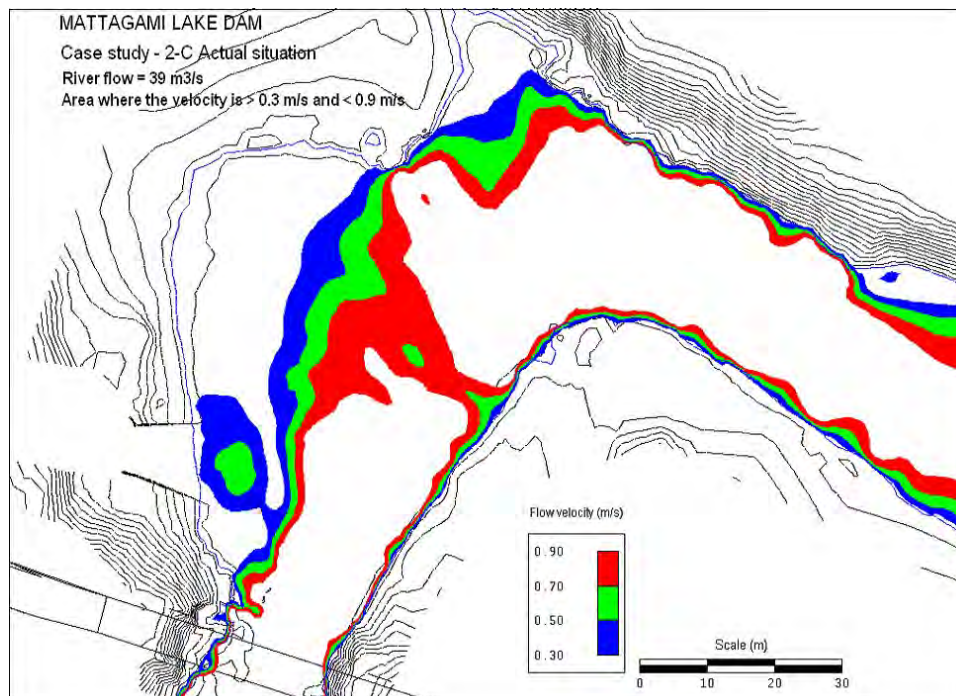
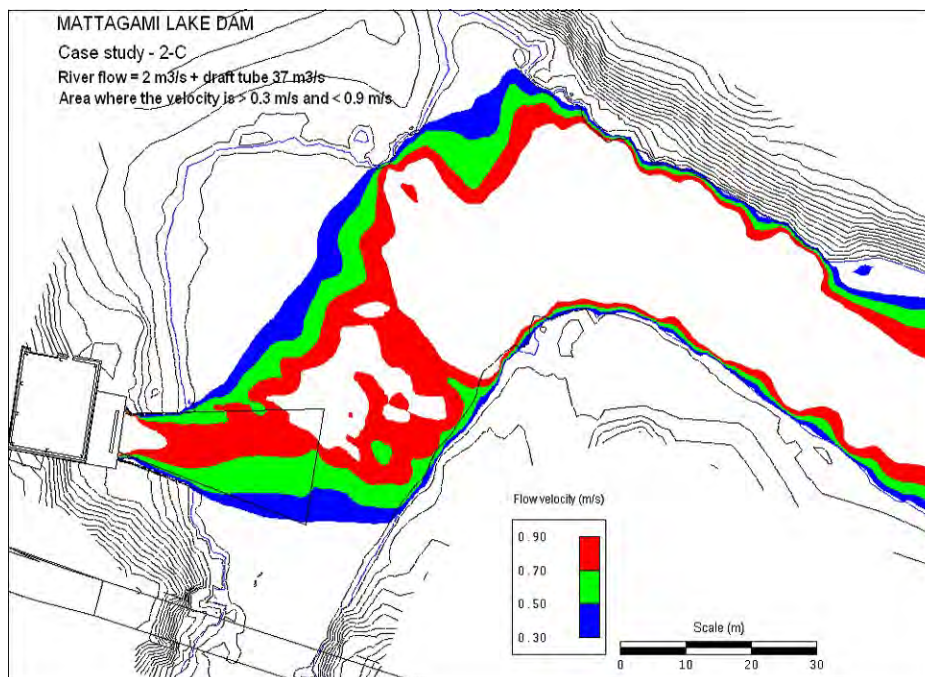


Figure 4.14 Areas where Typical Walleye Spawning Velocities will Occur in Area B and the Upstream Portion of Area C Under the Proposed GS Operating Conditions at a River Flow of 39 cms



Changes in flow between the proposed tailrace and downstream Kenogamissi Lake

The proposed GS will be operated within the parameters and obligations that are stipulated in the Mattagami River System Water Management Plan, as amended (OPG *et al*, 2006). For most of a typical year, this will result in little substantive change between pre-operational flows and post-operational flows downstream of the proposed powerhouse to Kenogamissi Lake. This will almost always be the case during fall, winter and early spring when river flow is sufficient to operate the GS, and during the walleye spawning and incubation period in mid to late spring when a minimum flow of 12-15 cubic metres per second is required. However, in addition to shutdowns for repairs or other technical issues, the GS must be shut down when there is insufficient water storage to allow the generating unit to operate at its minimum rated capacity (estimated to be 20%). This would occur when the reservoir's storage capacity is low and inflows are less than 8-12 cubic metres per second (assuming a station flow capacity of 40-47 cubic metres per second).

A minimum 2.8 cubic metres per second flow (called "Ecological Flow") as discussed with the MNR and the DFO will be released for the duration of the year outside of the walleye spawning, incubation, hatch and dispersal period, to maintain the fish habitat in the 550 metre long river section between the tailrace of the new station and Kenogamissi Lake when the unit is not operating. The agreed-upon flow requirement balances the net economic, social and environmental benefits of the Proposed Undertaking at this site.

The 2.8 cubic metres per second minimum flow was the compromise value between the 3.2 cubic metres per second flow thought to be adequate by MNR, and the 2.5 cubic metres per second thought to be adequate by OPG, that were observed during a series of demonstration flows and associated field measurements undertaken September 8 – 11, 2008 (Appendix C). The monitoring plan discussed in Section 4.3 and provided in Appendix E, will identify any environmental issues that may arise through the use of 2.8 cubic metres per second as the minimum flow. OPG is committed to addressing any potential issues that are identified.

A minor amendment to the Water Management Plan is anticipated to accommodate the minimum flow requirements described above. Further information on this can be found in the Public and Agency Consultation Technical Support Document.

The frequencies of occurrence of various flows for the period 1986 to 2006 are provided in Table 4.3. Flows less than 8 cubic metres per second have occurred in all years from 1987 to 2006, except 2003. In seven of these years the flow was less than 8 cubic metres per second for 15 days or less. These low flow events almost always occur within the months of July to September. During the period 1987 to 2006, the number of days with river flow less than 2.8 cubic metres per second was approximately 191 (84+68+39 from Table 4.3), which is approximately 2.6% of the time, and on 84 of these days there was no flow through the dam. Zero discharge is achieved by jacking down the stop logs in the dam, and is undertaken when inflows are extremely low in order to maintain water levels in Mattagami Lake.

Table 4.3 Frequency of Average Daily Flow Discharged from the Mattagami Lake Dam Over the Period 1987 To 2006

Flow (cms)	Frequency (days)	Percent (%)
>=12	5,683	77.9
11 – 12	177	2.4
10 – 11	172	2.4
9 – 10	134	1.8
8 - 9	115	1.6
7 - 8	112	1.5
6 - 7	244	3.3
5 - 6	166	2.3
4 - 5	171	2.3
3 - 4	103	1.4
2 - 3	39	0.5
>0 -<2	68	0.9
0	84	1.2
Total	7,293	99.9

Presently, OPG operates the dam solely to meet their commitments under the Mattagami River System Water Management Plan (OPG *et al*, 2006). Based on the historical flows, and assuming that the GS would be operated for as much time as possible during dry periods (i.e. at 8 cubic metres per second, whenever that was available) the number of days that the facility would have passed the minimum flow of 2.8 cubic metres per second would have been approximately 575 days. Following construction of the GS, however, the operation would be adjusted, within the limits of the water management plan, to maximize the operation of the GS and thus minimize the period of time that the plant will be discharging the minimum flow of 2.8 cubic metres per second.

A series of photographs are provided in Appendix D, which illustrate the effect of flow changes upon habitat over a range of approximate flows from 2.4 to 13.3 cubic metres per second. Furthermore, the minimum flow study provided in Appendix C contains a series of photographs at precise locations and at precise flow rate, that also illustrates the relationship of flow rate and habitat, but over the range of 1.2 to 4.5 cubic metres per second. Based upon these photographs, no habitat components are lost at flows as low as 1.2 cubic metres per second. As well, no riffles are dewatered, nor do they become barriers to fish movement at flows as low as 1.2 cubic metres per second. A precise survey, undertaken as part of the minimum flow study, showed that the difference between the wetted area at a flow of 4.5 cubic metres per second and that at 3.2 cubic metres per second was about 4%, and the difference in wetted area between flows of 4.5 and 2.5 cubic metres per second was about 7.9%. Combined with a careful comparison of photographs taken at 12 cubic metres per second, it is estimated that the wetted area would be reduced by about 10% when flows are reduced from 12 to 2.8 cubic metres per second. It is expected that during dryer years when it becomes necessary to alternate between operating the GS at 8-12 cubic metres per second and shutting it down and

passing 2.8 cubic metres per second of water to maintain downstream aquatic habitats, that this will almost always occur sometime within July, August, and September, when there is no spawning for any of the fish known to occur in this section of river.

The reduction of flows to 2.8 cubic metres per second during the lake whitefish spawning period will likely have little impact upon spawning success. It is inferred from the scientific literature on this species that temperature is likely the primary cue for the initiation of spawning, and so lower flows should not affect the initiation of the spawning run. During the spawning run, lake whitefish spawn in the deep pools within this section of river, which are not appreciably different at 2.8 cubic metres per second than they are at 12 cubic metres per second. There is also sufficient water depth along this length of river, at 2.8 metres per second, to allow lake whitefish access to both known spawning areas.

Some aspects of the operation of the proposed GS will likely benefit fish habitat downstream of the GS. The number of days with flows less than 2.8 cubic metres per second will, in theory, be eliminated, removing the potential of zero flow at critical periods that might otherwise severely limit a fish population or a fish population year-class, or populations of benthic invertebrates. Riverine habitats, as well as their attendant fish and invertebrate communities, may also benefit from the improved precision of flow control afforded by the proposed GS, due to the incremental and remote operation of the proposed spill gate, headworks, and powerhouse bypass pipe, compared to the coarser and less timely adjustments afforded by the existing manual stop-log operation. More stable flows during the walleye spawning period may improve spawning success. However, those less mobile organisms, such as benthic invertebrates, which may have colonized habitats in shallower water over periods of extended higher flows, may be negatively affected when the GS is shutdown under conditions that allow only 2.8 cubic metres per second to be passed.

Information generated during the September 2008 minimum flow study (Appendix C) is used here to provide an estimate of the potential effect upon benthic invertebrates when flows are reduced to 2.8 cubic metres per second when the GS is shutdown. That study showed that the difference between the wetted area at a flow of 4.5 cubic metres per second and that at 3.2 cubic metres per second was about 4%, and the difference in wetted area between flows of 4.5 and 2.5 cubic metres per second was about 7.9%. Therefore, a flow of 2.8 cubic metres per second would be about a 6% reduction of area from a flow of 4.5 cubic metres per second. Even when the flow is 12-15 cubic metres per second, because of the channel shape, the apparent difference between the wetted area at 12-15 cubic metres per second and that at 4.5 cubic metres per second is small, and so we estimate that the reduction in wetted area, by reducing the flow from 12 to 2.8 cubic metres per second, would be about 10%. However, a short-term event that periodically reduces the wetted area by 10% does not translate directly to a 10% loss of the benthic invertebrate community, but will be somewhat less. This is due to the fact that (1) the benthic invertebrates of these habitats are adapted to fluctuating flows and therefore some within the dewatered area will escape by either moving vertically down into the substrate or laterally to the wetted portion of stream; and, (2) benthic invertebrate life cycles are such that only some of the community members would be affected on a given occasion.

4.3 MONITORING PLAN

A proposed monitoring plan is provided in Appendix E. It will further document walleye and lake whitefish spawning under existing conditions and following development, as well as the effect of minimum flows upon fish habitat within the bedrock pool upstream of the GS tailrace, and within the 550 metres of river between the tailrace and Kenogamissi Lake.

With the operation of the proposed GS at Mattagami Lake Dam, OPG has agreed to partner with the MNR for a 5 year interval, long-term monitoring study (20 years) of Lake Whitefish. This will be included under Section 11 (effectiveness monitoring) of the WMP at the time of the amendment.

5.0 SUMMARY AND CONCLUSIONS

This technical support document provides an aquatic environmental baseline, as well as the potential environmental effects of the proposed project and the recommended mitigative measures to minimize these effects.

The variety of habitats and habitat conditions in the study area can provide one or more of the spawning, nursery, foraging, over-wintering, juvenile, and adult habitat requirements for the fishes that reside in this section of the Mattagami River system. Between the Mattagami Lake Dam and Kenogamissi Lake the river provides important spawning habitat for some fish species, including walleye and lake whitefish, that reside in this section of the Mattagami River and in Kenogamissi Lake. The walleye is an important game fish in the Timmins area, and the lake whitefish is an important commercial and recreational fish. No fish species considered at-risk occurs in the vicinity of the Mattagami Lake Dam or the proposed GS.

Provided that the recommended mitigation measures are implemented, it is our opinion that the development of the Mattagami Lake Dam site, and the subsequent operation of the proposed GS, will not have a significant or measurable impact upon the composition or production of the Mattagami River fish community.

The key points of this assessment are as follows:

- The mitigation measures proposed to protect critical walleye and lake whitefish fish spawning habitats, are believed to result in no net loss of spawning habitat. There will be no changes in the volume of water, and no significant changes in water velocity, passing over the critical walleye and lake whitefish spawning habitat downstream of the GS during the respective spawning and incubation periods for these species.
- It is believed that the thoughtful design of the GS in combination with the general mitigation measures proposed, will prevent harmful alteration, disruption or destruction (HADD) of fish habitat, or a measurable change in habitat productive capacity.
- The areas that will be directly altered do not serve a critical habitat function during the in-water work window and, although they do contain fish, the fact that they will be temporarily unavailable is not expected to have a significant impact on the productive capacity of the system.
- Following the completion of construction the total amount of habitat will be unchanged.

During construction, potential impacts on the aquatic environment may occur due to in-water construction activities, blasting, soil erosion and turbidity generation, and accidental spills. Based on an assessment of the available baseline information and potential effects, as well as the implementation of the recommended mitigative measures, SENES concludes that effects during construction will be minimal, localized and short-term.

During operations, potential impacts on the aquatic environment may occur due to accidental spills. Based on assessment of the baseline information and potential effects, as well as the

implementation of the recommended mitigative measures, SENES concludes that the operation will have negligible effects on the aquatic environment.

Environmental protection during the proposed generating station's construction and operation will be ensured by adherence to the site-specific Environmental Management Plans, as well as compliance with regulatory standards and guidelines.

An Environmental Management Plan for the project will ensure that environmental protection will be achieved by describing government agency requirements, OPG policy, 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.

Table 5.1 summarizes potential construction and operation effects, the recommended mitigative/remedial measures to minimize or obviate these impacts and the net effects.

Table 5.1 Summary of Potential Effects and Recommended Mitigative/ Remedial Measures

Effect/Activity	Recommended Mitigative/Remedial Measure	Net Effect
Construction		
Soil erosion	<ul style="list-style-type: none"> • Adherence to Erosion and Sediment Control Plan. 	Negligible effect
Incidental spills of oil, gasoline and other liquids during construction	<ul style="list-style-type: none"> • Adherence to Spills Emergency Preparedness and Response Plan. 	Negligible effect
Hazardous Materials/ Waste	<ul style="list-style-type: none"> • Adherence to Hazardous Materials Management Plan and Waste Management Plan. • Waste disposal in accordance with regulatory requirements. 	Negligible effect
Blasting	<ul style="list-style-type: none"> • Adherence to DFO guidelines (Wright and Hopky, 1998) and blasting engineer recommendations. 	Negligible effect
In-water construction activities	<ul style="list-style-type: none"> • 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. • Confined upland disposal of dredged material. 	Negligible effect
Operation		
Incidental spills of oil, gasoline and other liquids during operation	<ul style="list-style-type: none"> • Adherence to Spills Emergency Preparedness and Response Plan. 	Negligible effect

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7.0 ACRONYMS AND ABBREVIATIONS

~	Approximately
AP	Acid potential
ARD	Acid rock drainage
BMP	Best Management Practice
CaCO ₃	Calcium carbonate
CLI	Canada Land Inventory
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
CPUE	Catch-per-unit-effort
DBC	Design-Build-Contractor
D.O.	Dissolved oxygen
Dr.	Drive
ECGM	Environmental Construction Guidelines Manual
e.g.	For example
ER	Environmental Report
ESA	Environmental Site Assessment
<i>et al.</i>	And others
GS	Generating station
>	Greater than
HADD	Harmful alteration, disruption or destruction (of fish habitat)
Hydro One	Hydro One Networks Inc.
i.e.	That is
LRIA	<i>Lakes and Rivers Improvement Act</i>
<	Less than
Max.	Maximum
MDL	Method detection limit
Min.	Minimum
ML/ARD	Metal Leaching and Acid Rock Drainage
MNR	Ministry of Natural Resources
MOE	Ontario Ministry of the Environment
MOEE	Ontario Ministry of Environment and Energy
MRCA	Mattagami Region Conservation Authority
N	North
NHIC	Natural Heritage Information Centre
No.	Number
NP	Neutralizing potential
OPG	Ontario Power Generation Inc.
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
pers. comm.	Personal communication
PWQG	Provincial Water Quality Guideline
PWQO	Provincial Water Quality Objective

MLD Generating Station Aquatic Environment TSD

S1	Extremely rare in Ontario; usually fewer than 5 occurrences (in a 10-km by 10-km Mercator square grid)
S1S2	Extremely rare to very rare in Ontario
S2	Very rare in Ontario; usually between 5 to 20 occurrences (in a 10-km by 10-km Mercator square grid)
S2S3	Very rare to uncommon in Ontario
S3	Rare to uncommon in Ontario; usually between 20 to 100 occurrences (in a 10-km by 10-km Mercator square grid)
S3S4	Rare to common in Ontario
S4	Common in Ontario; apparently secure, usually more than 100 occurrences (in a 10-km by 10-km Mercator square grid)
S5	Very common in Ontario; demonstrably secure
SAN	Accidental
SARA	<i>Species at Risk Act</i>
SE	Exotic; not believed to be a native component of Ontario's fauna
SENES	SENES Consultants Limited
sp.	One species
spp.	A number of species
STP	Sewage Treatment Plant
SVOC	Semi-volatile organic compound
SZN	Not of practical conservation concern as there are no clearly definable occurrences
TPH	Total petroleum hydrocarbons
TS	Transformer station
VOCs	Volatile organic compounds
YOY	Young-of-the-year
W	West

8.0 MEASUREMENT UNITS

cm	centimetre
°	degree
°C	degree Celsius
FTU	Formazin Turbidity Unit
GWh	gigawatt-hour
ha	hectare
Kg	kilogram
Kg/ha	kilogram per hectare
km	kilometre
km ²	square kilometre
KV	kilovolt
L/s	litre per second
M	metre
M/km	metre per kilometre
M/s	metre per second
M ³ /s	cubic metre per second
mg/L	milligram per litre
mm/s	millimetre per second
MW	megawatt
'	minute
no./100 mL	number per 100 millilitre
/h	per hour
%	percent
S	second
”	second
µg/L	microgram per litre
µmhos/cm	micromhos per centimetre
/m ²	per square metre

9.0 GLOSSARY

Acarina	Mites and ticks (water mites).
Acidity	The quantitative capacity of water to neutralize a strong base to a designated pH.
Algae	A group of unrelated simple plant organisms that live in aquatic habitats.
Alkalinity	Measure of a water's capacity to neutralize an acid.
Anaerobic	Condition lacking free oxygen.
Annelida	A phylum of invertebrates comprising the segmented worms.
Aquatic macrophytes	Rooted, usually vascular, aquatic plants, such as water lily, cattail, coontail, etc.
Arachnoidea	A class of primarily terrestrial arthropods including spiders, scorpions, harvestmen, ticks and mites.
Arthropoda	A phylum of invertebrate animals characterized by an outer body layer, the exoskeleton.
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.
Biological Oxygen Demand	Measure of the amount of oxygen required to oxidize the organic matter by anaerobic microbial decomposition to a stable inorganic form
Bivalva (Pelecypoda)	Clams.
Brownian Movement	The random movement of microscopic particles suspended in a gas or liquid.
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.).
Capacity Factor	Ratio of the actual energy produced to the maximum energy which could be delivered under continuous operation at maximum rating.
Ceratopogonidae	Biting midge fly larvae.
Chironomidae (chironomids)	Midge fly larvae.
Chute	A steeply-inclined natural passageway or constructed pipe or channel which conveys water from a higher to a lower level.
Class	A category used in the classification of organisms that consists of similar or closely related orders.

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 (aquatic).
Conductivity	Numerical expression of a water's ability to conduct an electrical current; the conductivity of water is dependent on its ionic concentrations and temperature.
Dam	A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir.
Diatoms	Unicellular algae, usually microscopic, that are characterized by having a cell wall of silica.
Diptera	Flies.
Drawdown	The magnitude of the change in water surface elevation of a well, reservoir, or natural body of water, resulting from the withdrawal of water.
Empididae	Dance fly larvae, dagger fly larvae.
Enchytraeidae	Potworms.
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.
Epipellic	Associated with (attached to) bottom sediments in waterbodies.
Epiphytic	Attached to vegetation, e.g., larger filamentous algae, mosses and aquatic macrophytes.
Extirpation	Elimination of a species in the wild of a particular area (e.g., Canada), but occurring elsewhere.
Family	A category used in the classification of organisms that consists of one or several similar or closely related genera.
Forebay	The part of a dam's reservoir that is immediately upstream from the powerhouse.
Freshet	High flows in a stream or river, usually occurring in the spring, caused by snow melt, runoff, heavy rains and/or high inflows.
Gain	A cut or groove to receive a timber, as a girder or fastener.
Genus (plural genera)	A group of animals and plants having common structural characteristics distinct from those of all other groups and usually containing several species.
Geotechnical	Concerned with the physical properties of soil, rock and groundwater usually in relation to the design, construction and operation of engineered works.
HADD	Harmful alteration, disruption or destruction (of fish habitat)
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.

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Head	The difference in elevation between the water surface at the intake and tailrace.
Headgate (Control Gate)	The gate that controls water flow into a hydroelectric dam.
Headpond	The reservoir from which water is extracted for power generation or spillage.
Hirudinea	Aquatic leeches.
Insecta	Insects.
Intake	A structure which regulates the flow of water into a water-conveying conduit.
Interstitial	Associated with openings particularly between things that are close together.
Ion (ionic)	An atom that is either negatively or positively charged.
Lentic	Slow flowing or still water, e.g., in ponds and lakes.
Lotic	Flowing water, e.g., in streams and rivers.
Lumbriculidae	A family of aquatic annelids (worms) in the order Oligochaeta.
Mirex/Photomirex	Although mirex (a cyclodiene insecticide) is no longer produced or used in North America, it is very persistent in the environment and highly resistant to degradation; it is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity in experimental animals; mirex can be photochemically converted in the environment to photomirex, a suspected gastrointestinal or liver toxicant.
Mollusca	Molluscs (snails and clams).
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	Worms.
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 lies on top of the underlying mineral or other deposit, e.g., bedrock
Penstock	A structure associated with a hydroelectric station, designed to carry water from the intake to the turbine.
Periphyton (Aufwuchs)	The organisms, collectively, that live attached to rocks, gravel, aquatic vegetation and other substrate.
pH	Indicates the balance between the acids and bases in water and is a measure of the hydrogen ion concentration in solution.
Phylum	A major division of the animal kingdom containing classes of animals.
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 waterbody.

MLD Generating Station Aquatic Environment TSD

Platyhelmenthes	A phylum of acoelomate (without a coelum) invertebrates comprising the flatworms, characterized by a flattened unsegmented body.
Plecoptera	Stonefly larvae.
Pneumatic	Involving the mechanic properties associated with air or other gas pressure.
Polychlorinated Biphenyls	A group of biologically persistent organic compounds containing chlorine, previously used in electrical transformers and capacitors because of their insulating capacity and fire resistance; due to their persistence, they are being phased out and destroyed.
Polycyclic Aromatic Hydrocarbons	Widespread organic compounds containing two or more aromatic (benzene) rings, e.g., anthracene, benzo(a)pyrene, naphthalene.
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.
Quonset Hut	A light weight prefabricated structure of corrugated steel having a semicircular cross-section.
Rip Rap	Broken rock/stones used to build a sustaining wall or foundation.
Rotifer	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.
Shannon-Wiener Diversity Index	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.
Sill	A horizontal member forming the upper and/or lower foundation, or part of the foundation, of a structure.
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 with characteristics that make it particularly sensitive to human activities or natural events.
Species	A group of closely related individuals which can and normally do interbreed to produce fertile offspring.
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.
Storage Capacity	The volume of water contained between the maximum and minimum allowable levels within a reservoir.

Tailrace	A channel through which the water flows away from a hydroelectric plant following its discharge from the turbine(s).
Talus	Sloping mass of rock fragments below a cliff.
Taxon (plural taxa) or Taxonomic Group	One of a hierarchy of levels in the biological classification of organisms: the seven major categories are (in order of decreasing size) kingdom, phylum (or division), class, order, family, genus, species. The taxonomic groups can be high (class level), intermediate (family level) or low (genus or species level).
Terrestrial	Belonging, living on or growing in the earth or land.
Threatened	A species likely to become endangered if limiting factors are not reversed.
Total Kjeldahl Nitrogen	Measure of both ammonia and organic nitrogen.
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.
Trichoptera	Caddisfly larvae.
Tricladida	Planarians, an order of Turbellaria.
Trophic	Level of organization in the food chain, e.g., producers, herbivores, carnivores.
Turbellaria	Free-living flatworms.
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 and 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.
Weir	A dam in the river to stop and raise the water.
Young-of-the-year	Fish that hatched during the year when caught.
Zooplankton	That portion of plankton consisting of animals, usually minute crustaceans and other small multicellular and single cellular animals.

**APPENDIX A
PHOTOGRAPHS**

Photograph 1. November 21, 2006.
Mattagami Lake.



Photograph 2. May 2, 2006.
Mattagami Lake after winter draw-down.



Photograph 3. May 2, 2006.

Upstream side of Mattagami Lake Dam showing old rock filled crib structures.



Photograph 4. May 2, 2006.

Rock rubble adjacent to the west end of the Mattagami Lake Dam.



Photograph 5. May 2, 2006. River flow is approximately $12 \text{ m}^3/\text{s}$.
View downstream from the deck of the Mattagami Lake Dam.



Photograph 6. June 21, 2006. River flow is approximately $13.7 \text{ m}^3/\text{s}$.
View upstream to Mattagami Lake Dam from road bridge.



Photograph 7. October 18, 2006. River flow is approximately 36.9 m³/s.
Panoramic view from beneath road bridge, showing upstream dam and habitats beneath and immediately upstream of bridge.



Photograph 8. May 2, 2006. River flow is approximately 12 m³/s.
Downstream view from deck of road bridge, showing most of Area B (Figure 2).



Photograph 9. May 2, 2006. River flow is approximately $12 \text{ m}^3/\text{s}$.
Area C showing bedrock along north bank and cobble/boulder along south bank (left).



Photograph 10. September 11, 2008. River flow is $1.2 \text{ m}^3/\text{s}$.
View from the south side of the river to the bedrock north side.



Photograph 11. August 28, 2007. River flow is approximately $7 \text{ m}^3/\text{s}$.
Area C showing cobble/boulder substrate.



Photograph 12. June 21, 2006.
Area D showing slower, deep water at river flow of approximately $13.7 \text{ m}^3/\text{s}$.



Photograph 13. May 3, 2006. Area E. River flow is approximately $12 \text{ m}^3/\text{s}$.
Upstream view with bedrock and large boulders on east side (left) and cobble and smaller boulders on west side (right).



Photograph 14. May 3, 2006. Area E. River flow is approximately $12 \text{ m}^3/\text{s}$.
Downstream view with bedrock and large boulders on east side (right) and cobble and smaller boulders on west side (left).



Photograph 15. August 28, 2007. Area E. River flow is approximately $7 \text{ m}^3/\text{s}$. View from west side showing cobble and boulder walleye spawning area.



Photograph 16. May 3, 2006. River flow is approximately $12 \text{ m}^3/\text{s}$. Area F. Where transition between lotic and lentic habitats occur.



Photograph 17. May 3, 2006.
Cobble/gravel substrate within Area F.



Photograph 18. May 2, 2007. Refer to Figure 2 for photograph location.
Small watercourse entering Area B from the west.



Photograph 19. May 2, 2007. Refer to Figure 2 for photograph location.
Incised portion of small watercourse.



Photograph 20. October 18, 2006. River flow is approximately 36.9 m³/s.
Whitefish dipnetters downstream of the road bridge.

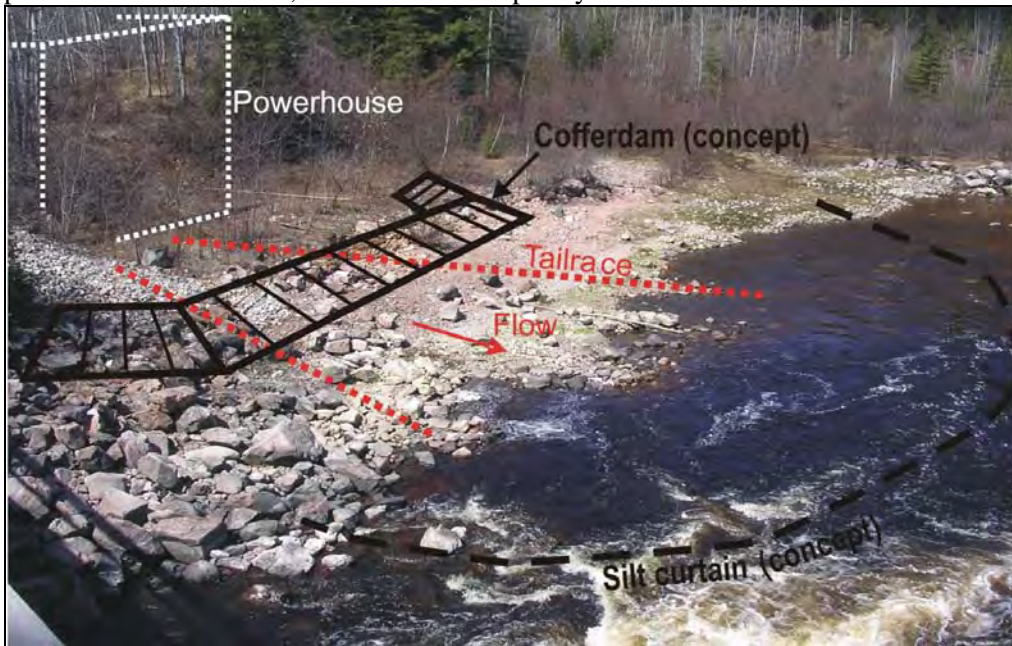


Photograph 21. May 2, 2006. River flow is approximately 12 m³/s.

View from west end of the Mattagami Lake Dam showing the bedrock riverbed immediately downstream of the two west-most sluice gates. The red line indicates the approximate limit (from the photographer) of the proposed intake channel.



Photograph 22. May 2, 2006. River flow is approximately 12 m³/s. View downstream of the road bridge showing the conceptual locations of the proposed powerhouse and tailrace, as well as the temporary cofferdam and silt curtain.



APPENDIX B
NUMERICAL MODELING OF PROPOSED TAILRACE CONFIGURATION



GESTION CONSEIL S.C.P. INC.

The logo for BPR is the letters 'BPR' in a white, serif font, set against a solid blue square background.



Ontario Power Generation

MATTAGAMI LAKE DAM DEVELOPMENT

NUMERICAL MODELING OF PROPOSED TAILRACE CONFIGURATIONS

TECHNICAL REPORT

SCP Reference: 64126E169 (60ET)

February 24, 2007
Revision: 01

Ontario Power Generation

Mattagami Lake Dam Development

Numerical Modelling of
Proposed Tailrace Configurations

TECHNICAL REPORT

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SCP Reference: 64126E169 (60ET)

February 24, 2007
Rev. 01



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APPENDIXES

- Appendix 1: Basic Data
- Appendix 2: Field Work Data
- Appendix 3: Raw Topographic Data and Land Model
- Appendix 4: Simulation Results

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1. INTRODUCTION

The Ontario Power Generation (OPG) is studying the feasibility of development of a small hydroelectric plant in immediate vicinity of the company's Mattagami Lake Control Dam. The field studies conducted in 2006 revealed the existence of fish spawning downstream of the existing Bailey bridge, where the proposed tailrace is to be located. In a meeting with Department of Fisheries and Oceans Canada (DFO) and Ministry of Natural Resources (MNR), the agencies requested a numerical study to assess the impact of the proposed tailrace configurations on the fish spawning.

OPG has commissioned SCP-BPR to conduct the numerical modeling study. The present report documents the details and results of this study. The figure included in Appendix 1 shows the location of the study area, which extends about 200 m downstream of the Bailey bridge

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2. NUMERICAL MODELLING

The study is based on 2D hydraulic modeling of about 200m-long section of the river downstream of the Bailey bridge. MODELEUR software developed by the "Institut National de Recherche Scientifique Eau-terre et Environnement (INRS-ETE) was utilized in simulation. Water level and flow measurements conducted on September 19 and December 11 2006 have been used to calibrate the model.

2.1 THE MODELEUR SOFTWARE

The MODELEUR software combines the features of a Geographical Information System (GIS) applied to river hydraulics, with powerful capabilities of pre- and post-processing of various finite element components. MODELEUR is coupled with a finite element solver for the solution of 2D hydrodynamic equations (St-Venant equations), which has the capacity to manage drying/wetting conditions to track the evolution of the shoreline with respect to water level. MODELEUR can achieve all phases of terrain data integration to produce a complete Numerical Terrain Model (NTM) based on a finite-element mesh. In addition, MODELEUR facilitates the use and control of hydrodynamic simulations. The software is a highly interactive multi-window application and runs on WindowsNT/95 PC platforms with Pentium processors. It is written in C++ with an internal architecture complying with the object-oriented programming philosophy. MODELEUR is made of several interconnected modules, such as data management, display, construction of NTM, simulation control, and various tools such as a data probe and a programmable calculator adapted to finite elements.

2.2 SUMMARY OF PERTINENT INFORMATION

Success of hydrodynamic simulation requires accurate description of the study area in the model, i.e. mainly topography and bathymetry, and the relationship between the water levels and the flows at various locations in the river. Also, flow and water level measurements made in September 2006 have been used to generate rating curves at various locations in the study area. All this information is called "basic data" for model input and included in Appendix 1.

2.3 ADDITIONAL FIELD WORK

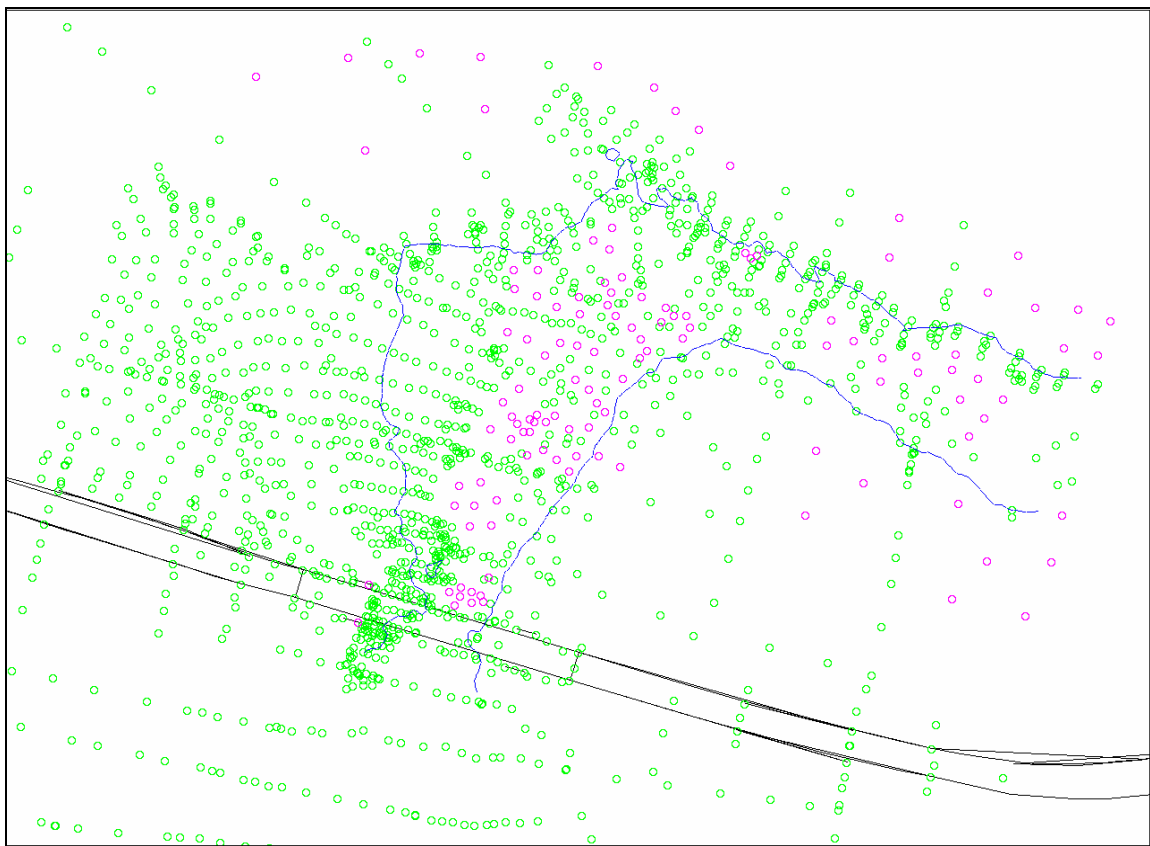
Analysis of the basic data has revealed the need for additional land surveys in order to adequately reproduce some of the characteristics of the study area. New land surveys have been conducted on December 11, 2006 by closing all stoplog sluices of the existing control dam, allowing only the leakage flow. Flow velocities and water level measurements were made at various locations in the study area. This additional field work has been supervised by the hydraulic engineer to ensure collection of the remaining critical data for the numerical simulation. The data for the new field work is included in Appendix 2.

3. MODEL CALIBRATION

3.1 LAND MODEL

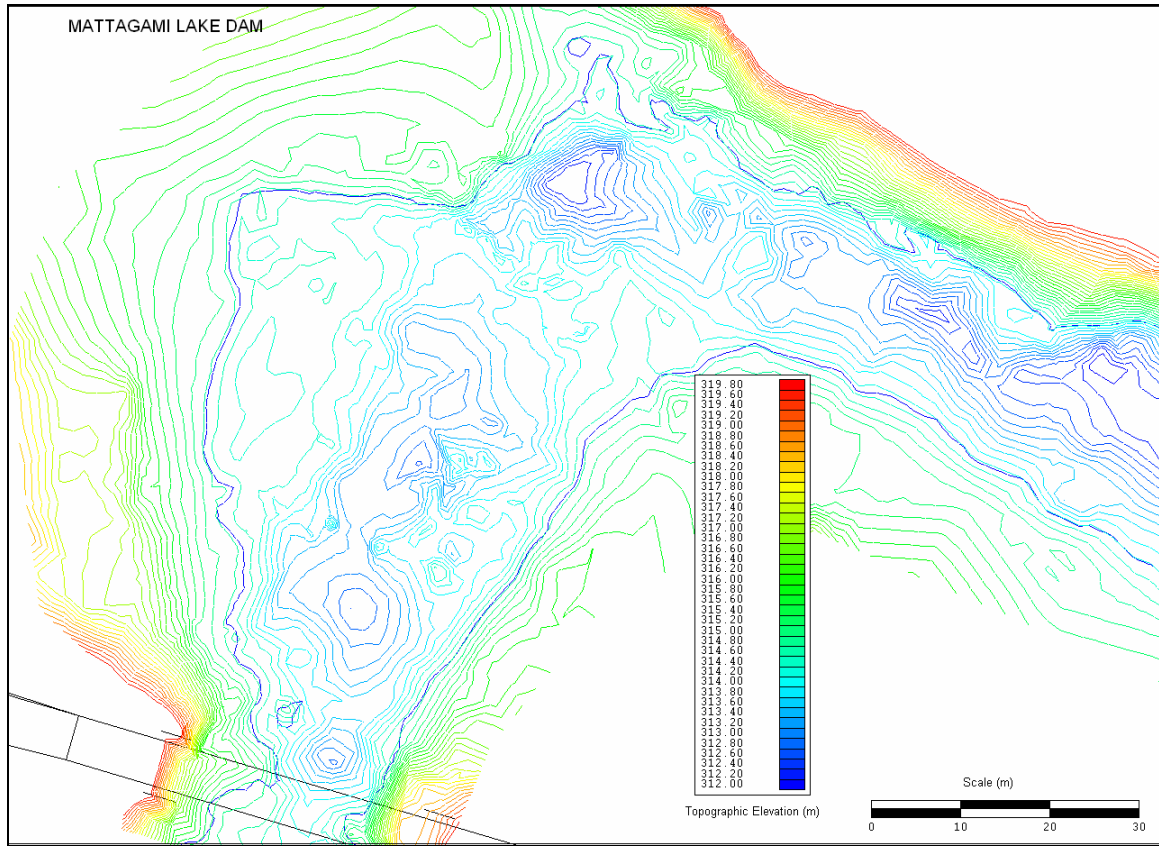
Topographical and bathymetric data come from the surveys conducted in July-August 2006 and December 11, 2006. The meshing allowing the characterisation of the topography and supporting the land model has been fine-tuned (1 mx1m mesh) in areas with changing topography and having an impact on the hydrodynamics of the river. Based on site observations, and photo and video recording made during the field investigation, some topographical points have been added manually in the raw topographic data file to ensure that the topography is adequately transferred over the meshing. Figure 3-1 shows the raw topographic data used in the model and Figure 3-2 shows the land model.

Figure 3-1: Raw Topographic Data



Green = Basic data.
Pink = Data added manually.

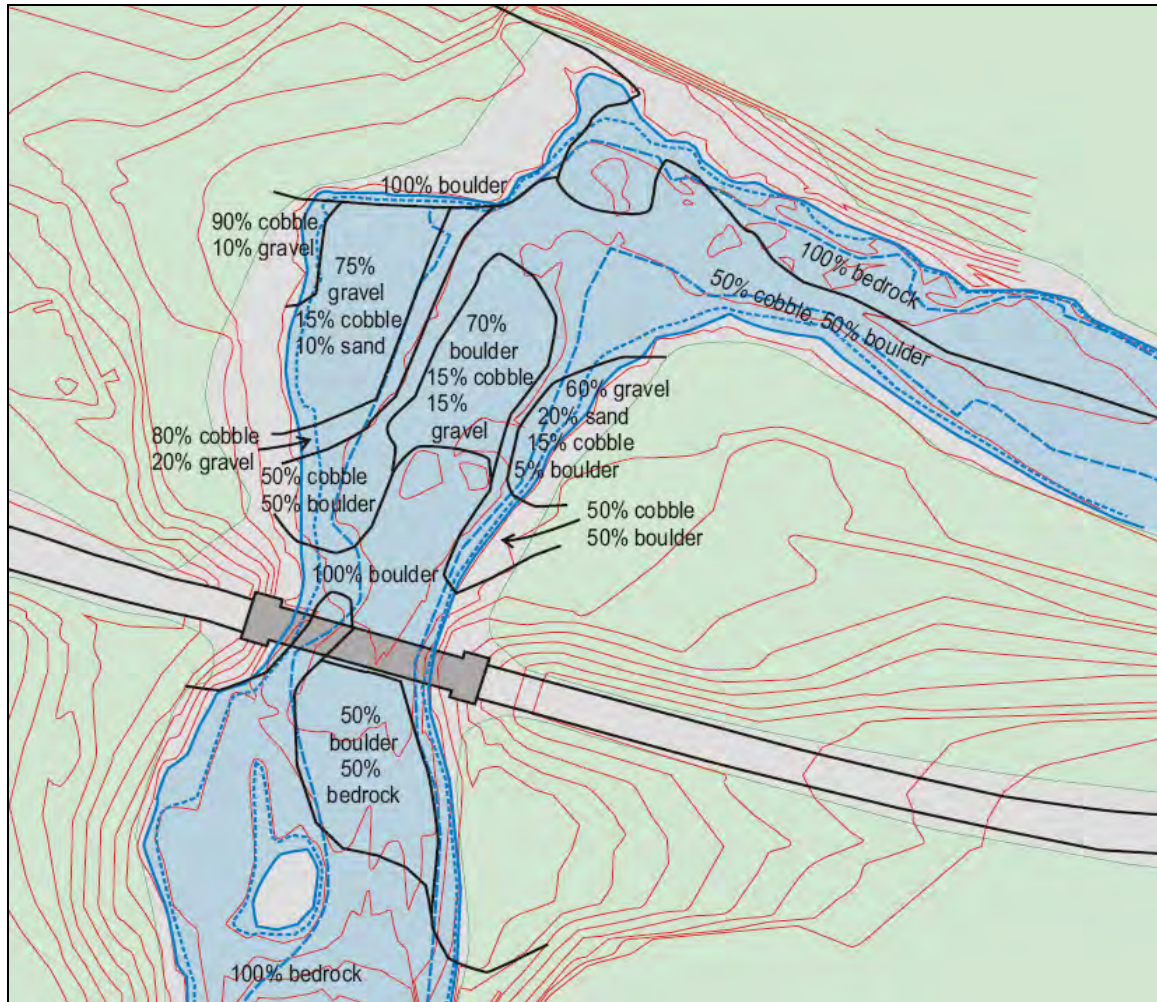
Figure 3-2: Land Model



3.2 ROUGHNESS COEFFICIENTS

The roughness coefficients (i.e., Manning coefficient) was determined based on observations of the river bed material reported by Cam Portt and Associates at the end of the fish habitat study in June 2006. Figure 3-3 (Appendix 3 of this report) shows the percentage distribution of the river bed material in the study area.

Figure 3-3: Characterisation of the River Bottom



3.3 CALIBRATION

The model has been calibrated based on measurements made on September 19 and December 11, 2007.

On December 11th, velocity and water level measurements were made at locations shown in Figure 3-4. The leakage flow was calculated as 2.2 m³/s based on the velocity measurements. Table 3-1 shows the comparison between the water level measurements and numerical model predictions. The results are in good agreement. The largest variation is 7 cm and this is acceptable considering the accuracy of water level measurements in the field, which can vary according to the position of the prism point. The superimposition of water lines predicted by the numerical model over the survey observations also illustrates the adequacy of the numerical model.

Figure 3-4: Calibration in Leakage Flow Conditions

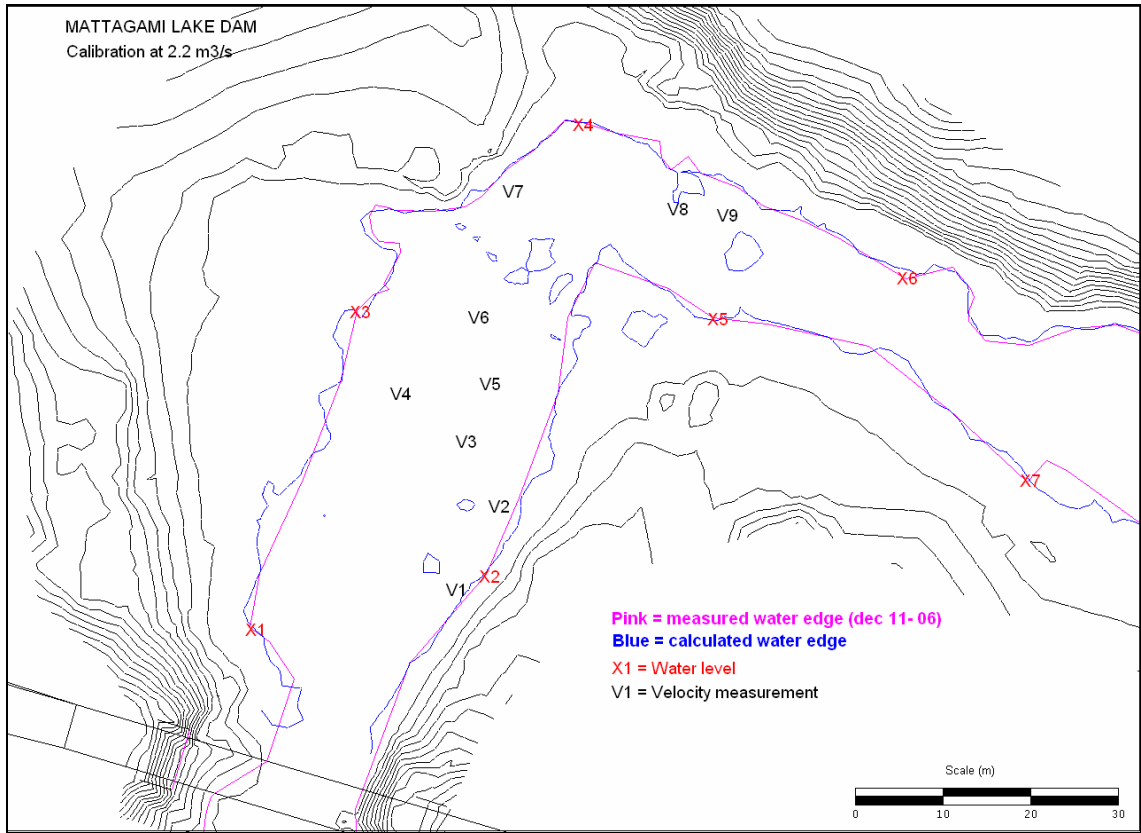


Table 3-1: Summary of the Water Levels for a Flow of 2.2 m³/s

Identification of the Point of Measurement	Value Measured <i>in situ</i> (m)	Calculated Value (m)
X1	314.34	314.29
X2	314.32	314.29
X3	314.33	314.28
X4	314.06	314.06
X5	313.92	313.99
X6	313.72	313.72
X7	313.75	313.70

Table 3-2 lists the current velocities measured at the site on December 11th at the locations shown in Figure 3-4. They have been used for calibration of the model. Table 3-2 also shows the velocities calculated by the model. Comparison shows the good correlation between the measured and calculated values, which proves again the adequacy of the calibration of the numerical model for the leakage flow. The biggest variation is 0.04 m³/s, which is acceptable considering the local conditions and the low flow.

Table 3-2: Summary of the Velocity for a Flow of 2.2 m³/s (measured vs. calculated)

Identification at the point of measurement	Value Measured <i>in situ</i> (m/s)	Calculated Value (m/s)
V1	0.16	0.15
V2	0.15	0.11
V3	0.02	0.04
V4	0.16	0.19
V5	0.15	0.11
V6	0.23	0.23
V7	0.56	0.58
V8	0.54	0.57
V9	0.99	0.95

Finally, the analysis of the water balance in way of the boundary conditions pertaining to the study area is the last element that allows the evaluation of the calibration of the model. As an example, the model calculates the flow values under the leakage flow conditions at the upstream model boundary (2.25 m³/s) and the downstream model boundary (2.18 m³/s). These values are differ from the field measurement of 2.2 m³/s by only 2.2% and 0.9% respectively, which are less than generally accepted limit of 5% for excellent simulations.

Table 3.3 shows the calibration results based on the September 19, 2006 data. A rating curve was established from these data (flow vs water level) and the simulations results were compared with the water levels obtained in the rating curve. Also, the flow calculated by model at the edge of the simulated area is shown in the table to evaluate the water balance.

The data from September 19, 2006 has also been used to set the boundaries applicable to the model (input and output). For each simulated flow, it is indeed necessary to specify the water level input and output of the modeled domain. These water levels have been estimated using flow measurements taken on September 19th. Appendix 2 includes the basic data that has been used.

**Table 3.3:
Summary of model validation based on September 19, 2006 measurements**

Flows (m ³ /s)	Water level at section 2* from rating curves (m)	Water level calculated by the model (m)	Flows calculated by the model (m ³ /s)
14	314.68	314.72	13.7
17	314.81	314.80	16.6
39	315.38	315.33	38.5
74	315.81	315.78	74.2

* Section 2 is located 30 m upstream of the 90deg elbow in the river (downstream of the planned location)

4. RESULTS

Several flow conditions have been simulated for three powerhouse configurations shown in Figure 4-1. The distance between the closest point of the powerhouse case and the road is shown in Table 4-1, as well as the angle of the tailrace centreline relative to the bridge.

Figure 4-1: Case study for tailrace and powerhouse location

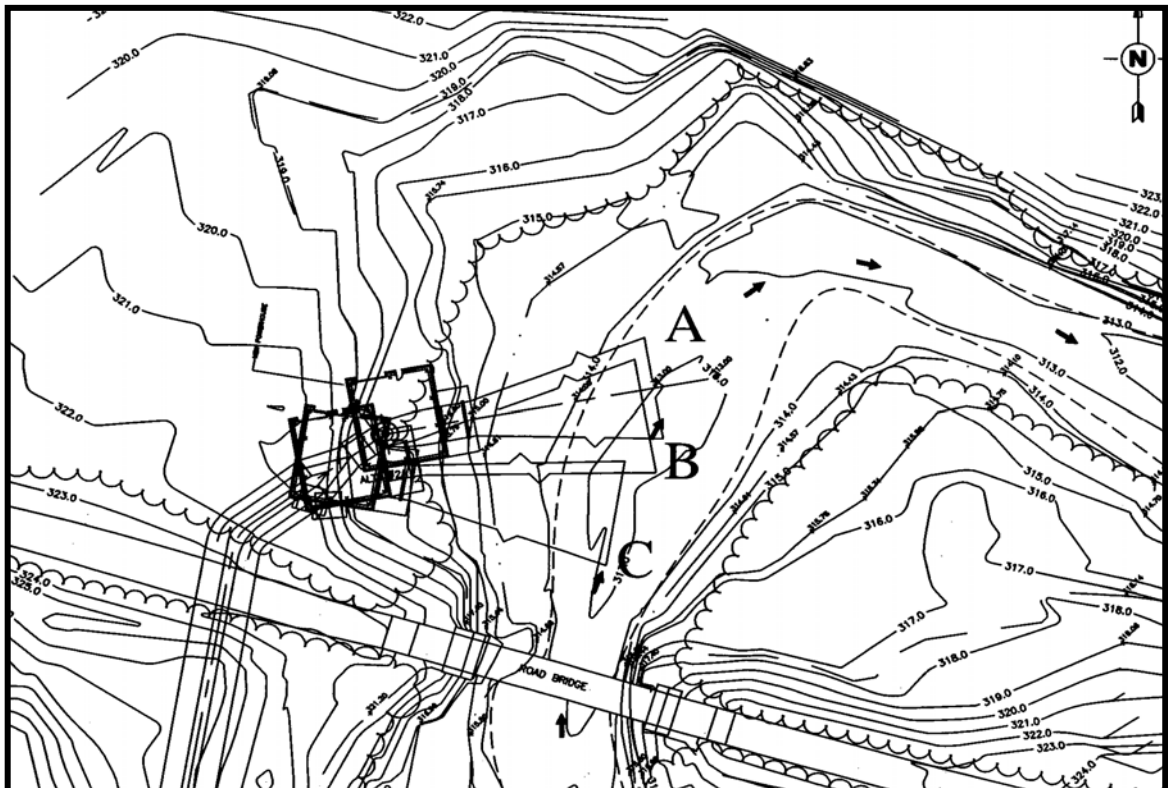


Table 4-1:
Distance Between the Powerhouse Case and the Road
and the Angle of the Tailrace Centreline Relative to the Bridge

Case study	Distance between the powerhouse case and the road (closest point) (m)	Angle of the tailrace centreline relative to the bridge (in degrees)
A	20	27
B	11.5	27
C	13	6

**Table 4-2:
Coordinates of the power house (MTM, NAD 83)**

Case study	Pts	X (m)	Y (m)
A	1	458 390.614	5 318 090.142
	2	458 392.273	5 318 075.838
	3	458 404.424	5 318 078.097
	4	458 401.765	5 318 092.400
B	1	458 381.295	5 318 084.033
	2	458 383.953	5 318 069.730
	3	458 396.104	5 318 071.988
	4	458 393.446	5 318 086.292
C	1	458 383.820	5 318 086.214
	2	458381.392	5 318 071.869
	3	458 393.579	5 318 069.807
	4	458 396.006	5 318 084.152

The topography has been modified to accommodate the proposed powerhouses and tailraces. Appendix 3 shows a longitudinal-section of the powerhouse, draft tube and tailrace. The hydrodynamic mesh supporting the calculation is shown in Figure 4-2. It includes more than 16,502 nodes. All the simulation results are included in Appendix 4.

Figure 4-2: Hydrodynamic Mesh

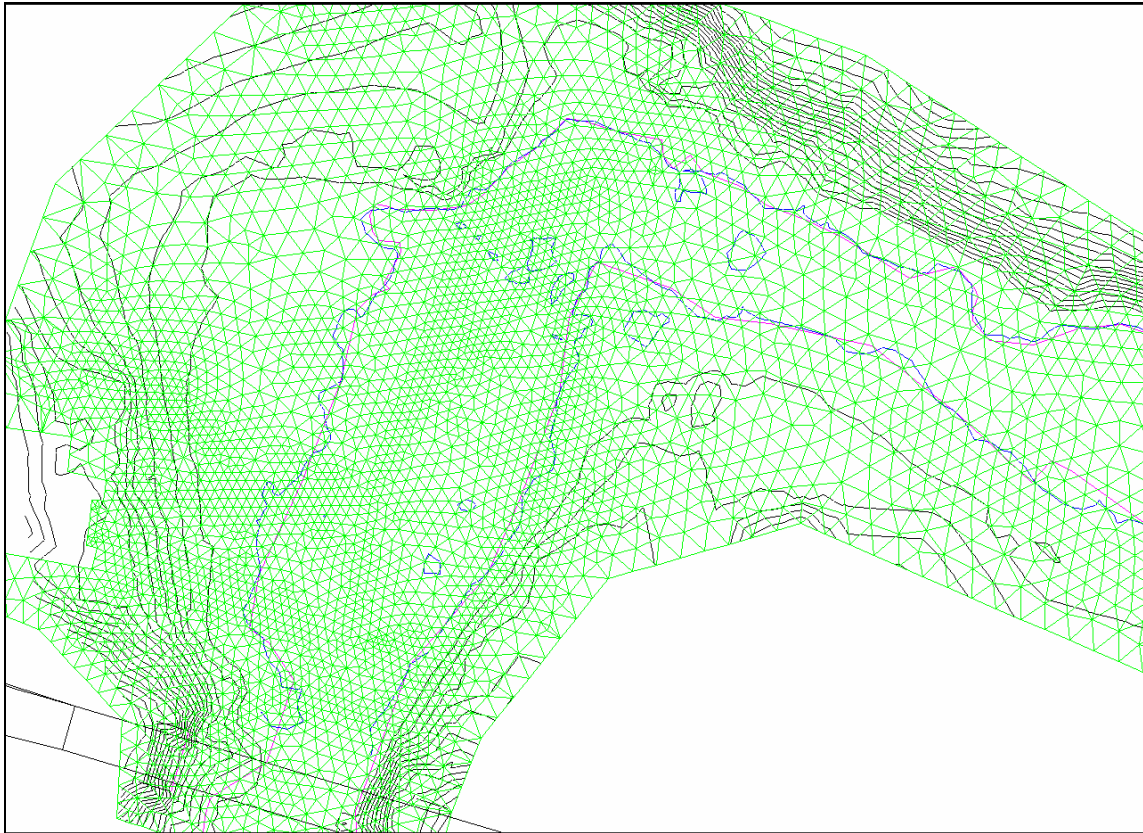


Table 4-3: Summary of the Studied Scenarios

Tailrace Configuration	Flow from Dam (m ³ /s)	Flow from Tailrace (m ³ /s)	Results
None (actual situation)	37	0	Figure A-4.1
Case study A	2	35	Figure A-4.2
None (actual situation)	39	0	Figure A-4.4
Case study B	2	37	Figure A-4.5
None (actual situation)	14	0	Figure A-4.7
Case study C	2	12	Figure A-4.8
None (actual situation)	39	0	Figure A-4.12
Case study C	2	37	Figure A-4.13
None (actual situation)	74	0	Figure A-4.17
Case study C	37	37	Figure A-4.18
None (actual situation)	17	0	Figure A-4.22
Case study C	2	15	Figure A-4.24
None (actual situation)	12	0	Figure A-4.27
Case study C	4	12	Figure A-4.29

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4.1 SCENARIO - 37 M³/S - TAILRACE CONFIGURATION -A-

Figure A-4.1 of Appendix 4 shows the velocity field results for a river flow of 37 m³/s prior to the construction of the powerhouse. Flow velocities are very high under the bridge (2.7 to 3.0 m/s) due to the restriction caused by the abutment of the structure and the steep slope of the water course at that location. A 50-meter transition area can be observed after, where velocities reach 1 m/s. In the meander, at the threshold, the velocity increases to 1.5 m/s. Further, the velocity is maintained in the straight section of the river after the meander.

Figure A-4.2 of Appendix 4 shows the velocity field results after the construction of the powerhouse for tailrace configuration Case Study A (Figure 4-1 above). The flow coming out of the draft tube is 35 m³/s and the river flow under the bridge is 2 m³/s. As shown in Figure A-4.3, this scenario includes significant changes in the distribution of the velocity field up to the threshold located in the meander. Downstream of this threshold, the changes are negligible. The main modifications occur in the section under the bridge and at the draft tube's exit point.

4.2 SCENARIO - 39 M³/S - TAILRACE CONFIGURATION -B-

This scenario is very similar to the one mentioned above, except that the location of the draft tube has been slightly modified, as shown in Figure 4-1 above (Case Study B). The flow has also been adjusted in order to better represent the maximum rated capacity of the powerhouse. Figure A-4.4 of Appendix 4 shows the velocity field results for a river flow of 39 m³/s prior to the construction of the powerhouse.

As in the previous scenario, Figure A-4.5 of Appendix 4 shows the velocity field results after the construction of the powerhouse. The flow at the draft tube's exit point is 37 m³/s and the river flow under the bridge is 2 m³/s. As shown in Figure A-4.6, this scenario includes significant changes in the distribution of the velocity field up to the threshold located in the meander. Downstream of this threshold, the changes are negligible. The main changes occur in the section under the bridge and at the draft tube's exit point.

4.3 SCENARIO - 14 M³/S - TAILRACE CONFIGURATION -C-

In this scenario, the powerhouse is located closest to the embankment created for the road and the draft tube is almost perpendicular to the river flow, as shown in Figure 4-1 above (Case Study C). To model light flow conditions in the river and to show the impact of the project in these circumstances, the flow has been decreased to 14 m³/s. Figure A-4.7 of Appendix 4 includes the velocity field results in the river prior to the construction of the powerhouse.

As in the previous scenario, Figure A-4.8 of Appendix 4 shows the velocity field results after the construction of the powerhouse. The flow at the draft tube's exit point is 12 m³/s and the river flow under the bridge is 2 m³/s. As shown in Figure A-4.9, this scenario includes significant changes in the distribution of the velocity field only in the section under the bridge and in a 30-meter long transition area downstream of the bridge. Afterwards, the changes become negligible up to the threshold located in the meander of the river, as well as downstream of the threshold.

Figures A-4.10 and A-4.11 of Appendix 4 show the sections where the current velocity ranges between 0.3 and 0.9 m/s for the actual conditions and for the conditions after construction. This range of velocities corresponds to the optimal velocities for fish breeding.

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4.4 SCENARIO - 39 M³/S - TAILRACE CONFIGURATION -C-

In this scenario, the location of the powerhouse is the same as in the previous scenario, i.e. closest to the embankment created for the road. The draft tube is almost perpendicular to the river flow, as shown in Figure 4-1 above (Case Study C). To model an average flow in the river and the impact of the project in these circumstances, the flow has been increased to 39 m³/s. Velocity field results in the river prior to the construction of the powerhouse are shown in Figure A-4.12 in Appendix 4.

As in the previous scenarios, Figure A-4.13 of Appendix 4 shows the velocity field results after the construction of the powerhouse. The flow at the draft tube's exit point is 37 m³/s and the river flow under the bridge is 2 m³/s. As shown in Figure A-4.14, this scenario includes significant changes in the distribution of the velocity field in the section under the bridge, in a 40-meter long transition area downstream of the bridge and near the draft tube's exit point. Further, the changes are negligible up to the threshold located in the meander of the river, as well as downstream of the threshold.

Figures A-4.15 and A-4.16 in Appendix 4 show the areas where the current velocity ranges between 0.3 and 0.9 m/s for the actual conditions and for the conditions after construction. This range of velocities corresponds to the optimal velocities for fish breeding.

4.5 SCENARIO - 74 M³/S - TAILRACE CONFIGURATION -C-

In this scenario, the location of the powerhouse is the same as in the previous scenario, i.e. closest to the embankment created for the road. Also, the draft tube is almost perpendicular to the river flow, as shown in Figure 4-1 above (Case Study C). To model high flow conditions in the river and the impact of the project in these circumstances, the flow has been increased to 74 m³/s. The velocity field results in the river prior to the construction of the powerhouse are shown in Figure A-4.12 in Appendix 4. In these conditions, the flow velocity is higher than 3 m/s under the bridge and over a distance of more than 20 meters downstream of the bridge. After that point and up to the threshold in the meander, the velocities are higher than 1.5 m/s, even reaching 2.0 m/s in the section immediately after the meander.

As in the previous scenarios, Figure A-4.18 of Appendix 4 shows the velocity field results after the construction of the powerhouse. The flow at the draft tube's exit point is 37 m³/s. The river flow under the bridge is also 37 m³/s. As shown in Figure A-4.19, this scenario includes significant changes in the distribution of the velocity field in the section under the bridge, in a 60-meter long transition area downstream of the bridge and near the draft tube's exit point. Further, the changes are negligible up to the threshold located in the meander of the river, as well as downstream of the threshold.

Figures A-4.20 and A-4.21 in Appendix 4 show the areas where the current velocity ranges between 0.3 and 0.9 m/s for the actual conditions and for the conditions after construction. This range of velocities corresponds to the optimal velocities for fish breeding.

4.6 SCENARIOS AT 12, 16 AND 17 M³/S - TAILRACE CONFIGURATION -C-

In this group of scenarios, the location of the powerhouse is the same as in the previous scenario, i.e. closest to the embankment created for the road. Also, the draft tube is almost perpendicular to the river flow, as shown in Figure 4-1 above (Case Study C). Figures A-4.22 to A-4.29 in Appendix 4 show the results for these scenarios.

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5. CONCLUSIONS

The 2D hydraulic modeling activities using the MODELEUR-HYDROSIM software allows accurate hydrodynamic simulation of a 200m-long section of the river downstream of the Bailey bridge under present and future conditions. The model is calibrated based on excellent quality topographic and bathymetric surveys, water level and velocity measurements at the site and field observations of the river bed material in the study area. By using this data, rating curves were developed to define water level-river flow relationships at various locations in the model.

In conclusion, we believe that the results obtained for each scenario are sufficiently accurate representation of velocities and water levels to assess the impact of the proposed project on the fish habitat and spawning.

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APPENDIX 1

Basic Data

Gross Head = HWL - TWL

HWL: Headpond level measured with DCP

TWL: Surveyed water level at each section

TWL1: Surveyed water level at Section 1

H1: Gross Head at Section 1 (=HWL - TWL1)

Measured Values			
Flow (cms)	HWL (m)	TWL (m)	Section #
15.45	330.720	316.642	1
15.45	330.720	314.364	2
15.45	330.720	313.792	3
15.45	330.720	323.423	4
20.30	330.712	316.785	1
20.30	330.712	314.534	2
20.30	330.712	313.910	3
20.30	330.712	324.200	4
39.00	330.702	317.073	1
39.00	330.702	314.940	2
39.00	330.702	314.224	3
39.00	330.702	324.251	4
57.00	330.696	317.350	1
57.00	330.696	315.211	2
57.00	330.696	314.366	3
57.00	330.696	324.310	4
77.80	330.674	317.471	1
77.80	330.674	315.496	2
77.80	330.674	314.577	3
77.80	330.674	324.382	4
77.80	330.674	314.311	5
94.10	330.660	317.535	1
94.10	330.660	315.627	2
94.10	330.660	314.692	3
94.10	330.660	324.408	4
94.10	330.660	314.460	5

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APPENDIX 2 Field Work Data

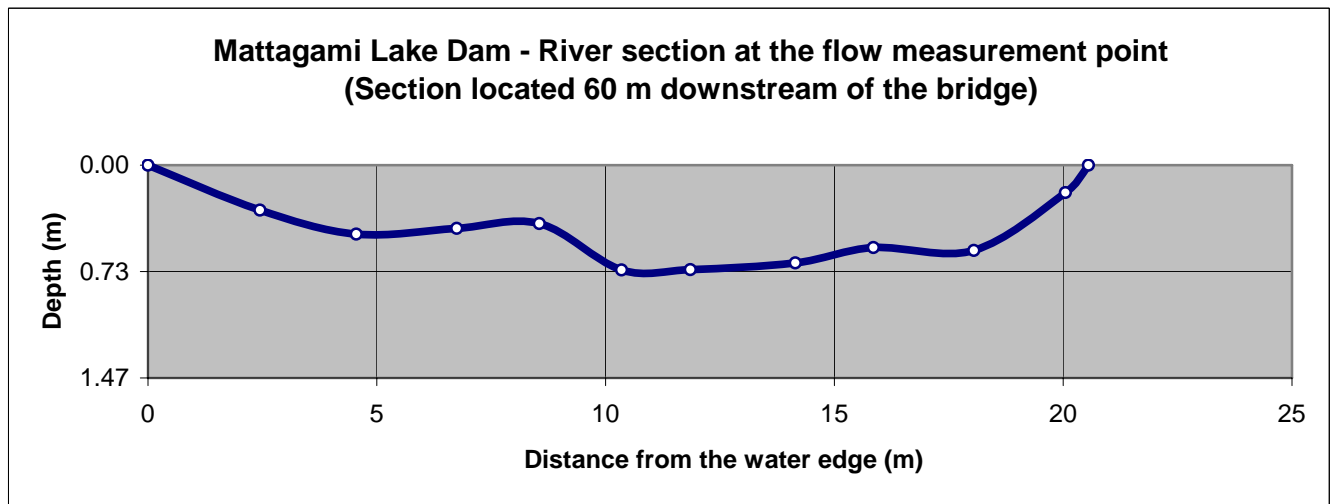
Flow measurements results / Taken with a current meter on Dec. 11,2006

Date
Dec. 11 2006

Water level
314.32

Point (#)	Velocity (m/s)	Distance (m)	Elevation	Water depth (m)	Surface (m ²)	Flow (m ³ /s)	Cumulative Distance (m)
0	0.00	---	314.320	0.00	---	---	0
1	0.05	2.5	314.009	0.31	0.38	0.01	2.5
2	0.22	2.1	313.845	0.47	0.83	0.11	4.6
3	0.26	2.2	313.883	0.44	1.00	0.24	6.8
4	0.20	1.8	313.917	0.40	0.76	0.17	8.6
5	0.21	1.8	313.598	0.72	1.01	0.21	10.4
6	0.35	1.5	313.600	0.72	1.08	0.30	11.9
7	0.28	2.3	313.647	0.67	1.60	0.50	14.2
8	0.25	1.7	313.752	0.57	1.05	0.28	15.9
9	0.06	2.2	313.733	0.59	1.27	0.20	18.1
10	0.27	2.0	314.130	0.19	0.78	0.13	20.1
11	0.00	0.5	314.320	0.00	0.05	0.01	20.6

Total: 2.16





Water control at the dam



Topographic survey



Flow measurement



Substrat characterisation



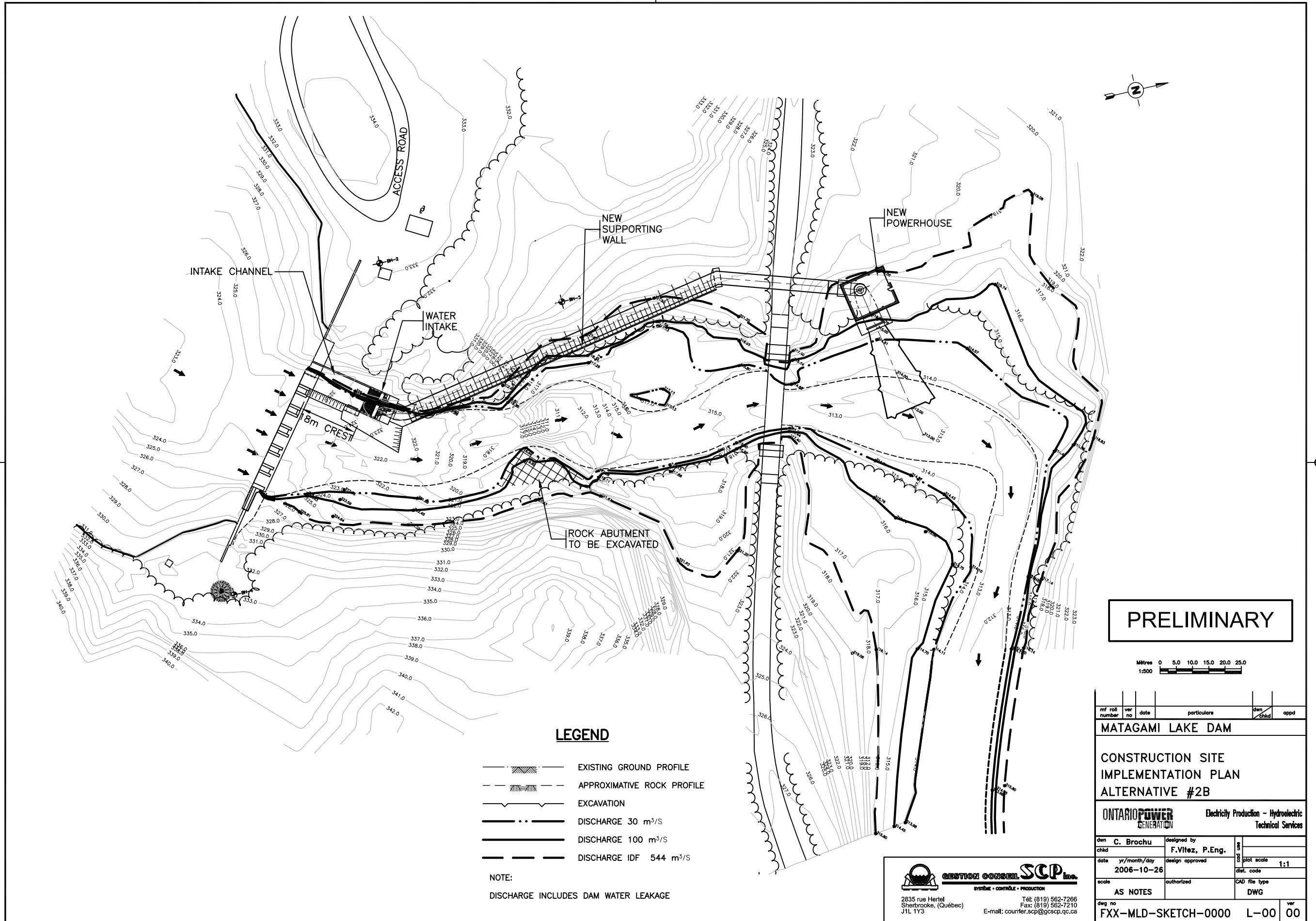
Bathymetric survey



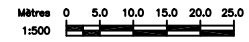
General view of the study area

<i>Ontario Power Generation</i>	<i>Mattagami Lake Dam Hydraulic Modeling Technical Report</i>	Our reference: 64126E169	
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APPENDIX 3
Raw Topographic Data and Land Model



PRELIMINARY



mf number	roll number	ver no	date	particulare	dwn chkd	appd
MATAGAMI LAKE DAM						
CONSTRUCTION SITE IMPLEMENTATION PLAN ALTERNATIVE #2B						
ONTARIO POWER GENERATION				Electricity Production - Hydroelectric Technical Services		
dwn	C. Brochu		designed by		F. Vitez, P.Eng.	
chkd			design approved			
date	2006-10-26		dist. code		1:1	
scale	AS NOTES		authorized		CAD file type	
					DWG	
dwg no	FXX-MLD-SKETCH-0000		L-00		ver 00	

LEGEND

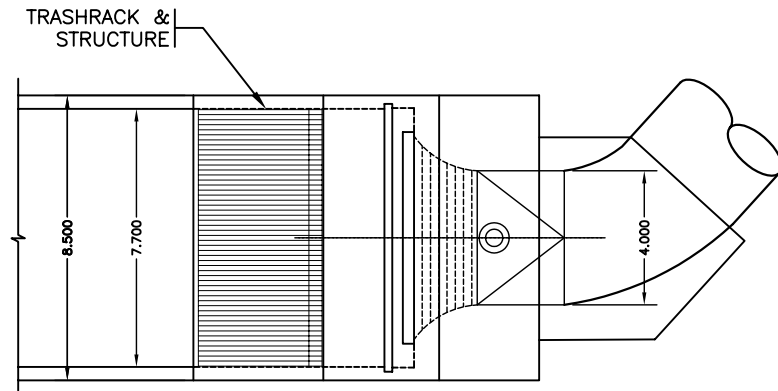
- EXISTING GROUND PROFILE
- APPROXIMATIVE ROCK PROFILE
- EXCAVATION
- DISCHARGE 30 m³/S
- DISCHARGE 100 m³/S
- DISCHARGE IDF 544 m³/S

NOTE:
 DISCHARGE INCLUDES DAM WATER LEAKAGE

GESTION CONSEIL SCP inc.
 Sherbrooke - CORNÉLIE - PRODUCTION
 2835 rue Hertel, Sherbrooke, (Québec) J1L 1Y3
 Tél: (819) 562-7266
 Fax: (819) 562-7210
 E-mail: courrier.scip@gcscsp.qc.ca

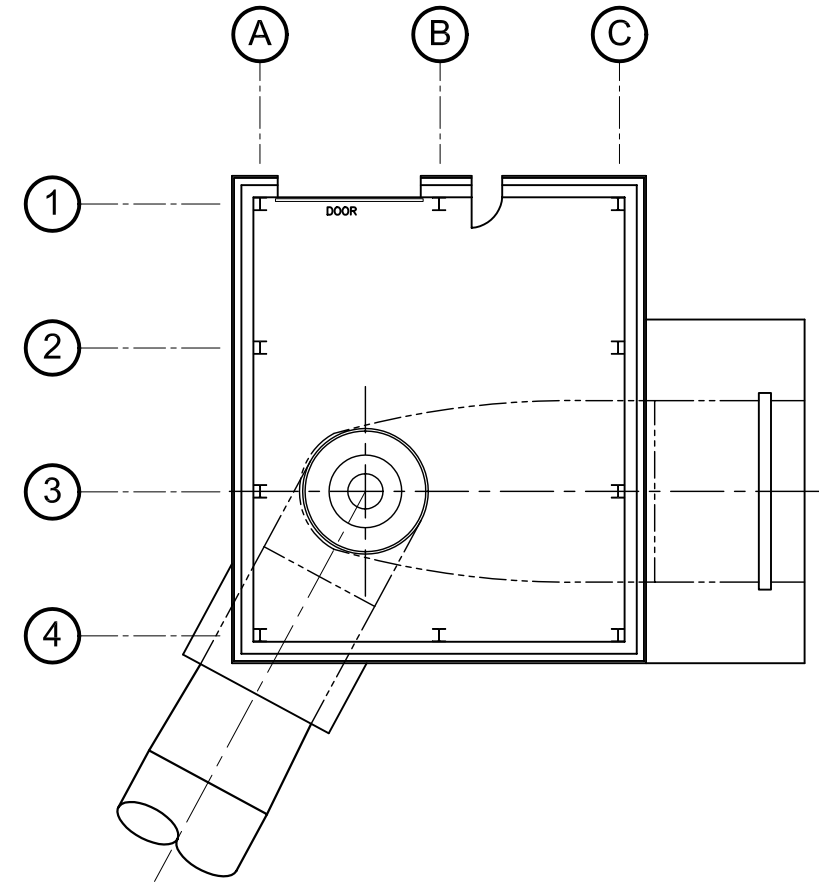
TITLEBLOCK VER 3.0 - AVRIL 1999

Rev 06 - 2006 - 5/4/06
 Logix name: Oued
 Drawing Name: P:\projets\Ontario Power Generation\200609-11 Mattagami Lake Dam\Design\DWG\SCP\Final Oct 2006\FXX-MLD-SKETCH-0000 AL-2B L-00.dwg

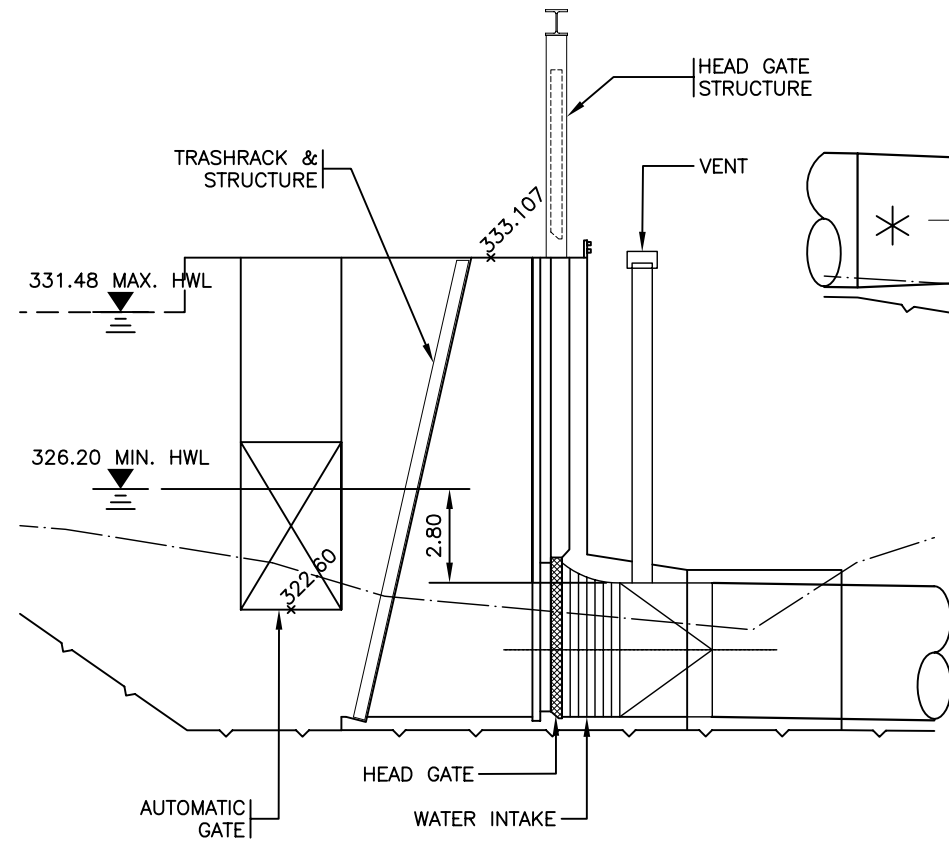


PLAN VIEW - INTAKE
 SCALE = 1:100

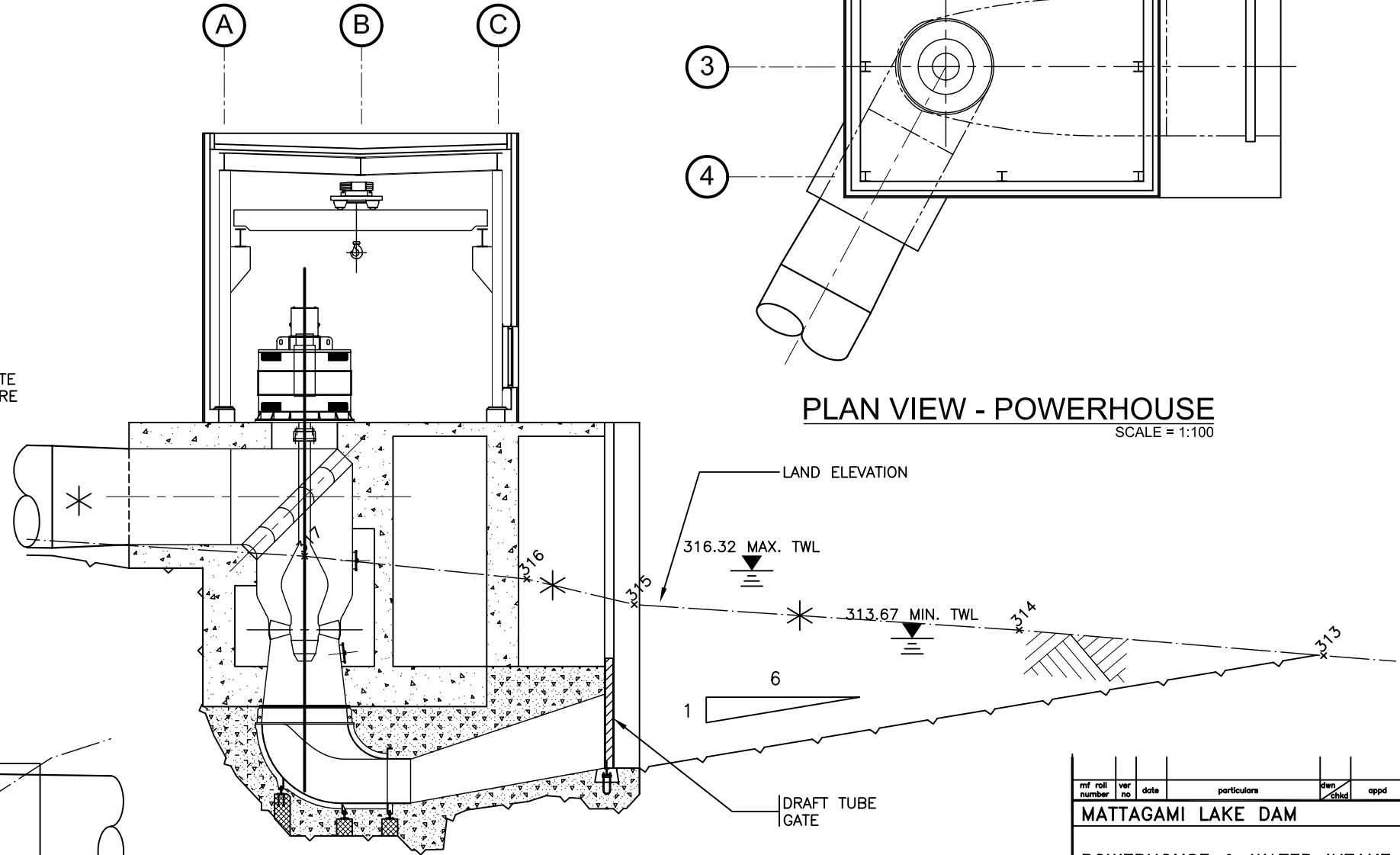
WATER LEVELS	
319.06	: IDF
315.76	: 100 Cm/s
314.57	: 30 Cm/s
*	Measured values



PLAN VIEW - POWERHOUSE
 SCALE = 1:100

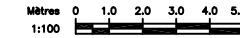


ELEVATION VIEW - INTAKE
 SCALE = 1:100



ELEVATION VIEW - POWERHOUSE
 SCALE = 1:100

PRELIMINARY



GESTION CONSEIL SCP inc.
 2835 rue Hertel
 Sherbrooke, (Québec)
 J1L 1Y3
 Tél: (819) 562-7266
 Fax: (819) 562-7210
 E-mail: courrier-scp@gcscp.qc.ca

mf number	roll no	ver no	date	particulars	dwg	chkd	appd
MATTAGAMI LAKE DAM							
POWERHOUSE & WATER INTAKE PLAN VIEW & ELEVATION ALTERNATIVE #2B							
ONTARIO POWER GENERATION				Electricity Production - Hydroelectric Technical Services			
dwg	C. Brochu			designed by	F. Vitez, P.Eng.		
chkd				design approved			
date	2006-10-26			dist. code	plot scale 1:1		
scale	AS NOTES			authorized	CAD file type DWG		
dwg no	FXX-MLD-SKETCH-0000			L-03	ver 00		

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APPENDIX 4 Simulation Results

Mattagami Lake Dam
Hydraulic study

Results

Scenario 37 m³/s

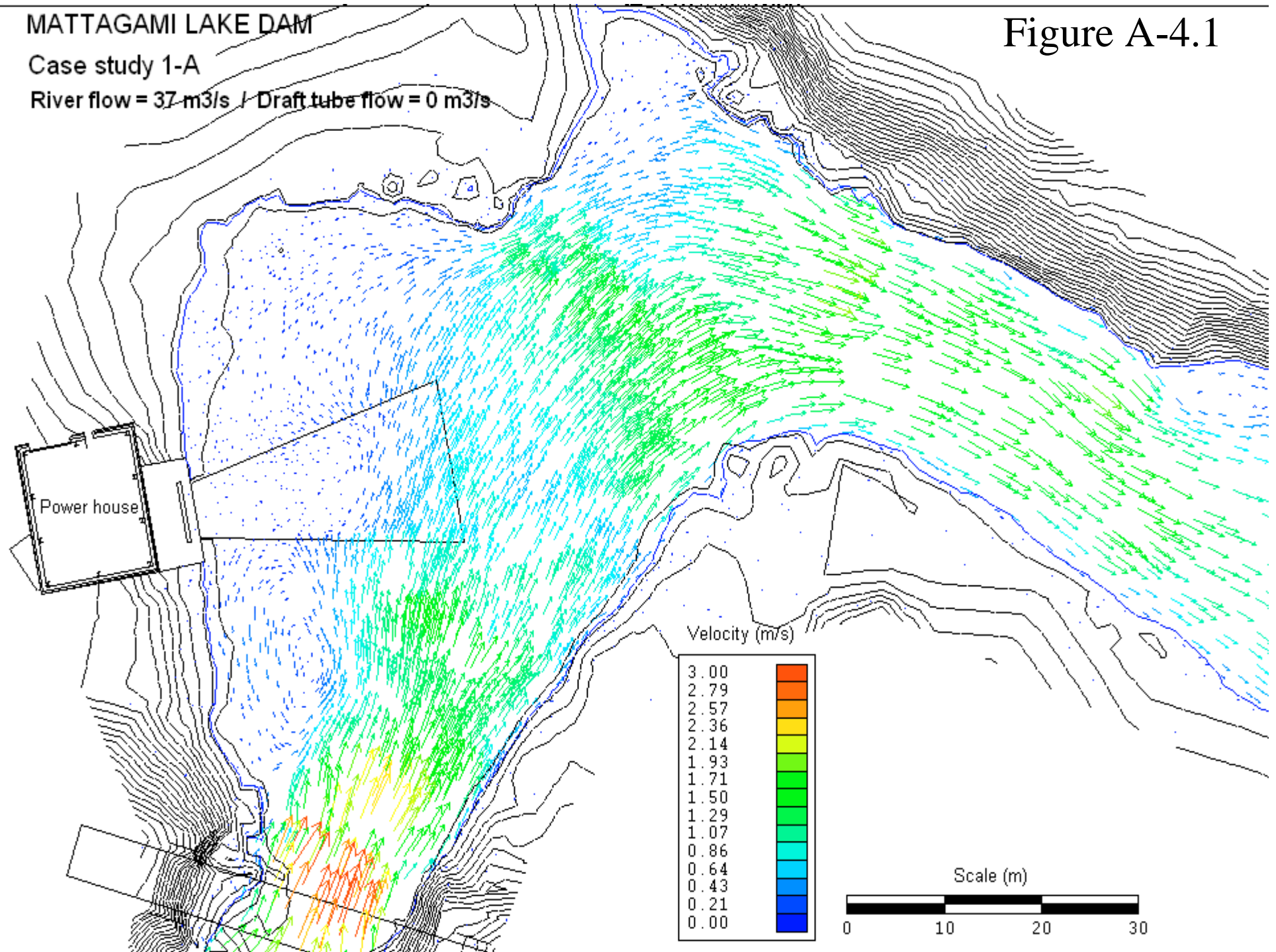
Case study A (1-A)

MATTAGAMI LAKE DAM

Case study 1-A

River flow = 37 m³/s / Draft tube flow = 0 m³/s

Figure A-4.1

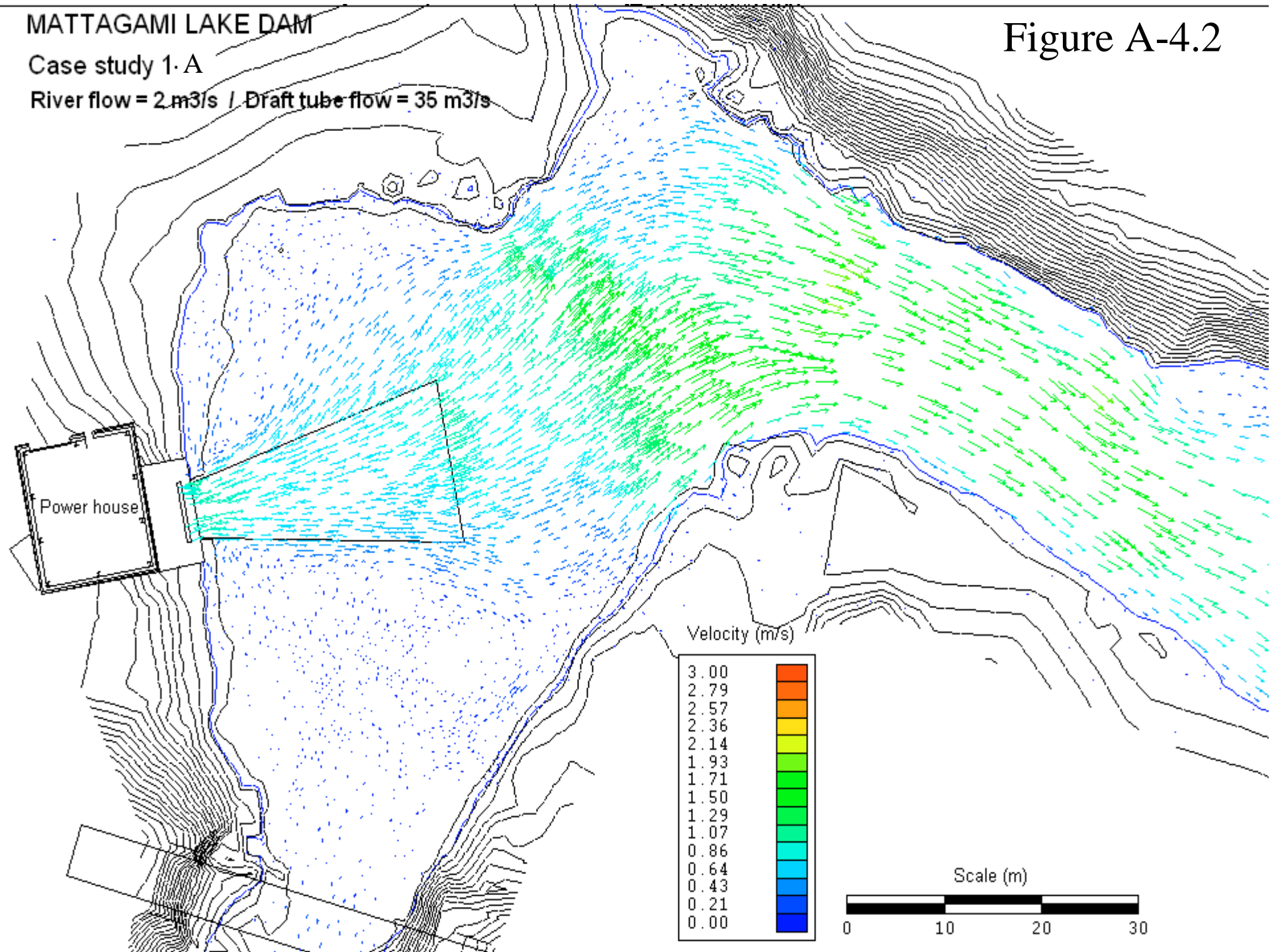


MATTAGAMI LAKE DAM

Case study 1-A

River flow = 2 m³/s / Draft tube flow = 35 m³/s

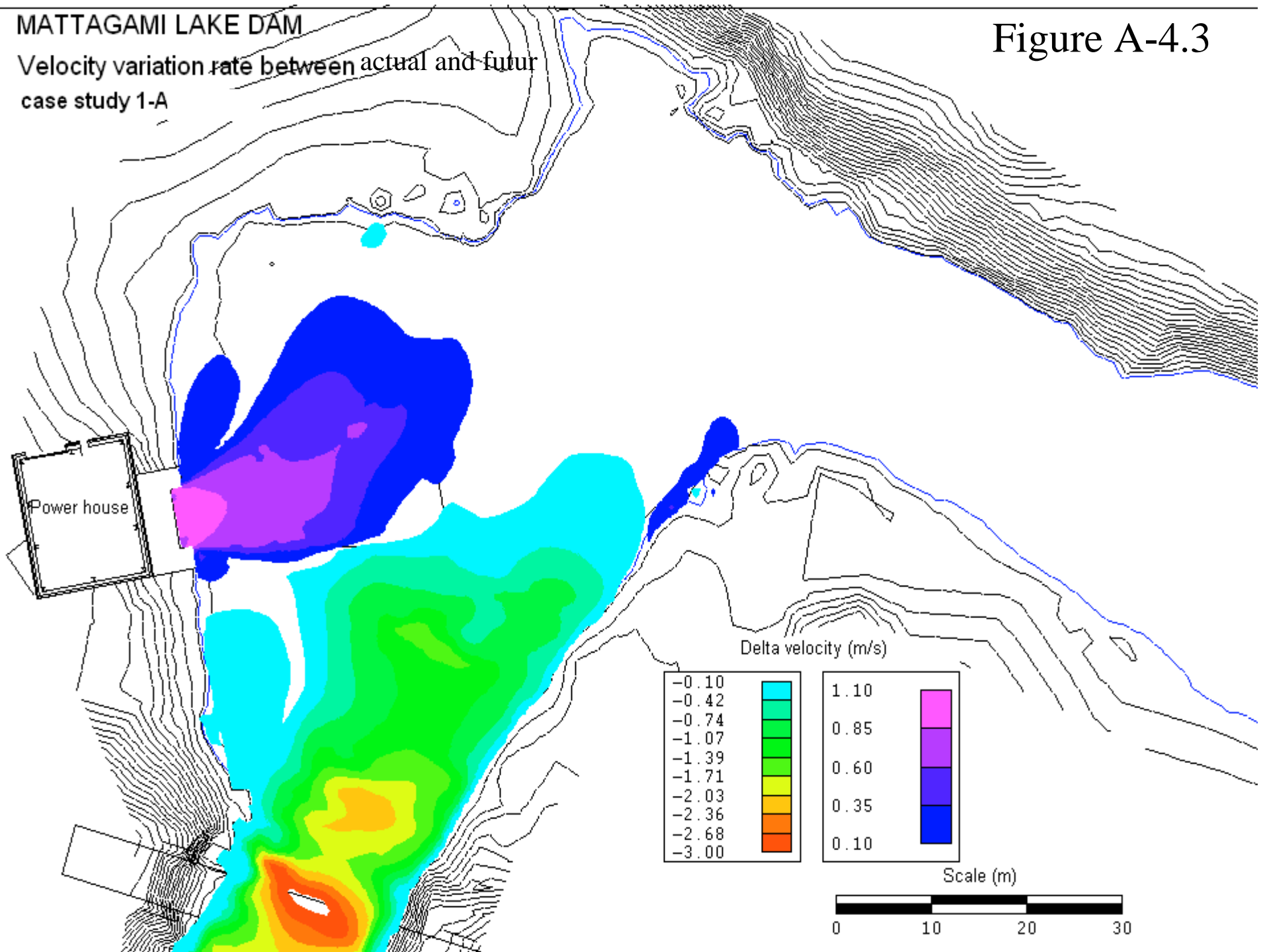
Figure A-4.2



MATTAGAMI LAKE DAM

Velocity variation rate between actual and futur
case study 1-A

Figure A-4.3



Mattagami Lake Dam
Hydraulic study

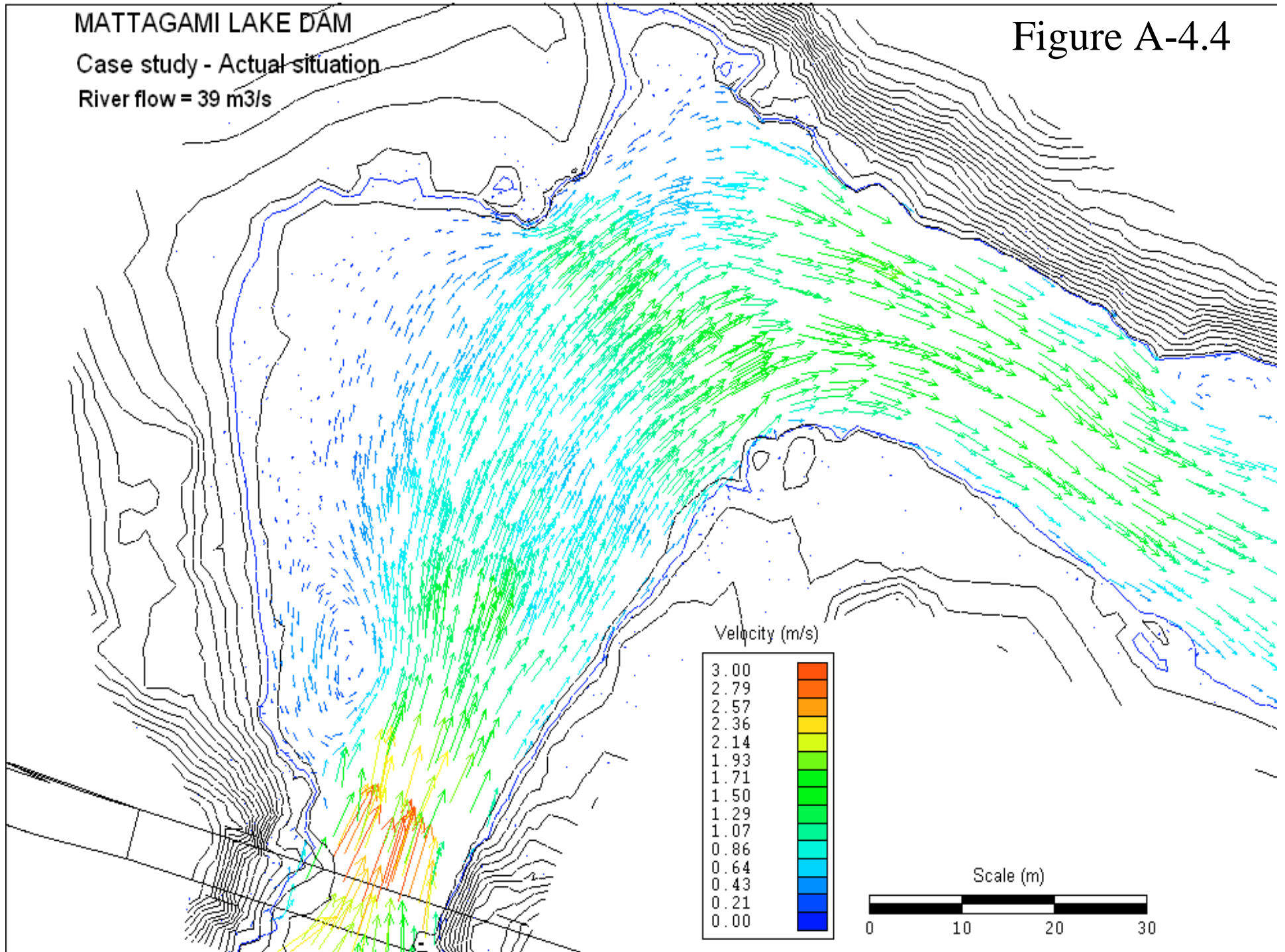
Results

Scenario 39 m³/s

Case study B (2-B)

MATTAGAMI LAKE DAM
Case study - Actual situation
River flow = 39 m³/s

Figure A-4.4

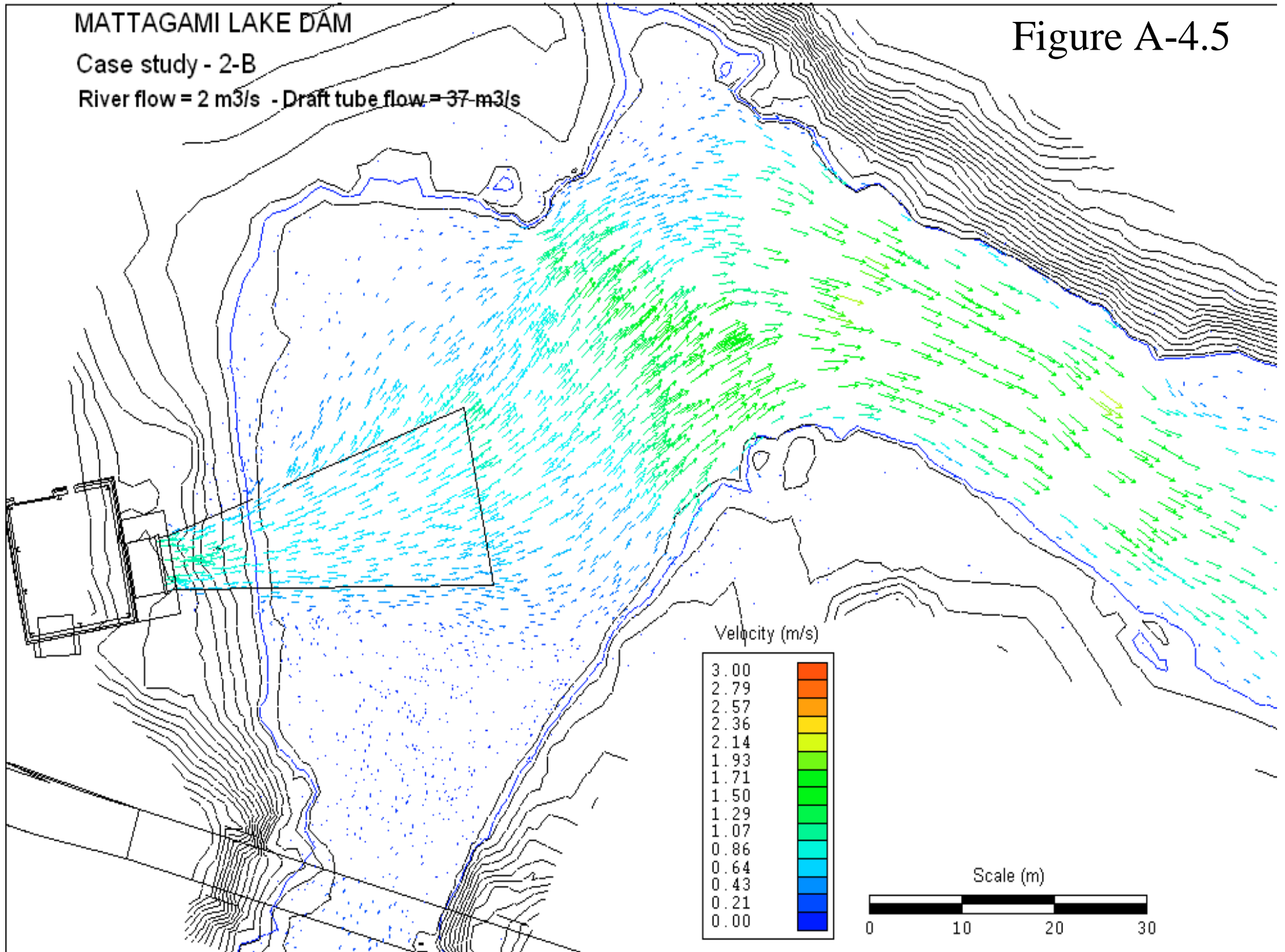


MATTAGAMI LAKE DAM

Case study - 2-B

River flow = 2 m³/s - Draft tube flow = 37 m³/s

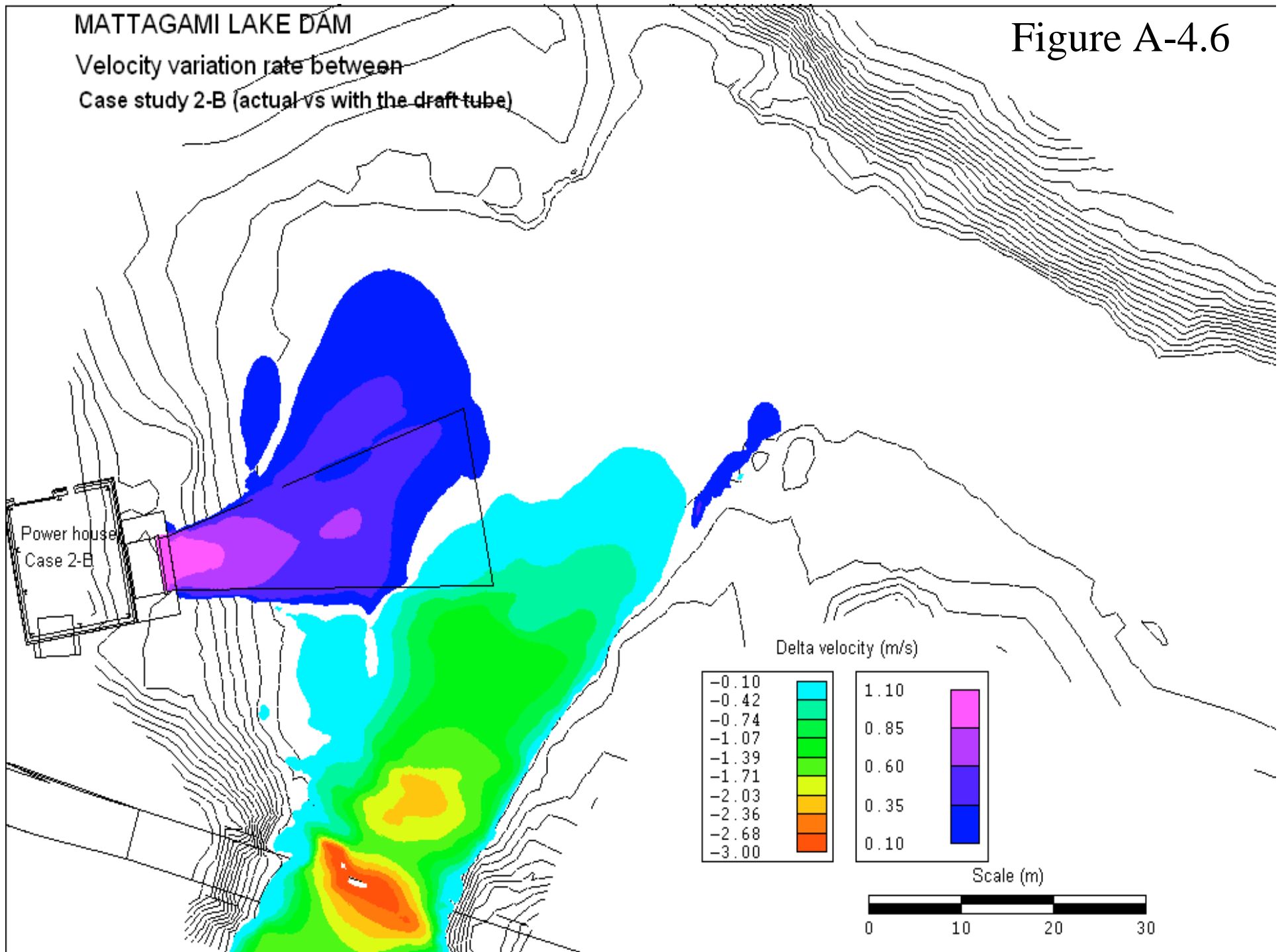
Figure A-4.5



MATTAGAMI LAKE DAM

Velocity variation rate between
Case study 2-B (actual vs with the draft tube)

Figure A-4.6



Mattagami Lake Dam
Hydraulic study

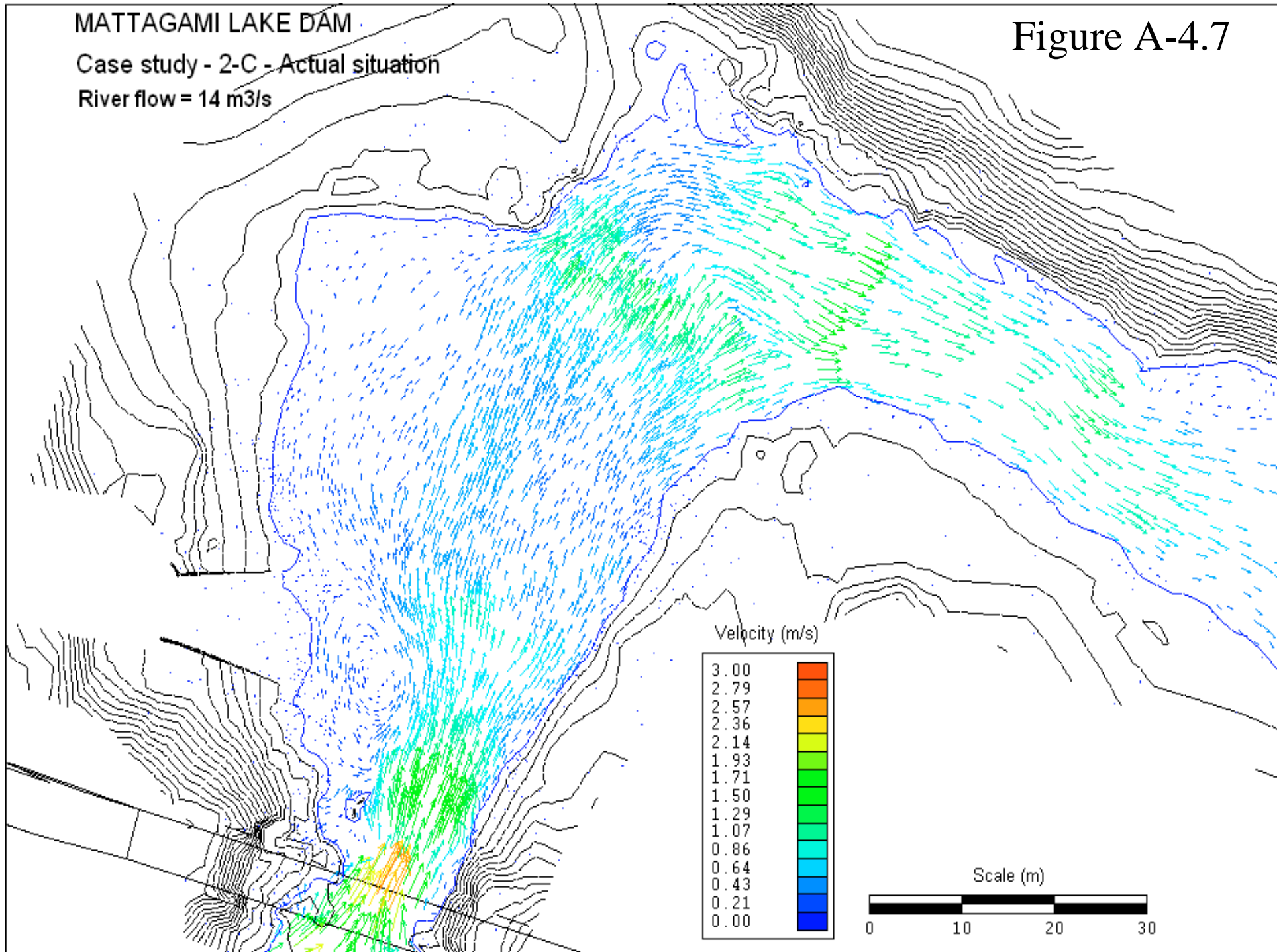
Results

Scenario 14 m³/s

Case study C (2-C)

MATTAGAMI LAKE DAM
Case study - 2-C - Actual situation
River flow = 14 m³/s

Figure A-4.7

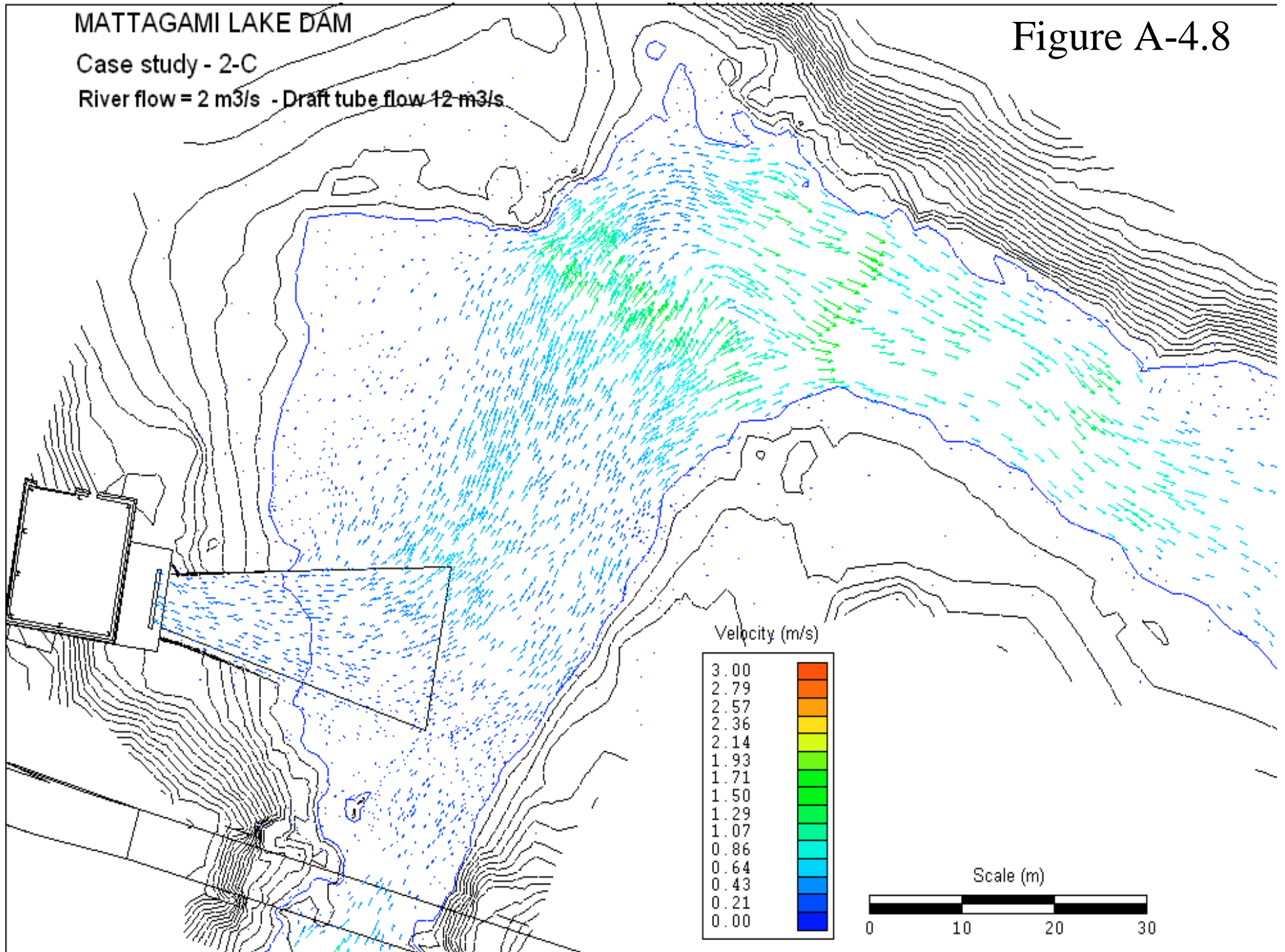


MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 2 m³/s - Draft tube flow 12 m³/s

Figure A-4.8



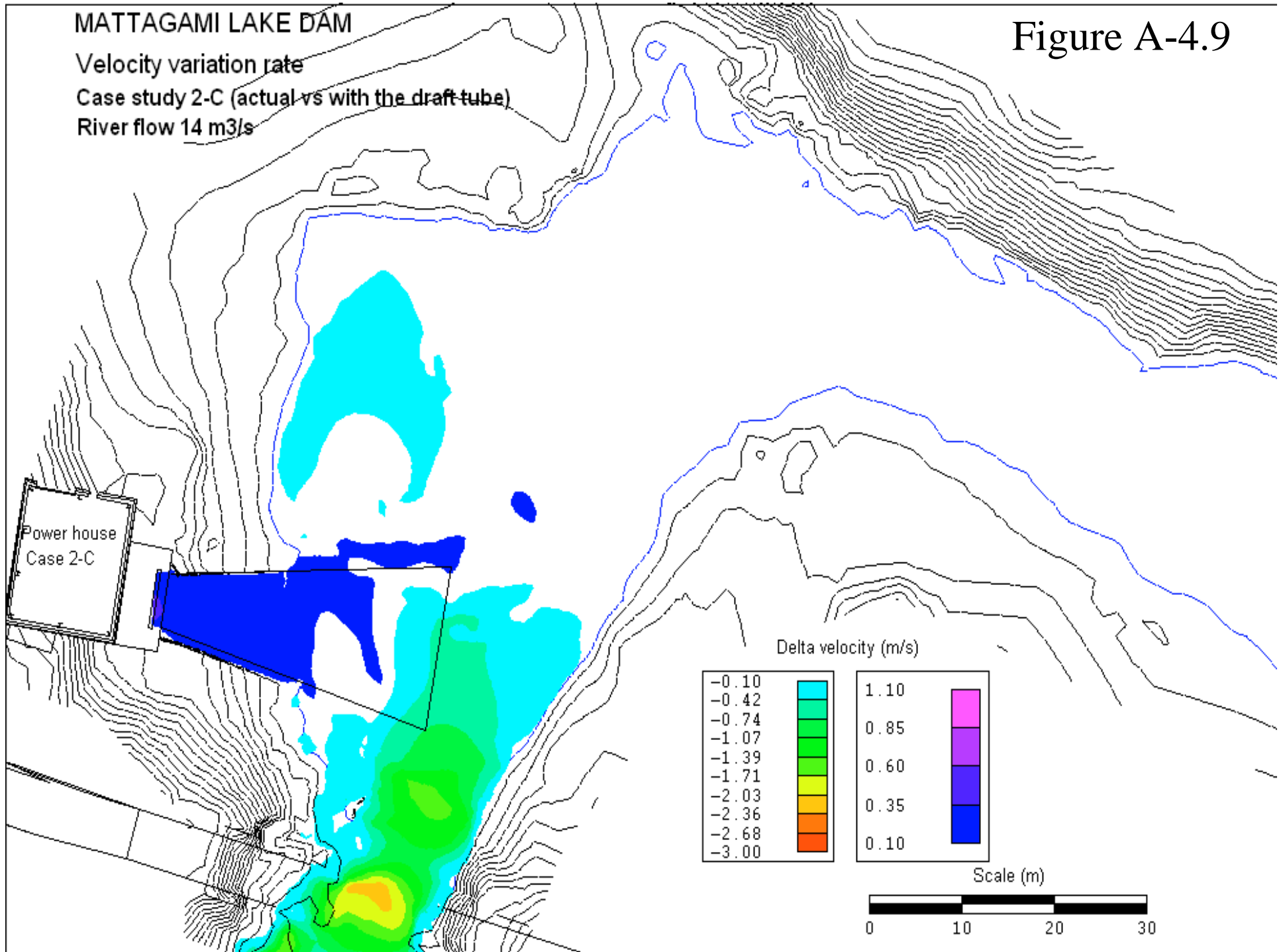
MATTAGAMI LAKE DAM

Velocity variation rate

Case study 2-C (actual vs with the draft tube)

River flow 14 m³/s

Figure A-4.9



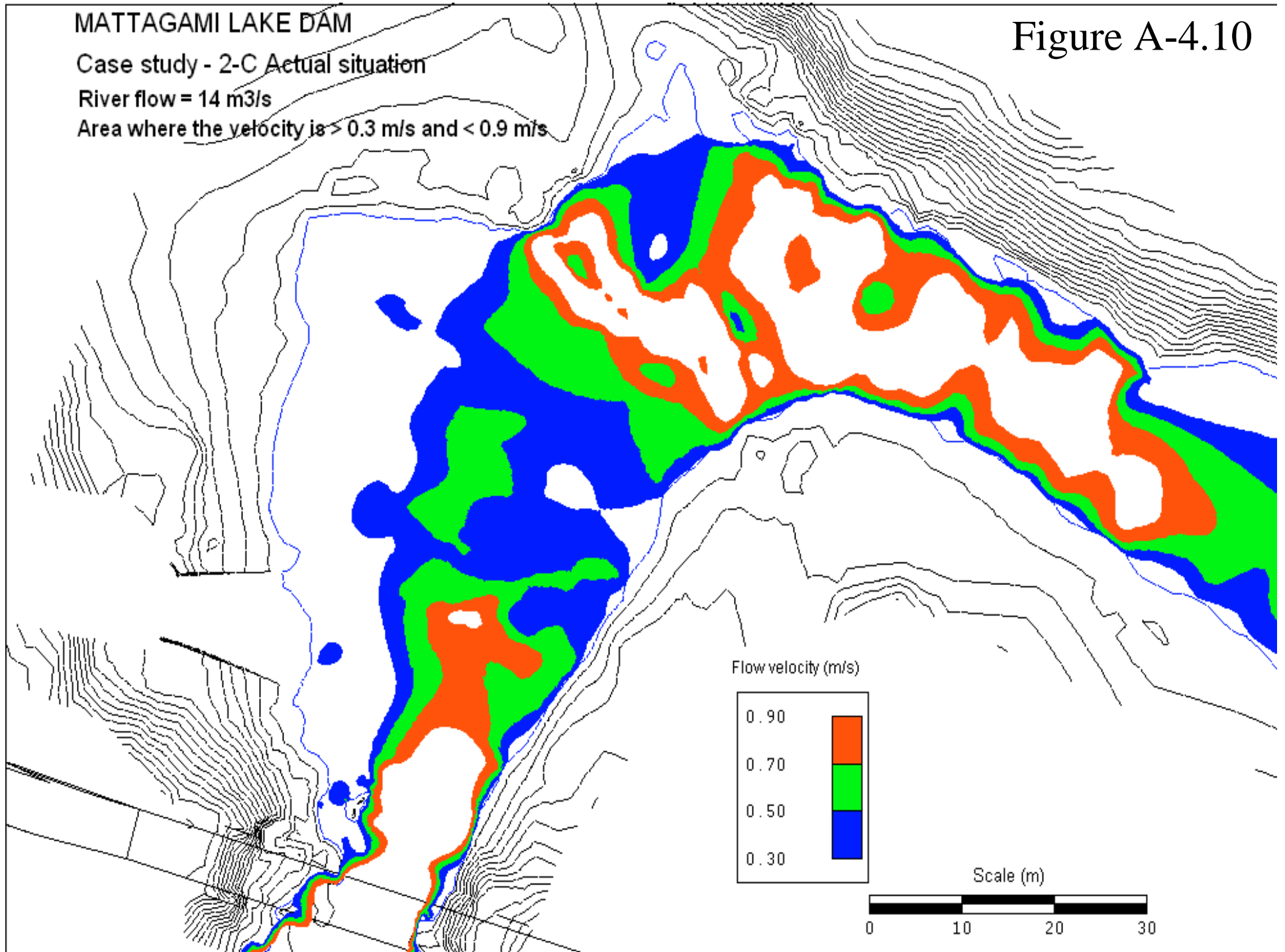
MATTAGAMI LAKE DAM

Case study - 2-C Actual situation

River flow = 14 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.10



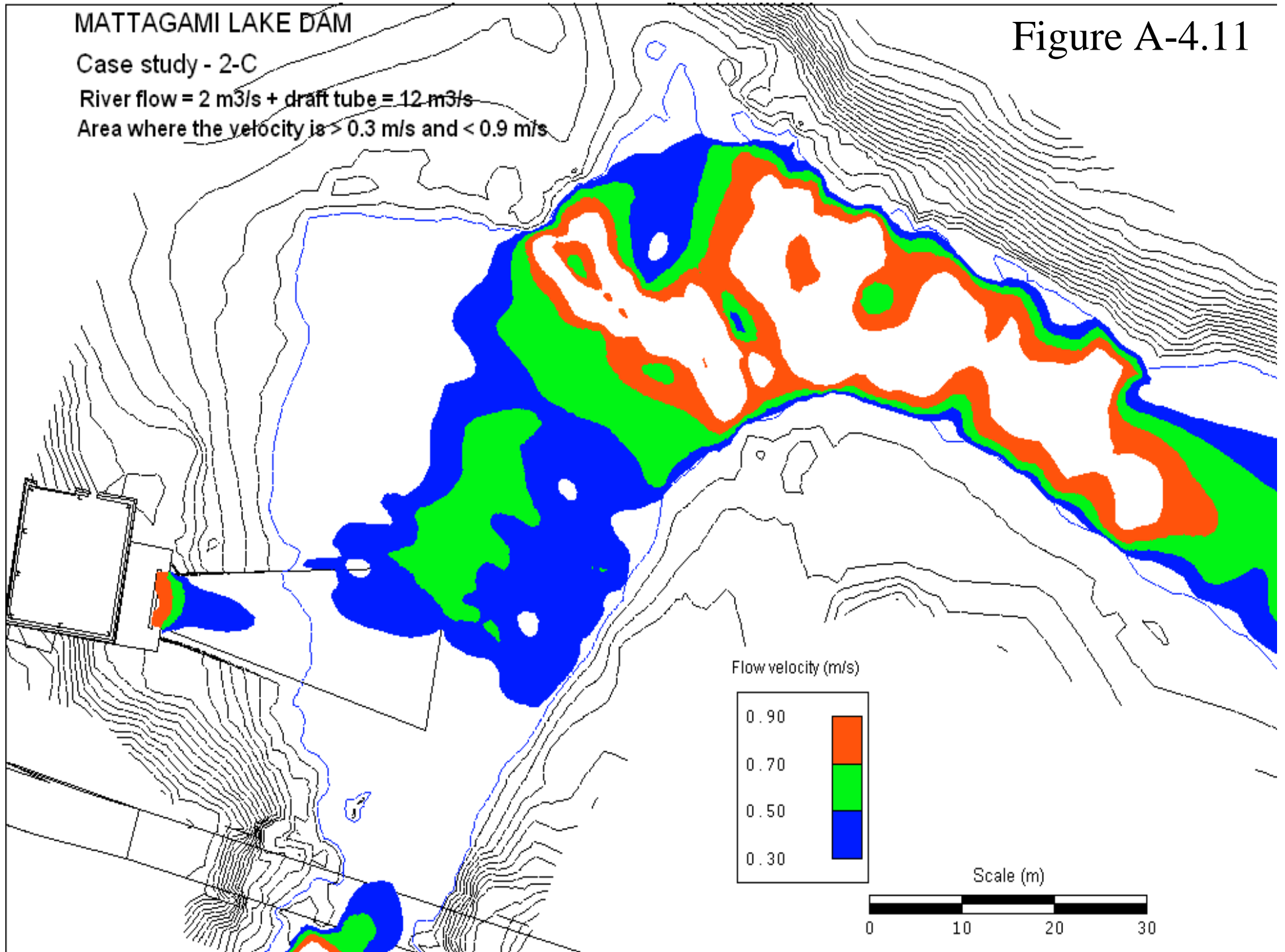
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 2 m³/s + draft tube = 12 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.11



Mattagami Lake Dam
Hydraulic study

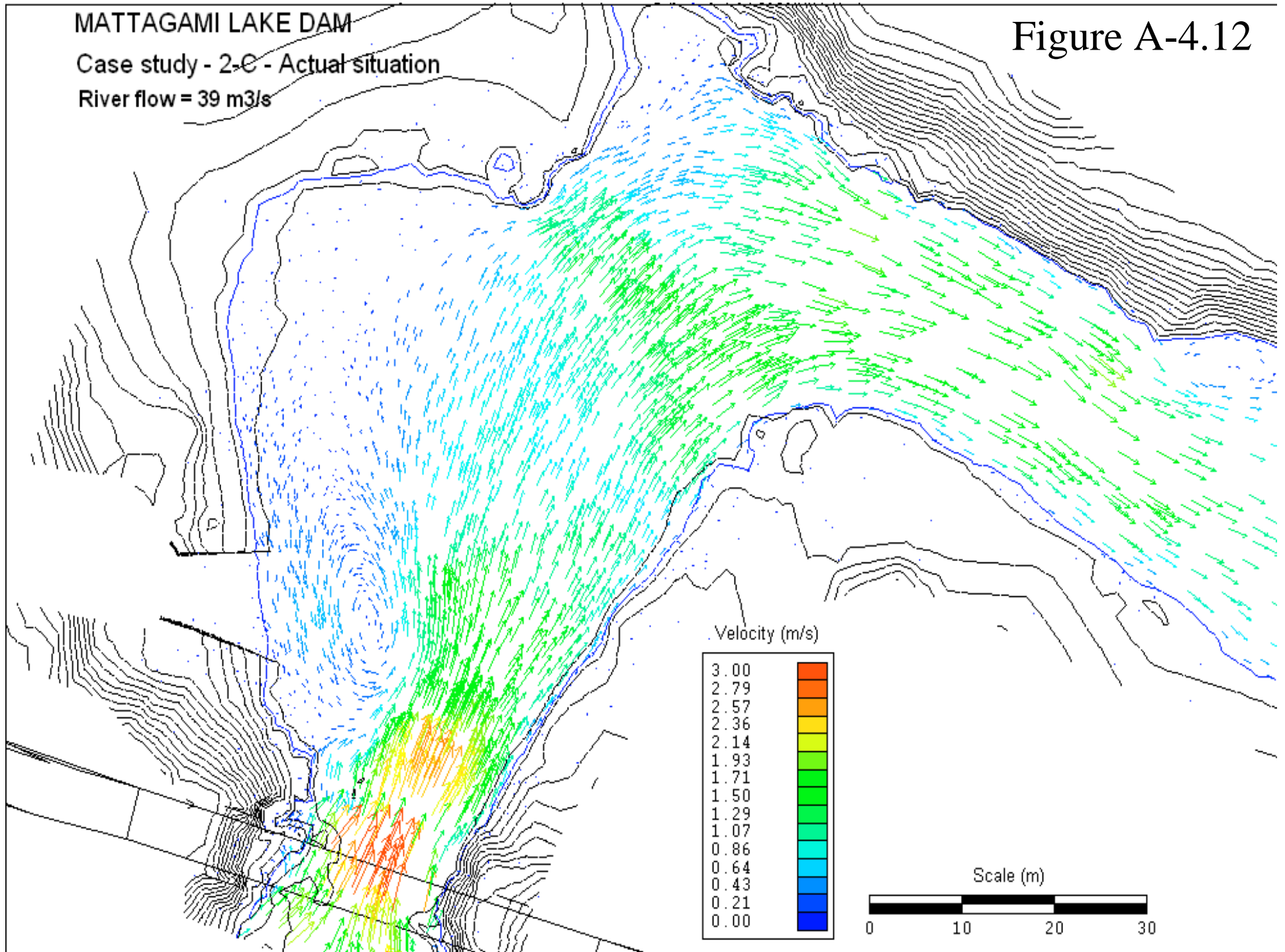
Results

Scenario 39 m³/s

Case study C- (2-C)

MATTAGAMI LAKE DAM
Case study - 2-C - Actual situation
River flow = 39 m³/s

Figure A-4.12

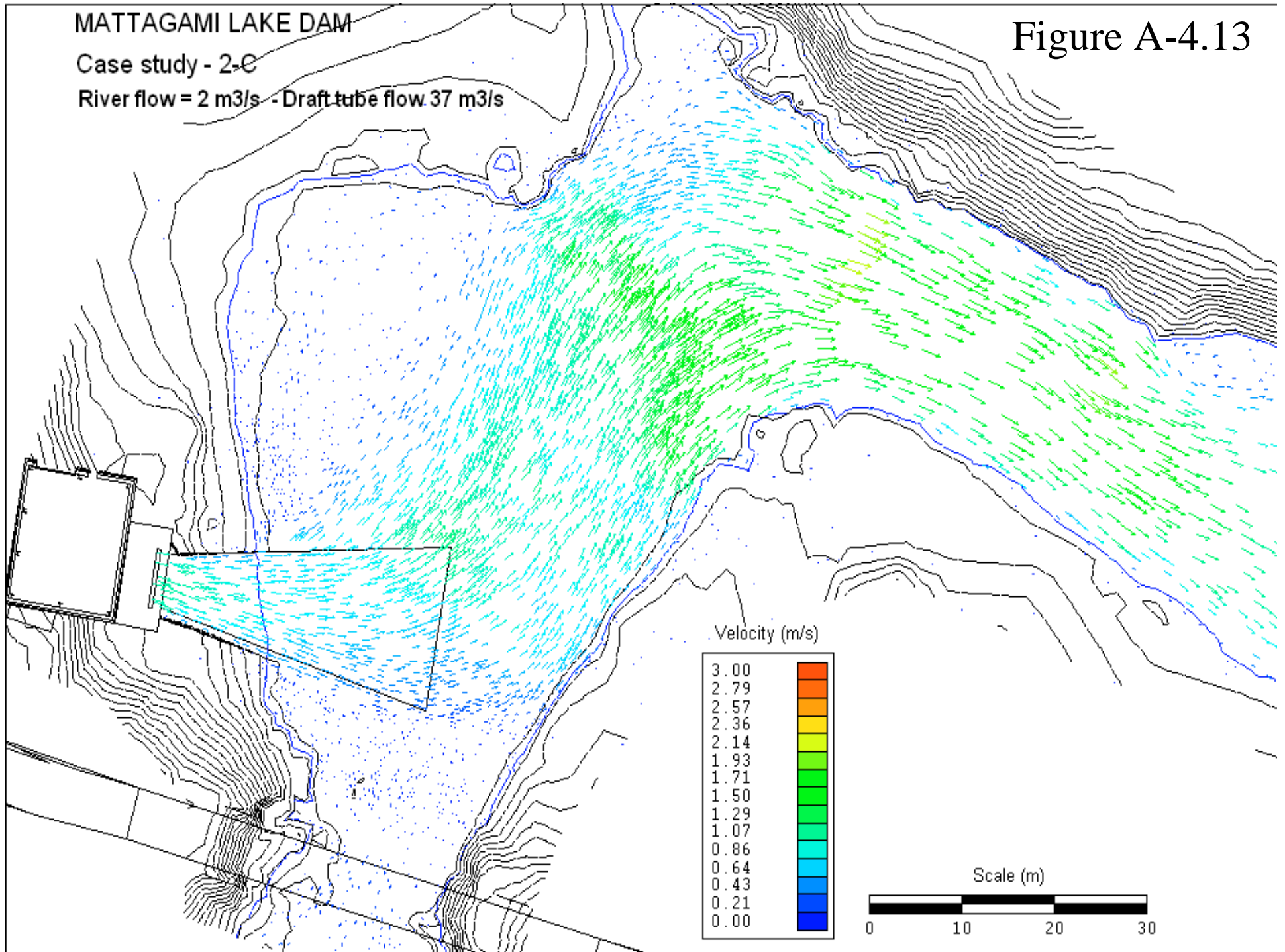


MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 2 m³/s - Draft tube flow 37 m³/s

Figure A-4.13

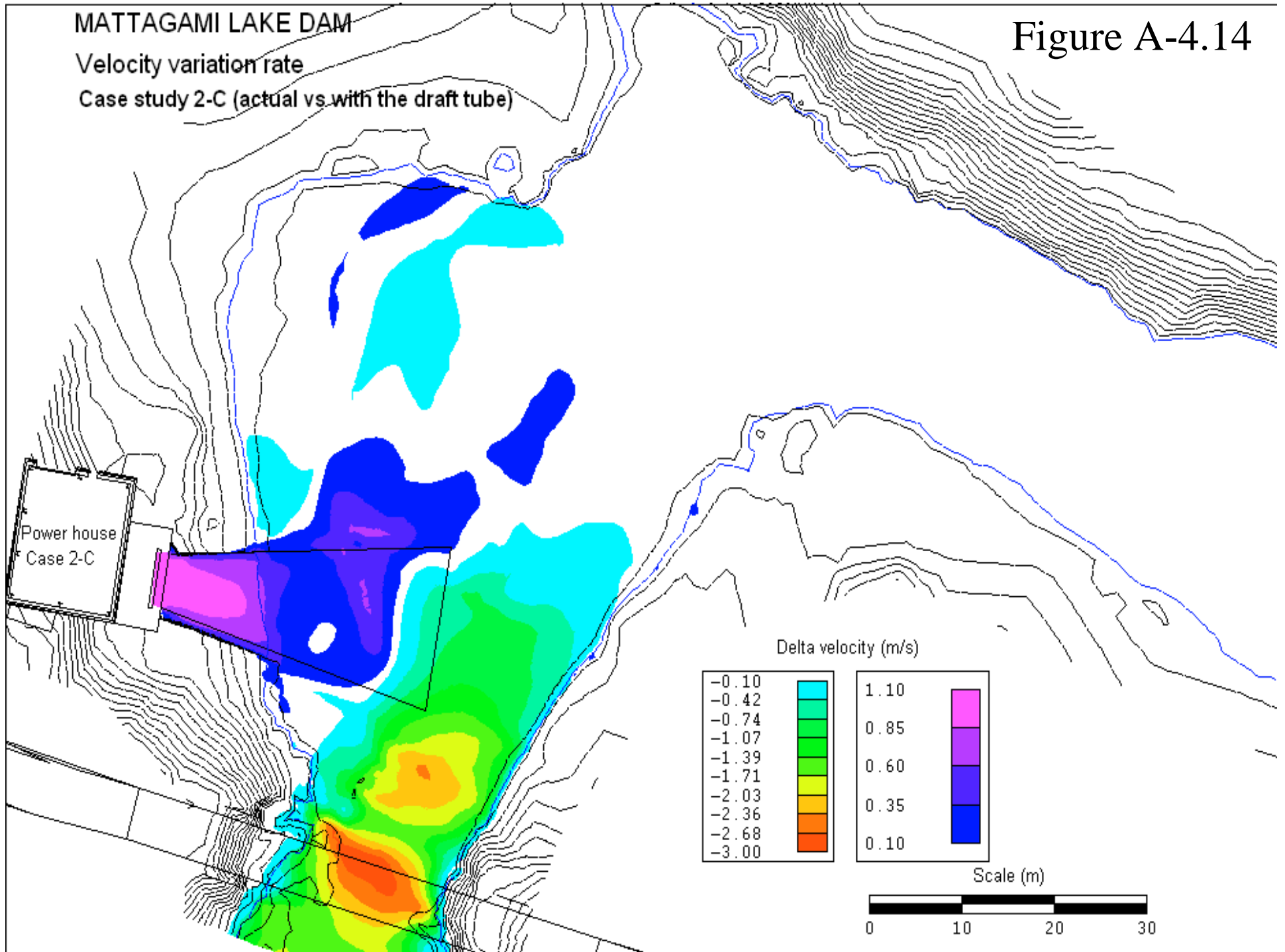


MATTAGAMI LAKE DAM

Velocity variation rate

Case study 2-C (actual vs with the draft tube)

Figure A-4.14



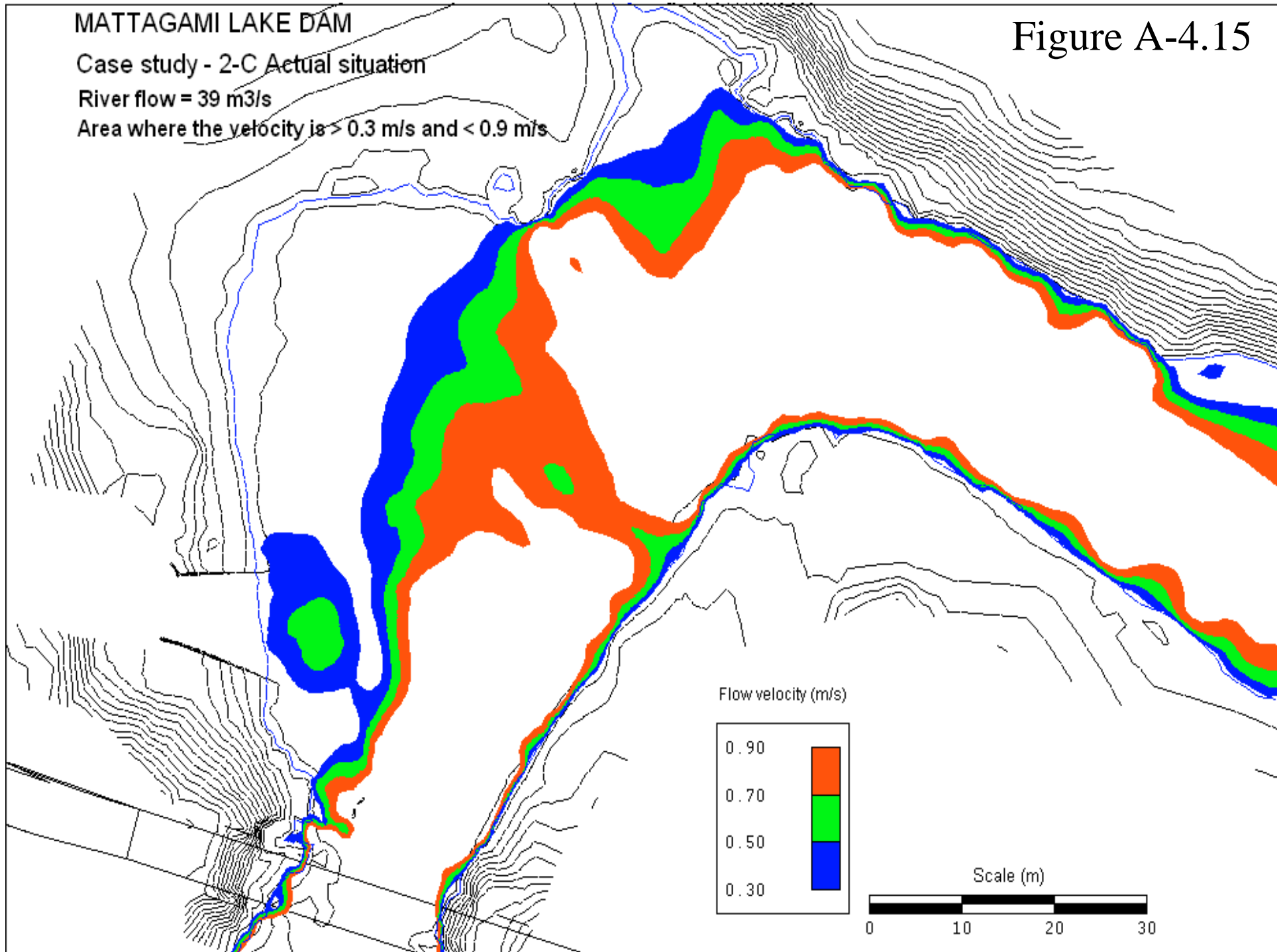
MATTAGAMI LAKE DAM

Case study - 2-C Actual situation

River flow = 39 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.15



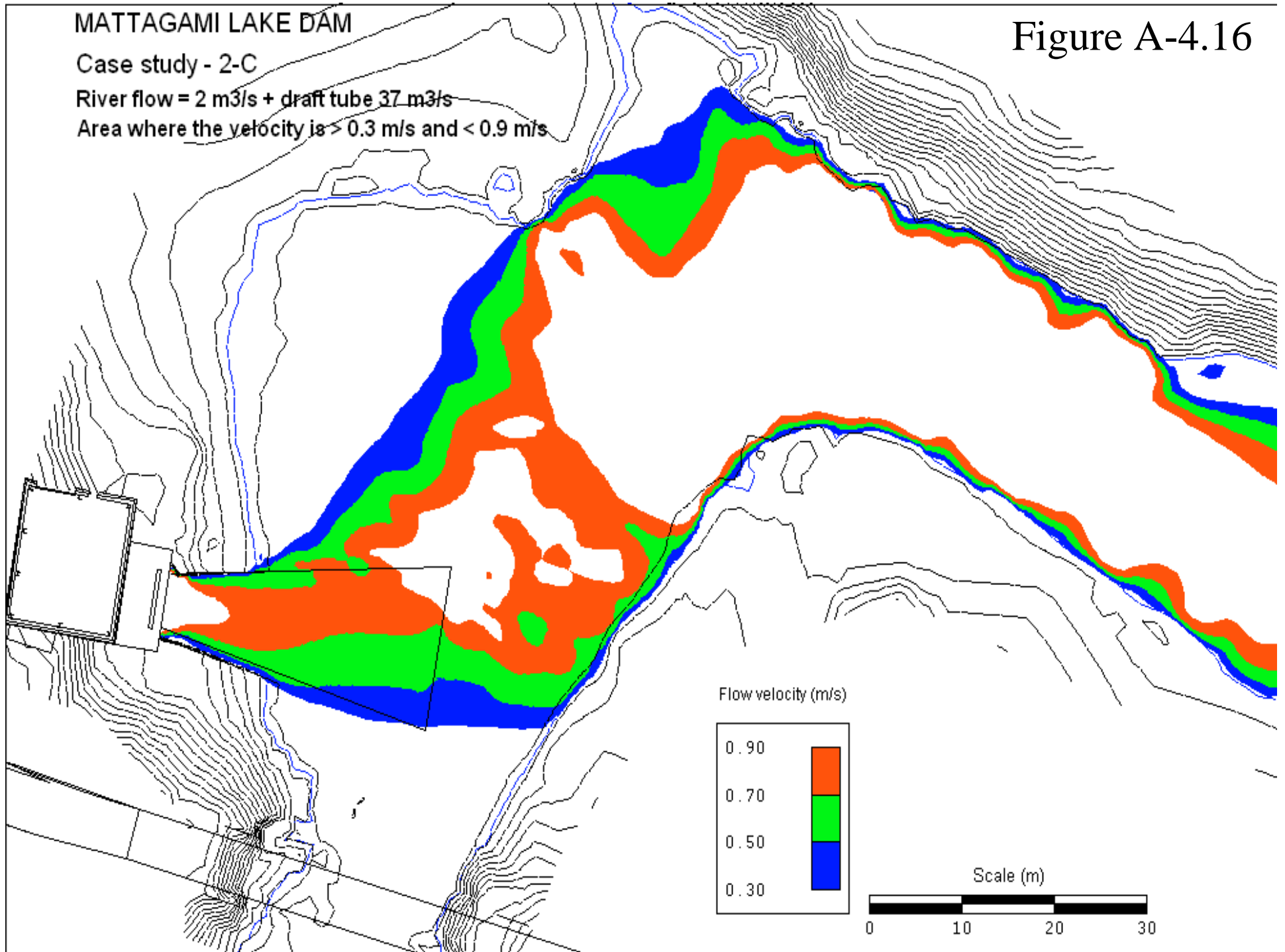
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 2 m³/s + draft tube 37 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.16



Mattagami Lake Dam
Hydraulic study

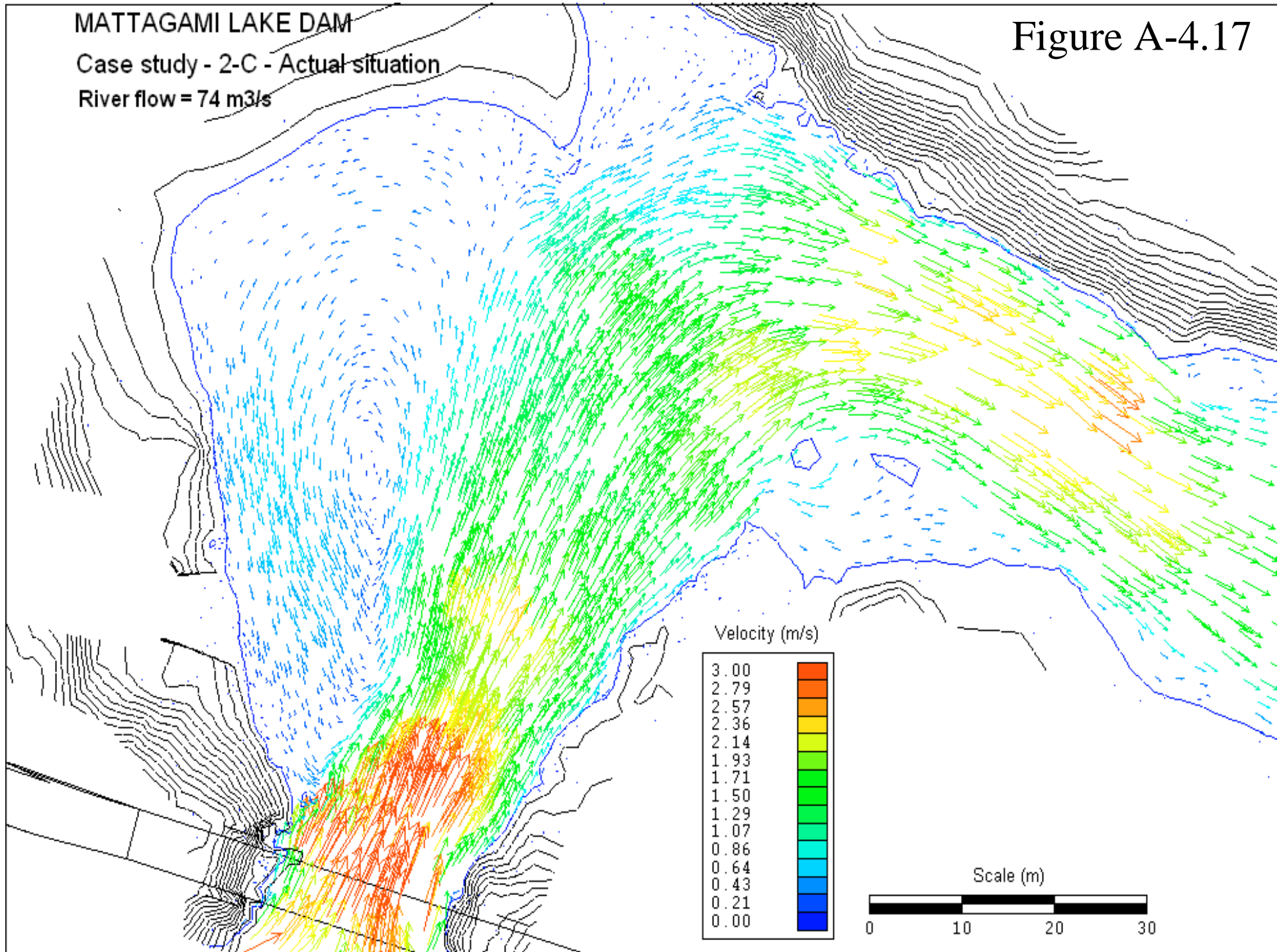
Results

Scenario 74 m³/s

Case study C (2-C)

MATTAGAMI LAKE DAM
Case study - 2-C - Actual situation
River flow = 74 m³/s

Figure A-4.17



MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 37 m³/s - Draft tube flow 37 m³/s

Figure A-4.18

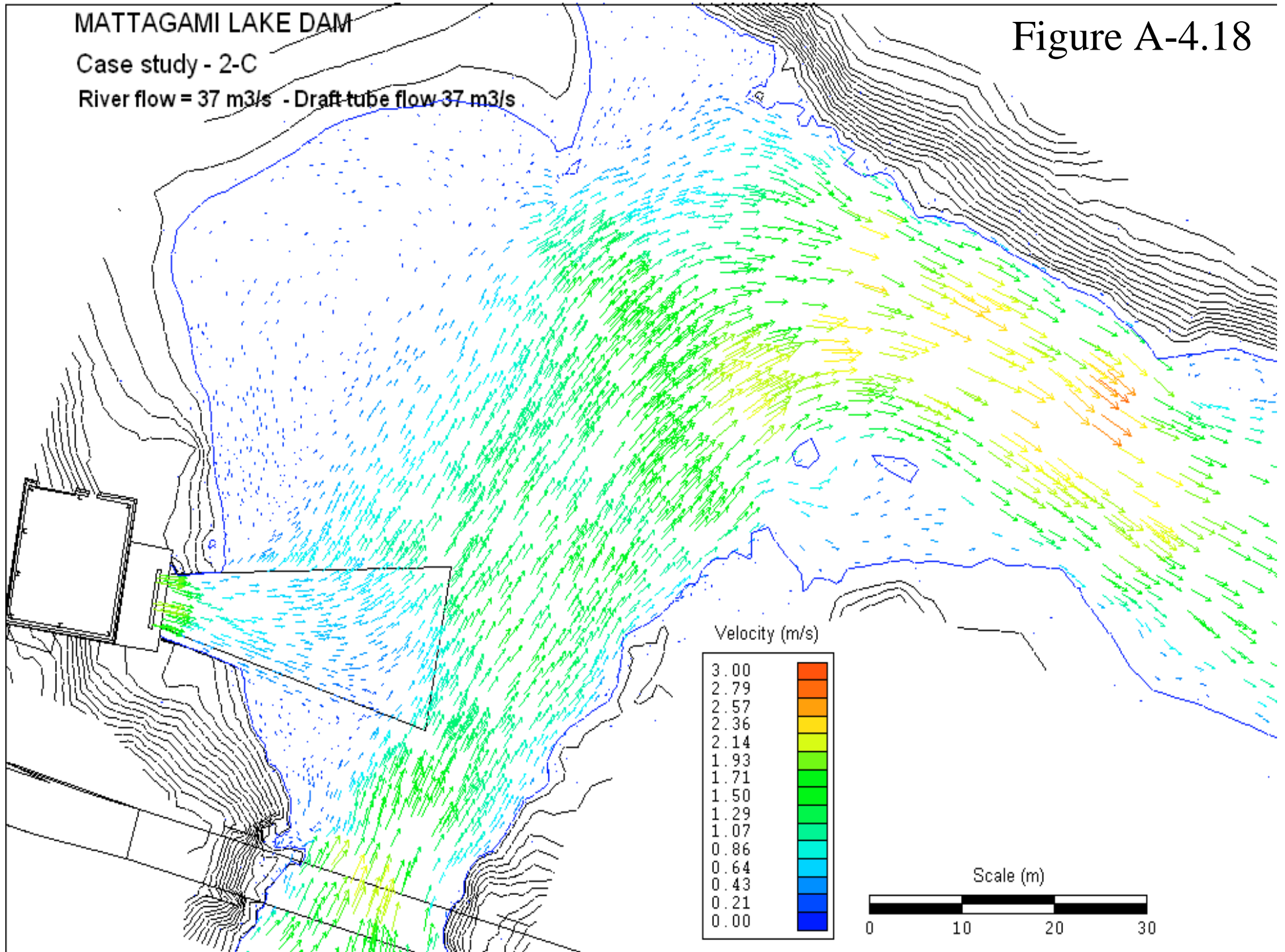
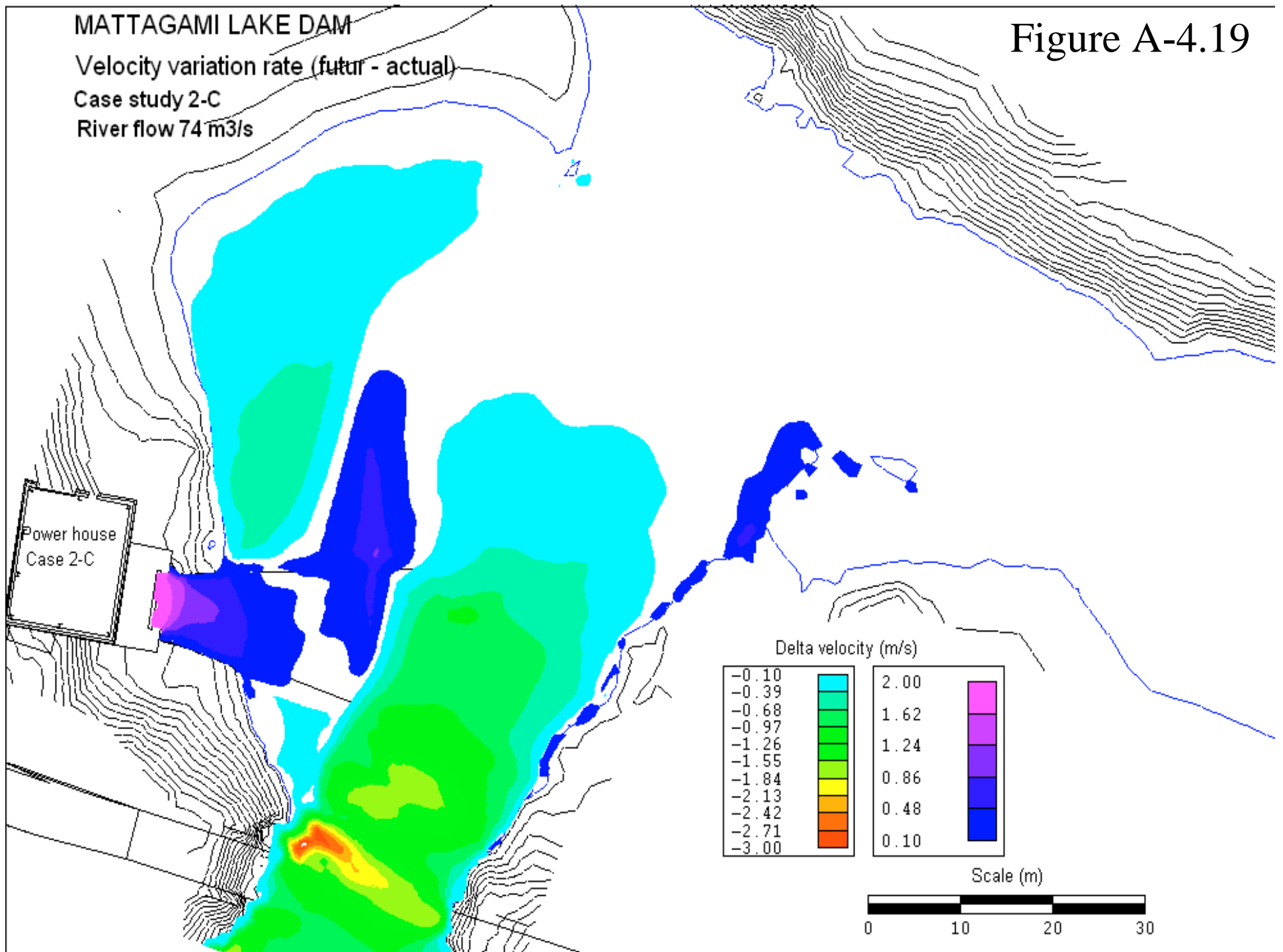


Figure A-4.19

MATTAGAMI LAKE DAM
Velocity variation rate (futur - actual)
Case study 2-C
River flow 74 m³/s



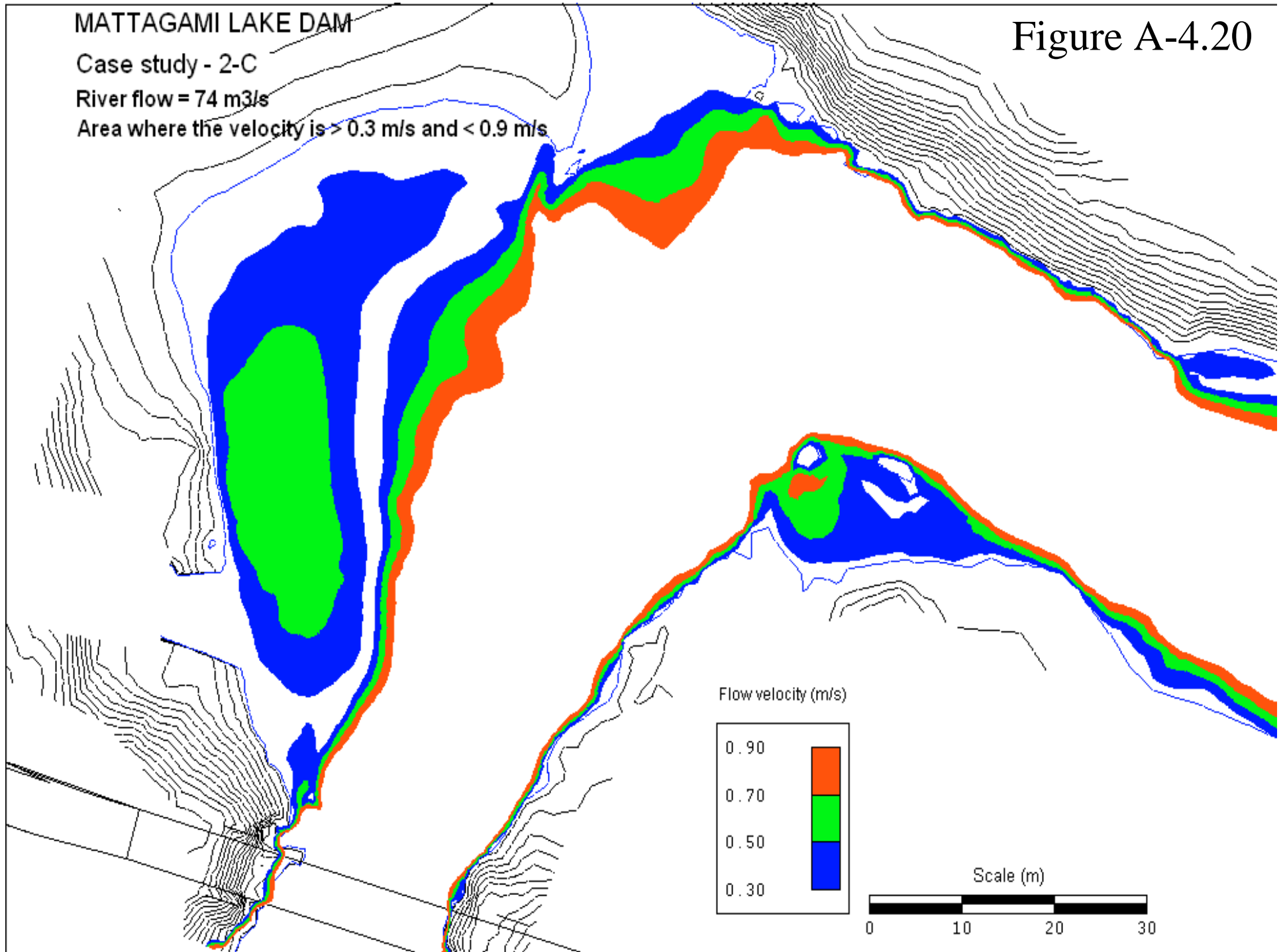
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 74 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.20



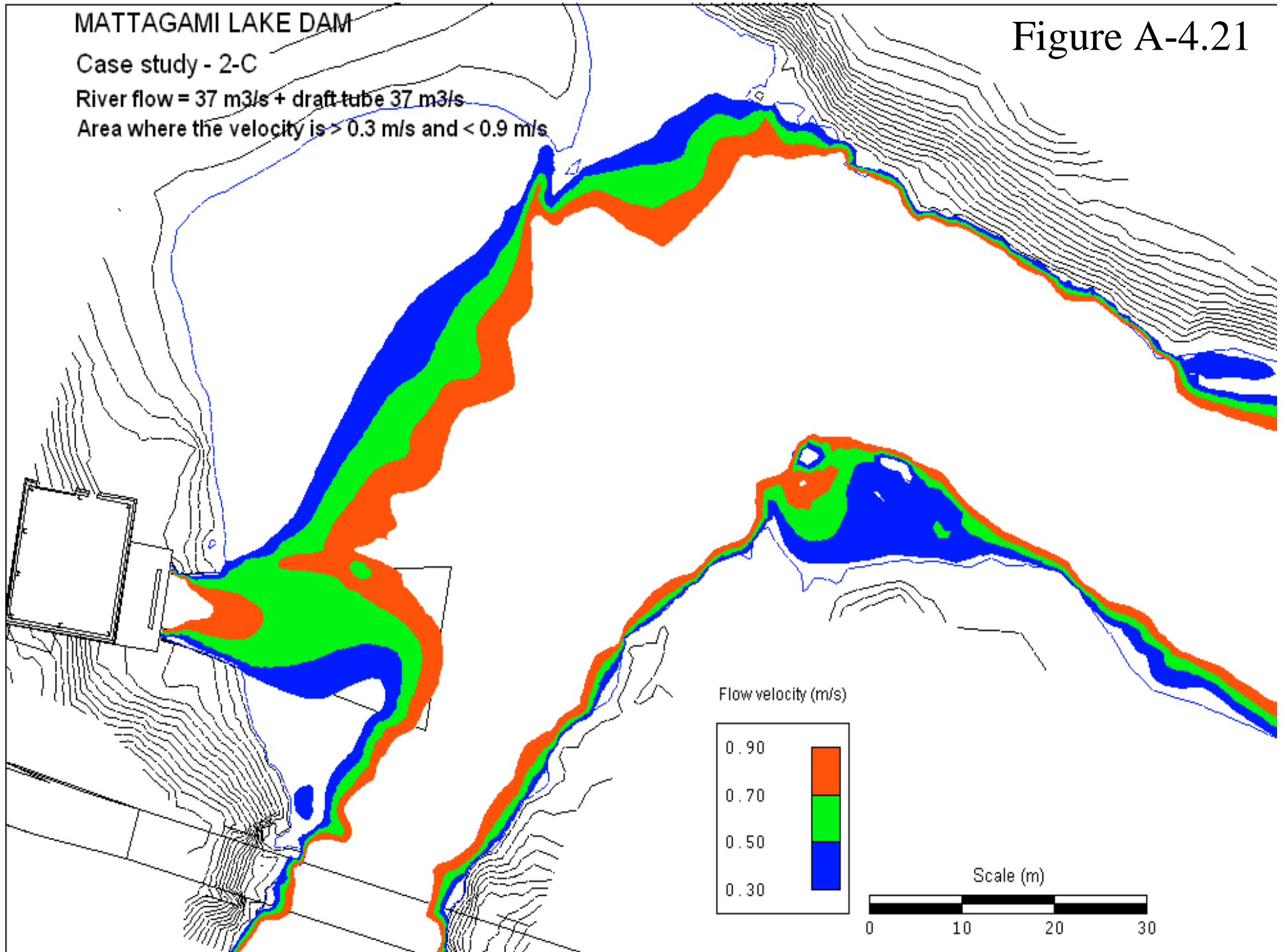
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 37 m³/s + draft tube 37 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.21



Mattagami Lake Dam
Hydraulic study

Results

Scenario 17 m³/s

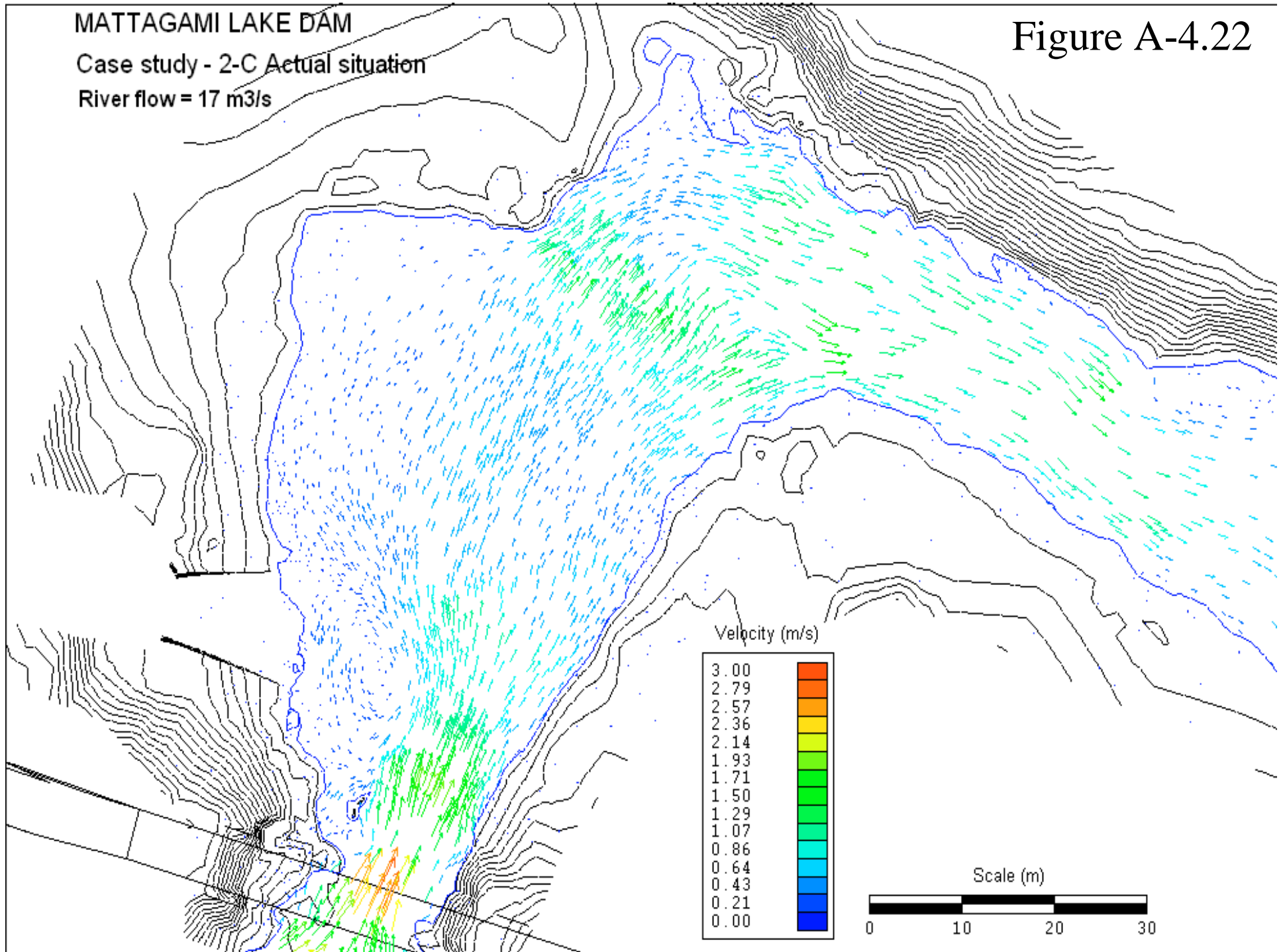
Case study C (2-C)

MATTAGAMI LAKE DAM

Case study - 2-C Actual situation

River flow = 17 m³/s

Figure A-4.22



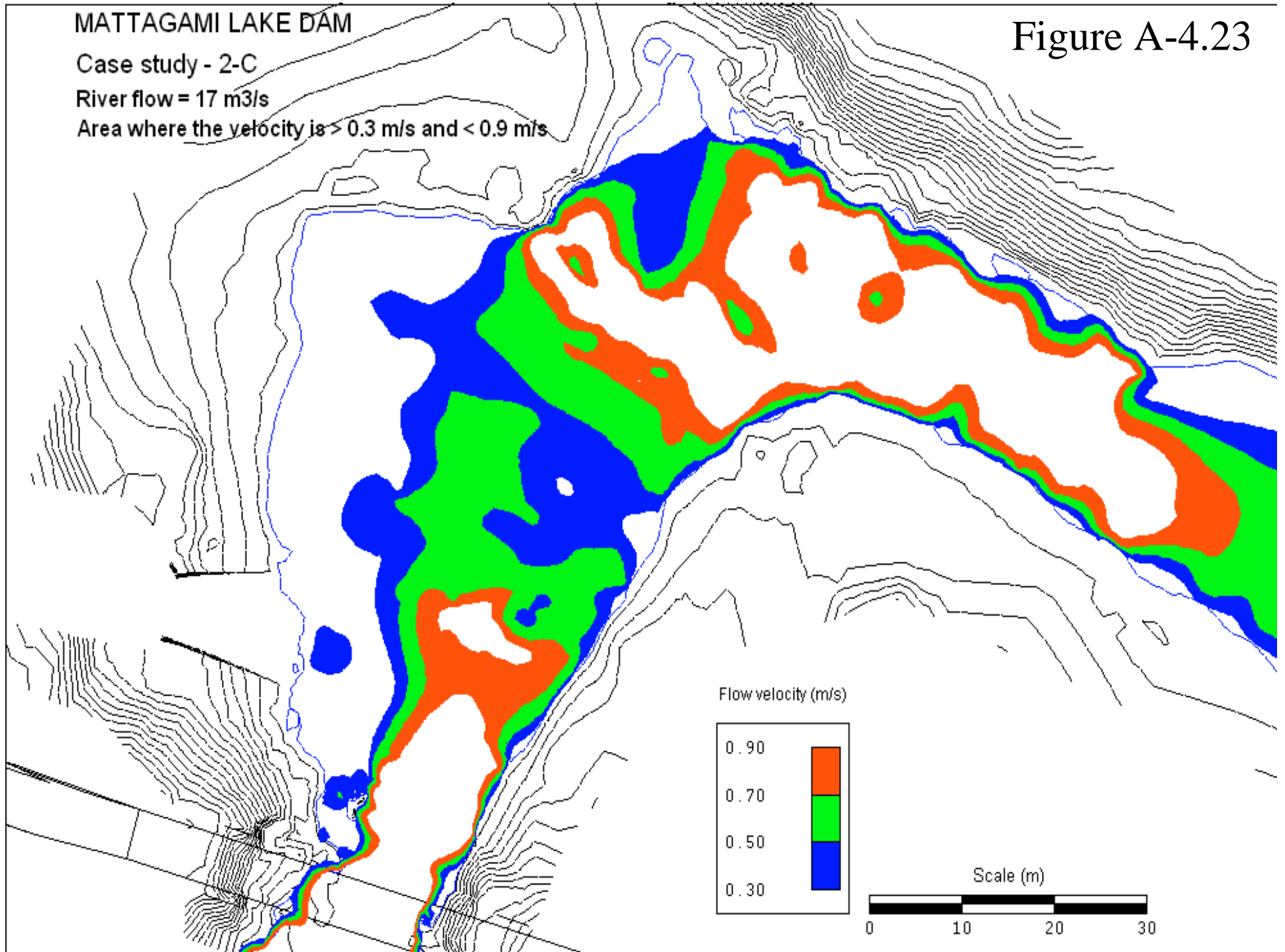
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 17 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.23

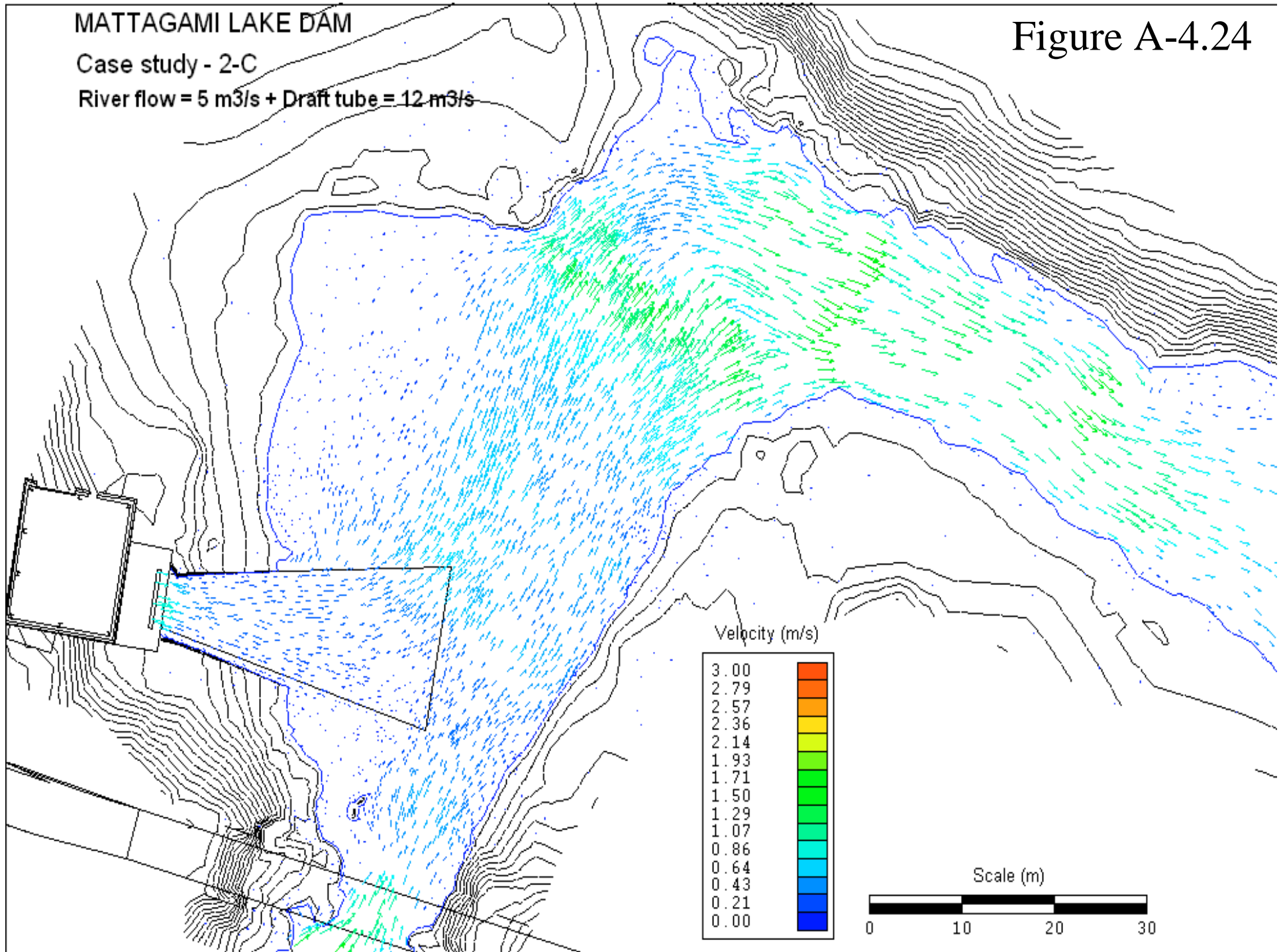


MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 5 m³/s + Draft tube = 12 m³/s

Figure A-4.24



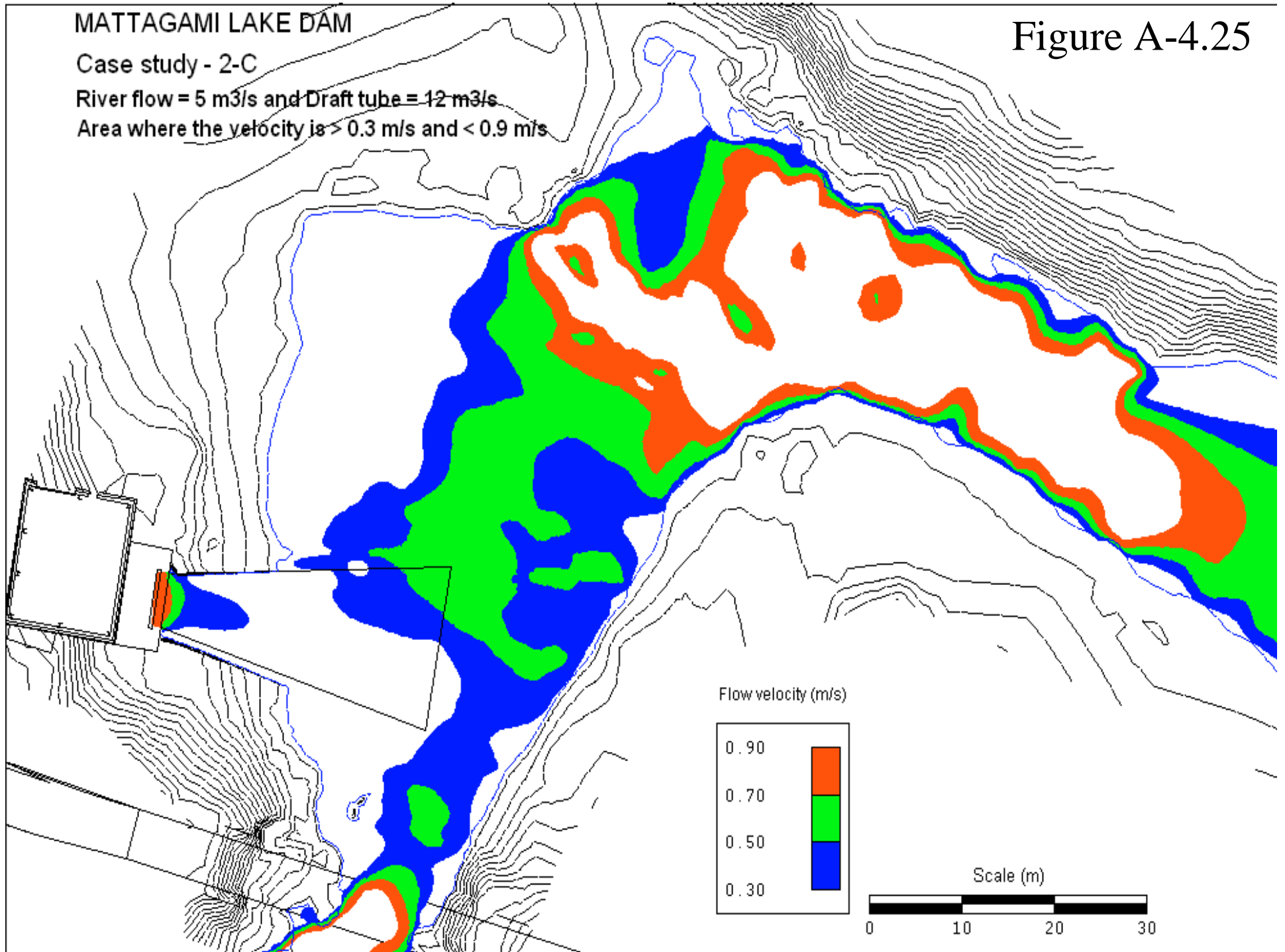
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 5 m³/s and Draft tube = 12 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.25



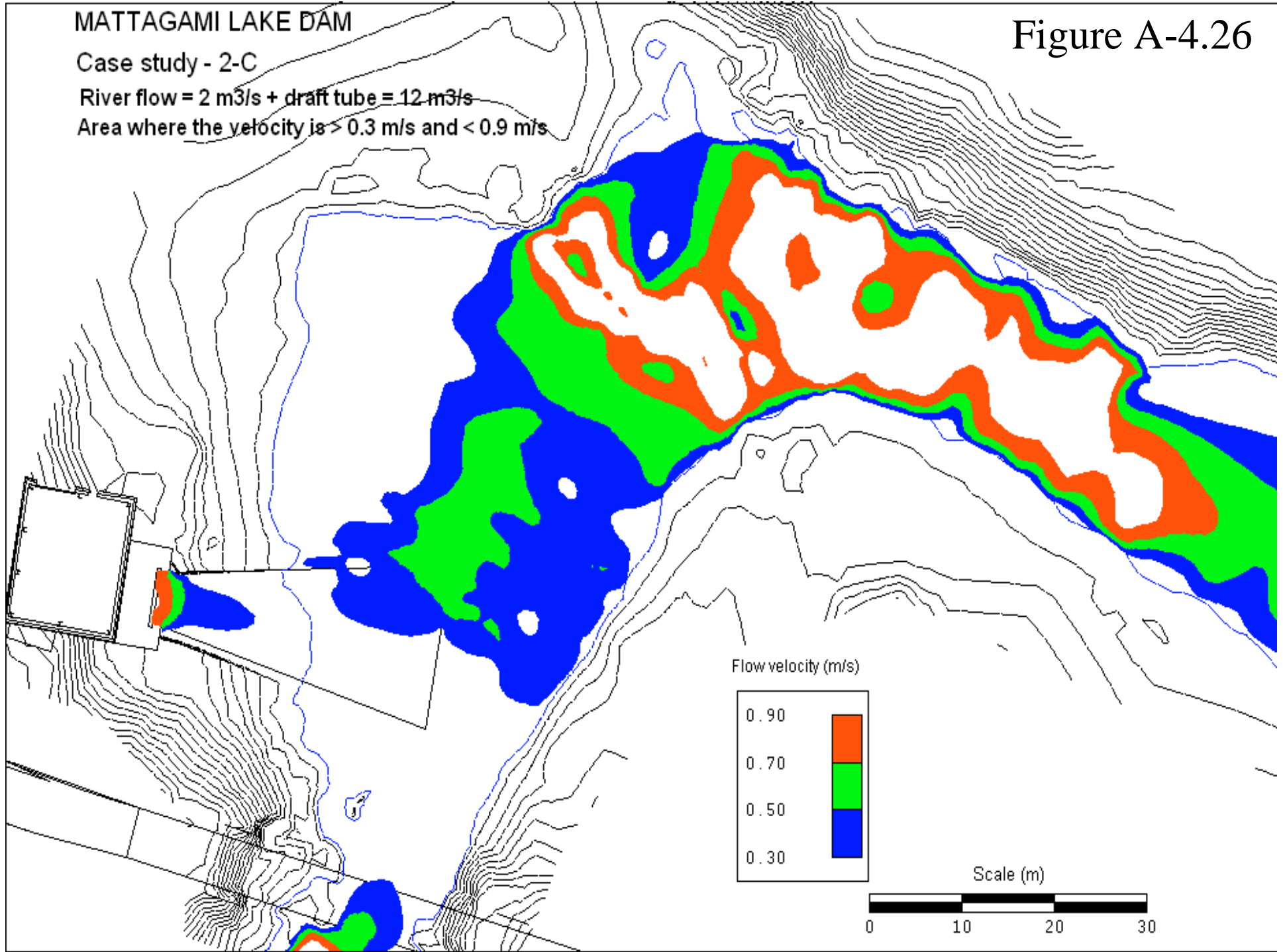
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 2 m³/s + draft tube = 12 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.26



Mattagami Lake Dam
Hydraulic study

Results

Scenario 12 and 16 m³/s

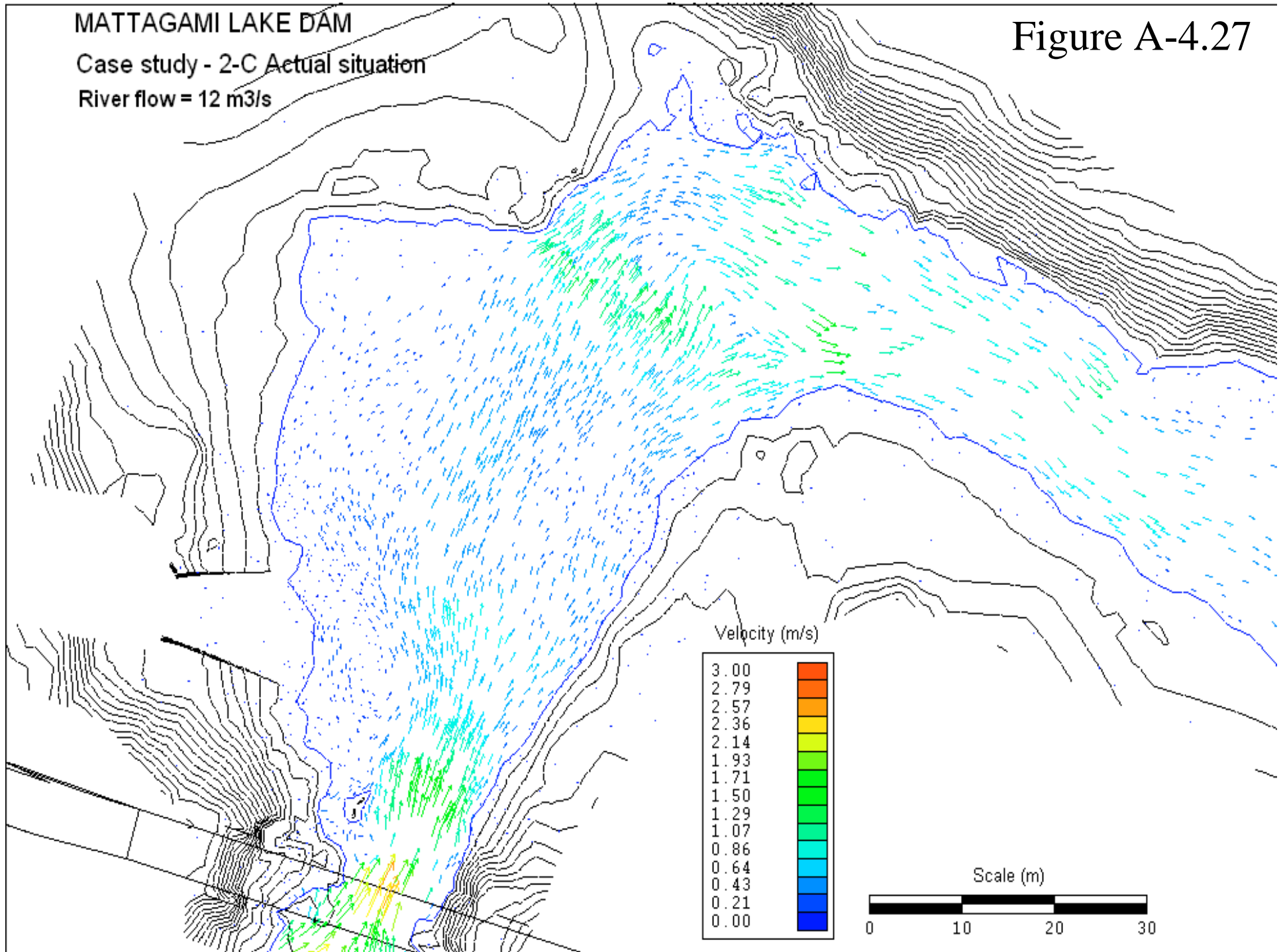
Case study C (2-C)

MATTAGAMI LAKE DAM

Case study - 2-C Actual situation

River flow = 12 m³/s

Figure A-4.27



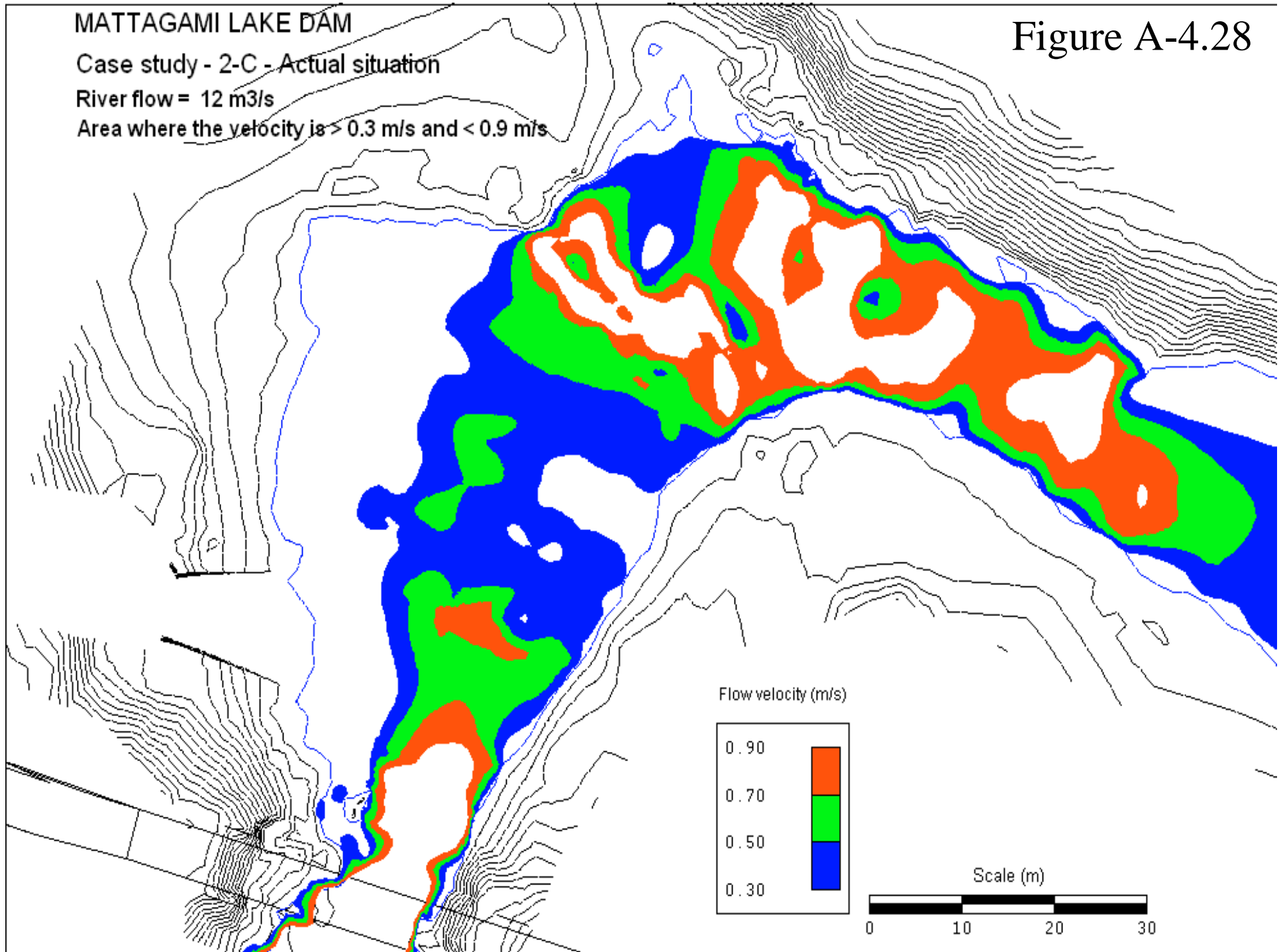
MATTAGAMI LAKE DAM

Case study - 2-C - Actual situation

River flow = 12 m³/s

Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.28

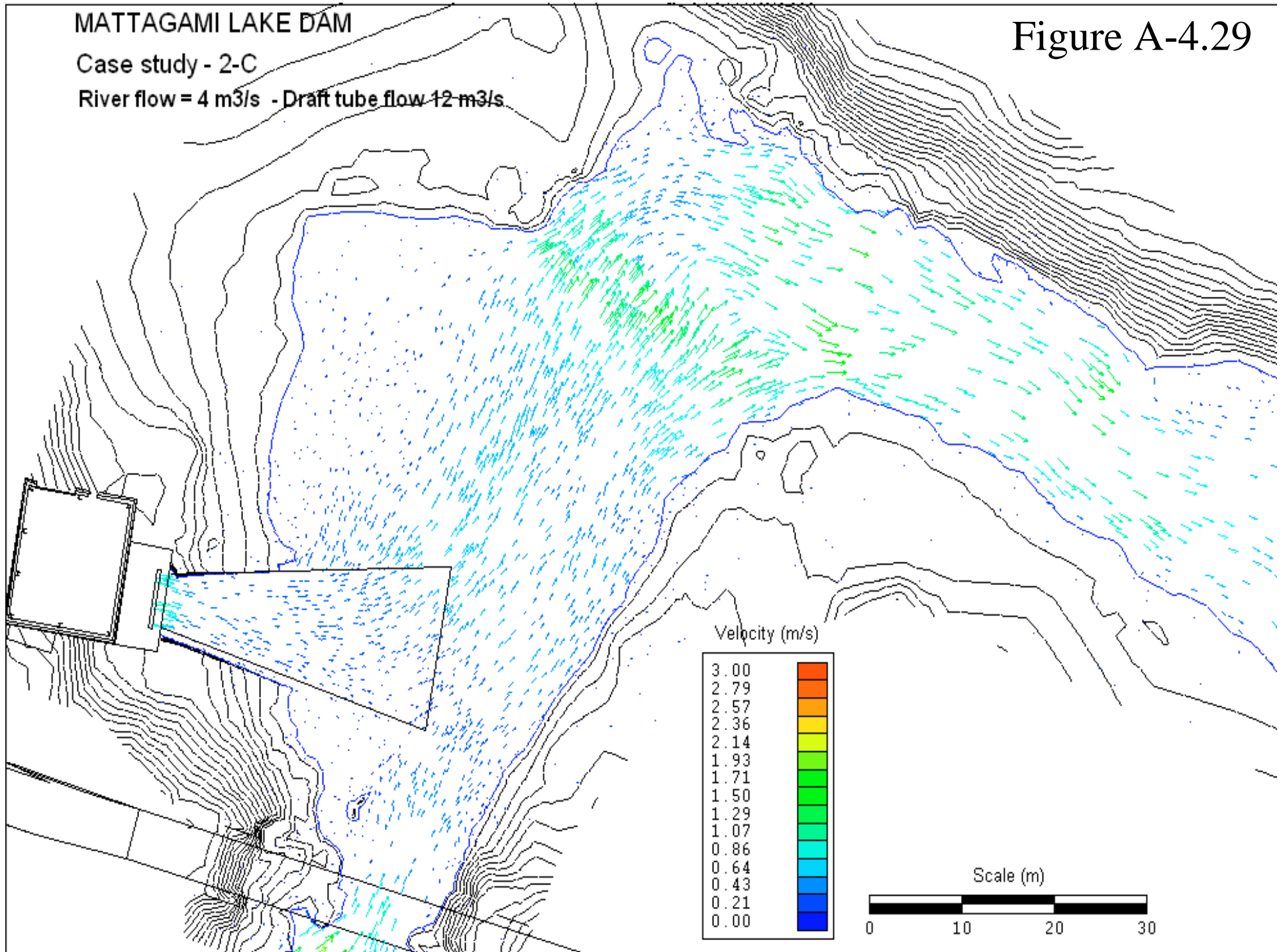


MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 4 m³/s - Draft tube flow 12 m³/s

Figure A-4.29



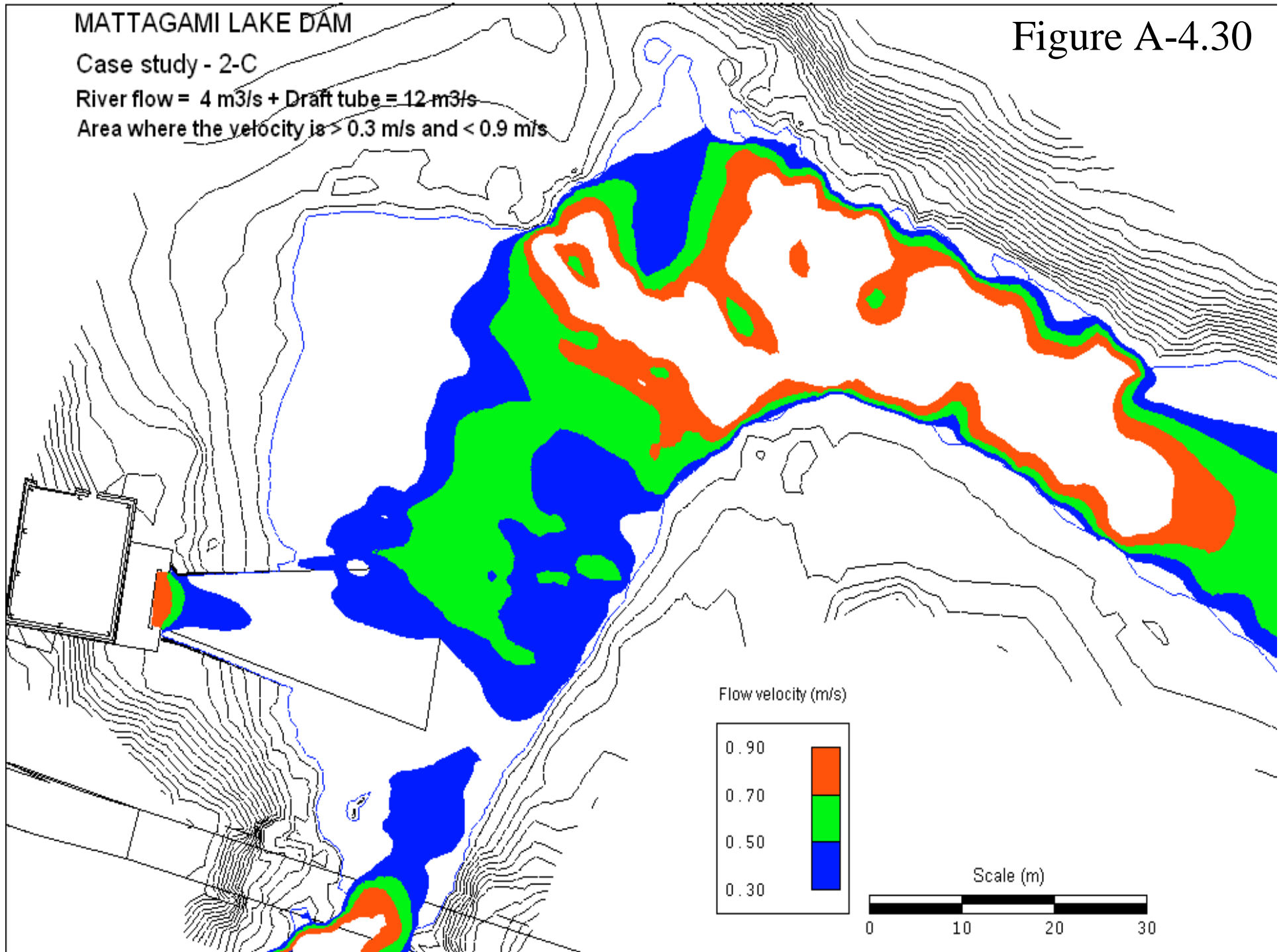
MATTAGAMI LAKE DAM

Case study - 2-C

River flow = 4 m³/s + Draft tube = 12 m³/s

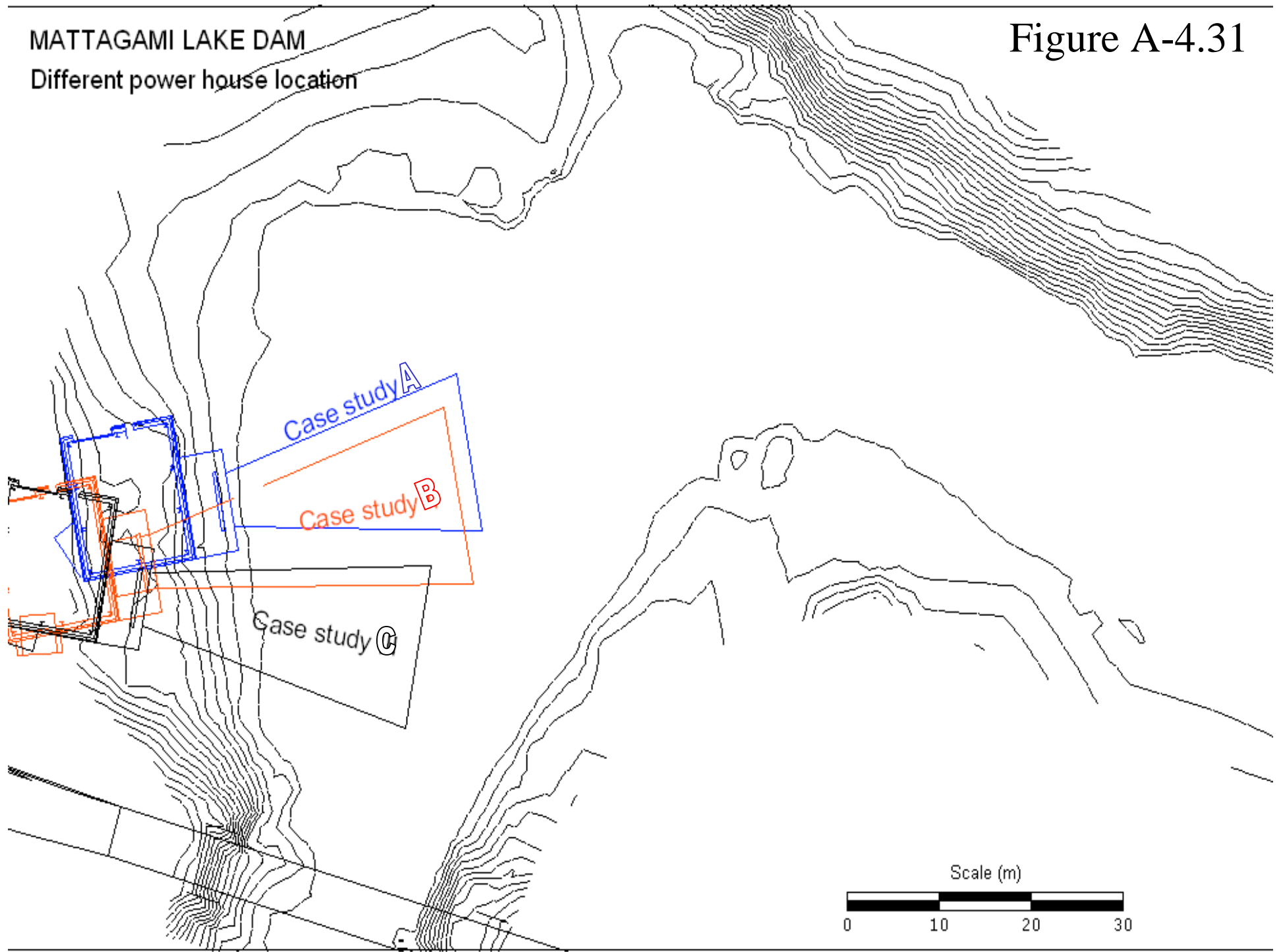
Area where the velocity is > 0.3 m/s and < 0.9 m/s

Figure A-4.30



MATTAGAMI LAKE DAM
Different power house location

Figure A-4.31



APPENDIX C
MLD GENERATING STATION MATTAGAMI RIVER ECOLOGICAL FLOW
ASSESSMENT

MATTAGAMI LAKE DAM GENERATING STATION
MATTAGAMI RIVER
ECOLOGICAL FLOW ASSESSMENT

Report date: December, 2008.
Prepared for: Ontario Power Generation Inc.
Hydroelectric Business Development
700 University Avenue, Office H18 E17
Toronto, Ontario
M8Z 5S4

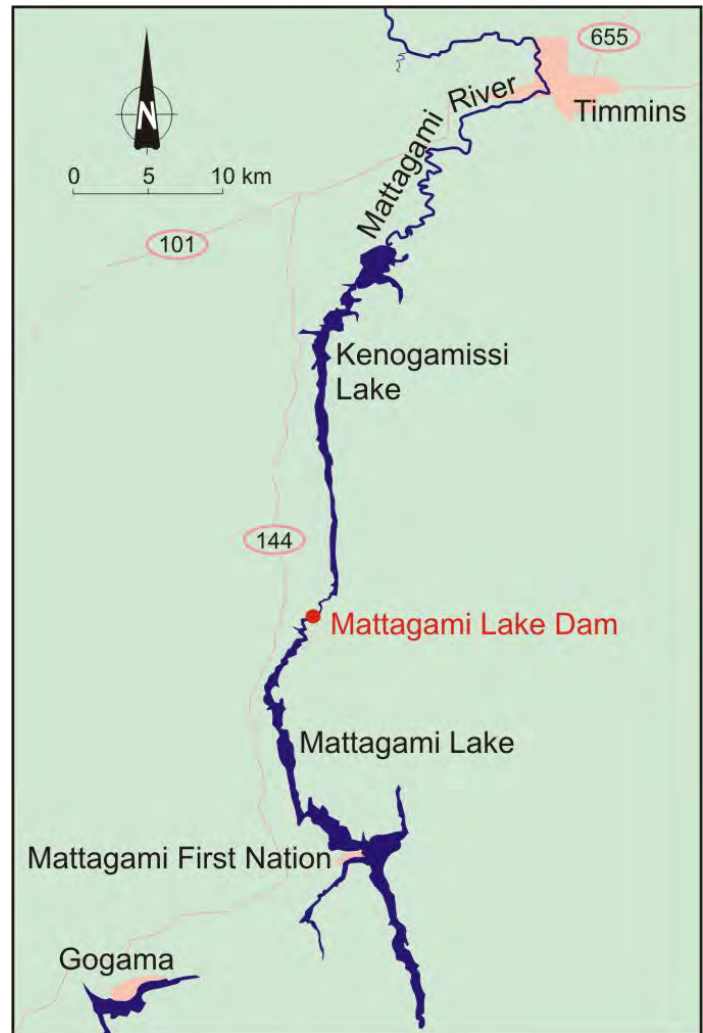
Prepared by: George Coker and Cam Portt
C. Portt and Associates
56 Waterloo Avenue
Guelph, Ontario
N1H 3H5

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1.0 INTRODUCTION

Ontario Power Generation Inc. (OPG) is proposing to develop a 5-7 megawatt (MW) hydroelectric generating station (GS), (Proposed Undertaking) in the immediate vicinity of OPG's existing Mattagami Lake Control Dam. OPG and Mattagami First Nation have entered into a non-binding Memorandum of Understanding (MOU) to discuss the possibility of the parties entering into a commercial relationship with respect to the Proposed Undertaking. The Mattagami Lake Dam is located approximately 54 kilometres (km) southwest of the Timmins city centre in the Mattagami River system (Figure 1). C. Portt and Associates was retained by Ontario Power Generation Inc. (OPG), as part of the SENES Consultants Limited project team, to assess the existing conditions with respect to fish and fish habitat in the area that would potentially be affected by the proposed generating station (GS), and to conduct a fisheries impact assessment of the proposed development. This assessment of aquatic habitat was conducted as part of the ongoing environmental assessment effort, and to address Ministry of Natural Resources (MNR), Timmins District Office, staff concerns regarding the appropriate post-development ecological flows within the Mattagami River study area that is located between the existing dam and downstream Kenogamissi Lake (Figure 2). It must be noted that this assessment was undertaken using methods developed specifically for the study area at the Mattagami Lake Dam, and therefore the results of this assessment cannot be used to justify ecological flows at other locations.



2.0 EXISTING FACILITY

The Mattagami Lake Dam was built in 1921, and controls flow from Mattagami Lake to Kenogamissi Lake which is the headpond of the Wawaitin GS. Mattagami Lake has the largest capacity of any reservoir on the upper Mattagami River system, and has an area of approximately

40 km², a mean depth of 8.3 m and a maximum depth of 76.2 m (OPG *et al*, 2006). In conjunction with Kenogamissi Lake, Mattagami Lake provides flood control for the City of Timmins and flow to downstream generating facilities (OPG *et al*, 2006). The dam also provides water level control in Mattagami Lake, and aids in water level control for Kenogamissi Lake (OPG *et al*, 2006). Access to the dam is provided by a forest access road that connects to Highway 141, located approximately 2 km west (Figure 1). The concrete dam is 115 m long, 9 m high, and has 6 sluice gates with a maximum discharge capacity of 524 m³/s. There is approximately 815 m of river between the dam and Kenogamissi Lake (Figure 2).

For dam safety purposes, a minimum flow of 30 m³/s is maintained during the winter period when the water level in Mattagami Lake is 330.70 m or higher in order to prevent significant ice load against the dam. When water temperature reaches 5 °C in spring a minimum flow of 12 m³/s is maintained during walleye spawning and incubation. The Ontario Ministry of Natural Resources (MNR) is required to notify OPG when the walleye are gathering in the pool below the dam.

3.0 PROPOSED HYDROELECTRIC DEVELOPMENT

Preliminary assessments conducted by OPG revealed that there is a potential for a small run-of-the-river hydroelectric GS at this site. While several options were examined, OPG's preferred concept would be expected to generate 5-7 MW of power. The new GS will have an average head of 16 m and maximum discharge capacity of about 40-47 m³/s depending on the final plant capacity.

The new plant will utilize the existing dam. A new intake will be located at the west end of the dam, utilizing the first two sluices (Figure 2). A 145 metre long steel penstock with a diameter of about 4 m would then carry water along the western bank of the river and under the existing road to a powerhouse which would be located immediately north of the existing bailey bridge on the west bank of the river (Figure 2). The powerhouse will contain one turbine, probably a double regulated Kaplan unit. This technology will facilitate the most efficient use of the water resources available at this site. The tailrace channel flares out in plan view to reduce the exit velocities. The construction duration is expected to be about 2 years, estimated to start in the fall of 2009. The target for the in-service date is fall 2011.

The proposed GS is designed as a run-of-the-river facility. During normal operation, some portion of the water that would previously have flowed through the river channel downstream of the dam to Kenogamissi Lake, will be diverted through the penstock and generating facility and then to the river channel downstream of the road bridge, and from here to Kenogamissi Lake (Figure 2).

4.0 METHODS

Preamble

Based upon previous meetings between MNR and OPG, it was believed that issues related to determining the appropriate ecological flow within the study area (Figure 2) may be resolved by determining a mutually acceptable method of habitat assessment under various flow regimes. To this end, a meeting between Jamie Mucha (MNR Biologist) and George Coker (Biologist representing OPG) was conducted on July 15, 2008, to develop a reasonable means of evaluating the impacts of potential ecological flows that is both acceptable to OPG and MNR, and scientifically supportable. It was agreed by both parties (MNR and OPG) that OPG should have a clear, science-based justification, before recommending an ecological flow, and that some elements of a Demonstration Flow Assessment (Railsback and Kadvany, 2008), combined with basic measurements of habitat, were suitable to assess the complex pool/run/riffle/rapid habitat within the study area under the relatively small range of flow to be assessed (i.e. 1 to 5 m³/s). The determination of an appropriate ecological flow will be based primarily upon striking a balance between the maintenance of predevelopment habitat components and the production of electricity. An additional meeting was conducted within the study area on August 6, 2008, to fine-tune the details of the proposed field program to assess ecological flow downstream of the road bridge, and to discuss the amount of ecological flow that would be required upstream of the road bridge to maintain the fish habitat in the bedrock pool (Figure 2) as well as to maintain fish passage to the bedrock pool. The final study design that was approved by both MNR and OPG is provided in Appendix A.

Assessment of ecological flow downstream of the road bridge

The field work component of this assessment occurred over September 8 - 11, 2008. On September 8 the flow in the study area was reduced by log operations at the Mattagami Lake Dam, from approximately 25 m³/s to approximately 5 m³/s. On-site discussions with the dam operators and the surveyors occurred at this time to determine the most efficient way to undertake the required stoplog adjustments and habitat measurements. The limits of the habitat segments and the locations of the depth and velocity measurement transects were flagged along the stream edge.

Demonstration Flows were conducted at 4.5, 3.2, 2.5, and 1.2 m³/s, over September 9 to 11, 2008. Velocity and flow measurements were undertaken by OPG (Hydro Engineering Division) at established sections within the study area using an RD Instrument Rio Grande 1200 KHz ZedHed Acoustic Doppler Current Profiler (ADCP). The ADCP uses the doppler shift principle to measure the magnitude and direction of velocity. The difference in frequency between the transmitted and reflected sound is proportional to the relative velocity between the ADCP and scatters within the water column. The ADCP was mounted in a small set of pontoons and pulled across each transect during each of the flow conditions. The recorded data were then downloaded to a computer and analyzed in detail to present both profiles and velocities for each transect. These data were used to characterize flow velocity and water depth at nine transects, as well as accurately calculate the river discharge at each demonstration flow. A survey crew

(Global Surveying) using a total station (Sokkia SET3 030R3 reflectorless), determined the exact location of the wetted perimeter of the approximately 610 m length of river within the study area, as well as established the locations of transects and photographic vantage points. Digital photographs were taken from a number of fixed locations to provide a visual record of the entire study area at each demonstration flow.

As stated, demonstration flows were conducted at 4.5, 3.2, 2.5, and 1.2 m³/s. Additional demonstration flows within the range of 0 - 5 m³/s would have been difficult to conduct, as the incremental change in flow that can be achieved using stoplogs is constrained by the size of the stoplogs, and at very low flows the leakage between stoplogs becomes a significant proportion of the flow being released at the dam. After the final demonstration flow, the substrate was classified and mapped by total station and GPS, so that measurements of water depth and wetted perimeter could be overlaid with substrate type.

Biologists Jamie Mucha and George Coker examined the study area under each flow demonstration, and discussed the habitat values of each. Their comparative discussions were aided by surveyor marks left upon the river substrate that showed the wetted perimeter of each demonstration flow, and by water level marks made with a carpenter's crayon at selected locations.

The main deviation from the field methods that had been crafted prior to the collection of field data (Appendix A), occurred when it was found that the depth and velocity measurements that were to occur across selected transects within discrete habitat segments (pools, riffles, runs), could not be undertaken with measurement rod and flow velocity meter because of safety concerns due to water depth and flow velocity, especially at the 4.5 and 3.2 m³/s demonstration flows. Instead, the ADCP was employed to collect depth and velocity data, as it did not require that personnel wade across the river to acquire these measurements. Since the ADCP can only be effectively used in areas without excessive turbulence, most of the pre-selected transects could not be used, necessitating the establishment of alternative transects with flow conditions that would allow the use of the ADCP.

Assessment of ecological flow between the dam and the road bridge

The field investigation detailed above was extended upstream of the road bridge to include the area of the bedrock pool, to provide data pertaining to the maintenance of habitat within the bedrock pool, as well as fish passage from downstream to the bedrock pool. It was recognised from the outset that the flow required to maintain habitat and fish passage relative to the bedrock pool will be lower than the range of demonstration flows used in the field investigation. Therefore, additional detailed channel measurements, collected upstream of the road bridge on December 11, 2006, were used as supplemental information to aid in the determination of an appropriate ecological flow in this area.

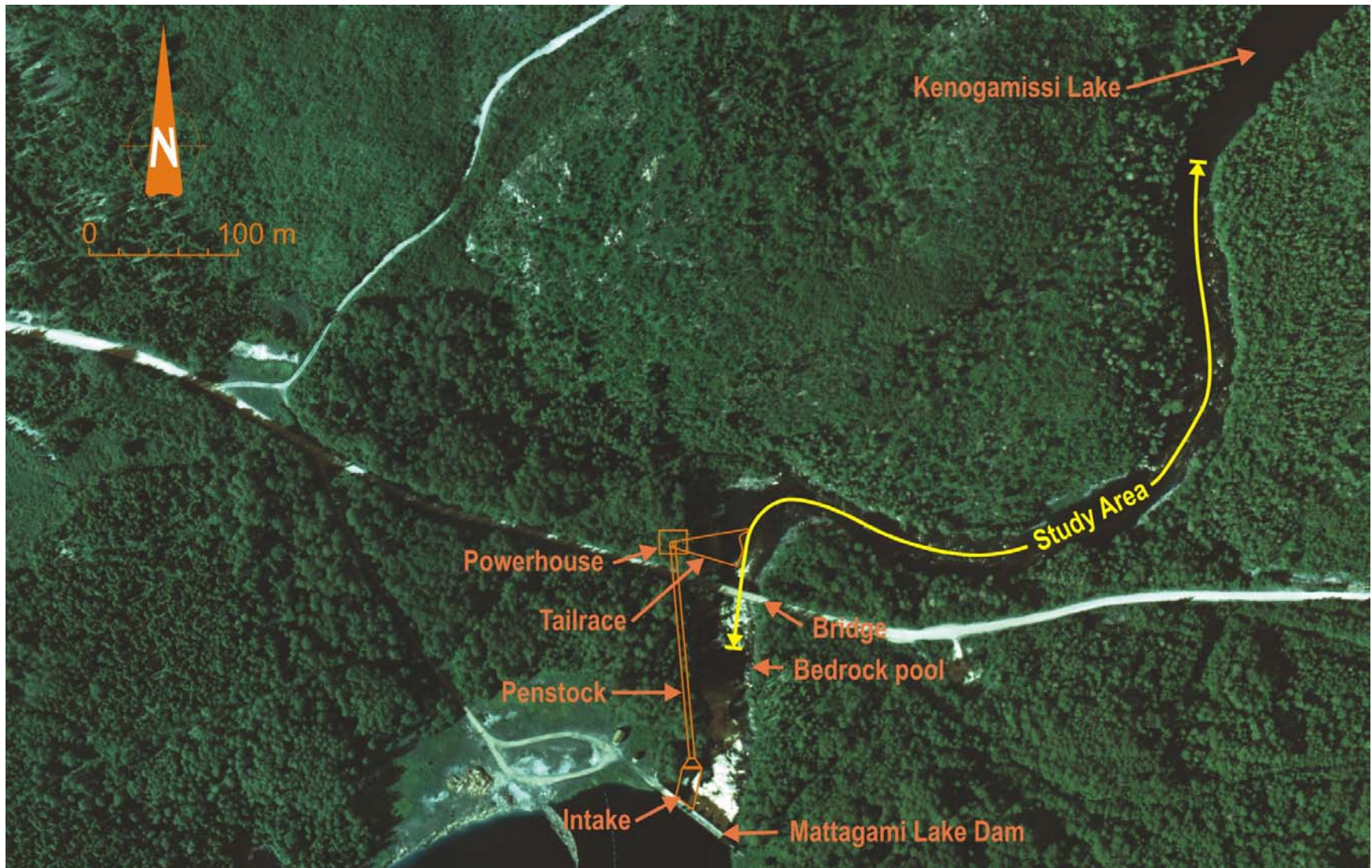


Figure 2: An annotated aerial LIDAR photograph of the project vicinity, showing the study area, the main site features, and the location and basic layout of the proposed hydroelectric station.

5.0 RESULTS AND DISCUSSION

5.1 Wetted perimeter

The results of the wetted perimeter measurements are provided in Table 1 and illustrated in Figures 3 and 4. The measurements and comparative percentages do not include the effect of the incremental exposure of individual rocks in shallow habitats, as observed in many of the comparative photographs provided in Appendix B, with the location at photograph series 3 (Figure 3) being the most extreme case. Regardless, Table 1 and Figure 5 demonstrate that the channel morphology in this particular section of the Mattagami River results in less than a proportional decrease in habitat area relative to flow reduction. Reductions in habitat area over the upper three demonstration flows (4.5 - 2.5 m³/s) are modest, and amount to a total of approximately 8%.

Table 1: Demonstration flow and the corresponding habitat area, with comparative calculations of percent flow and area reductions.

Flow (m ³ /s)	Area (m ²)	% of flow at 4.5 m ³ /s	% of area at 4.5 m ³ /s
4.5	13,550	100	100
3.2	13,012	71.1	96.0
2.5	12,484	55.6	92.1
1.2	11,403	26.7	84.2

5.2 Substrate

The results of the substrate mapping are provided in Figure 4. The Wentworth (1922) classification system was used, but modified by combining cobble with small boulders, with the class of large boulders (>0.5 m) added. It was thought that this would be a more relevant classification scheme considering the habitat types within the study area, as well as the fact that most areas with cobble-sized substrate also included a large and sometimes dominant proportion of smaller boulders.

Generally, areas of cobble and small boulder were impacted most by reductions in wetted perimeter, but this is in line with the dominance of this substrate class within the study area. No unique substrate types were eliminated from the wetted habitat at any of the four demonstration flows, and all substrate types present in the study area appeared to be impacted by declining flow in a manner proportional to their abundance.

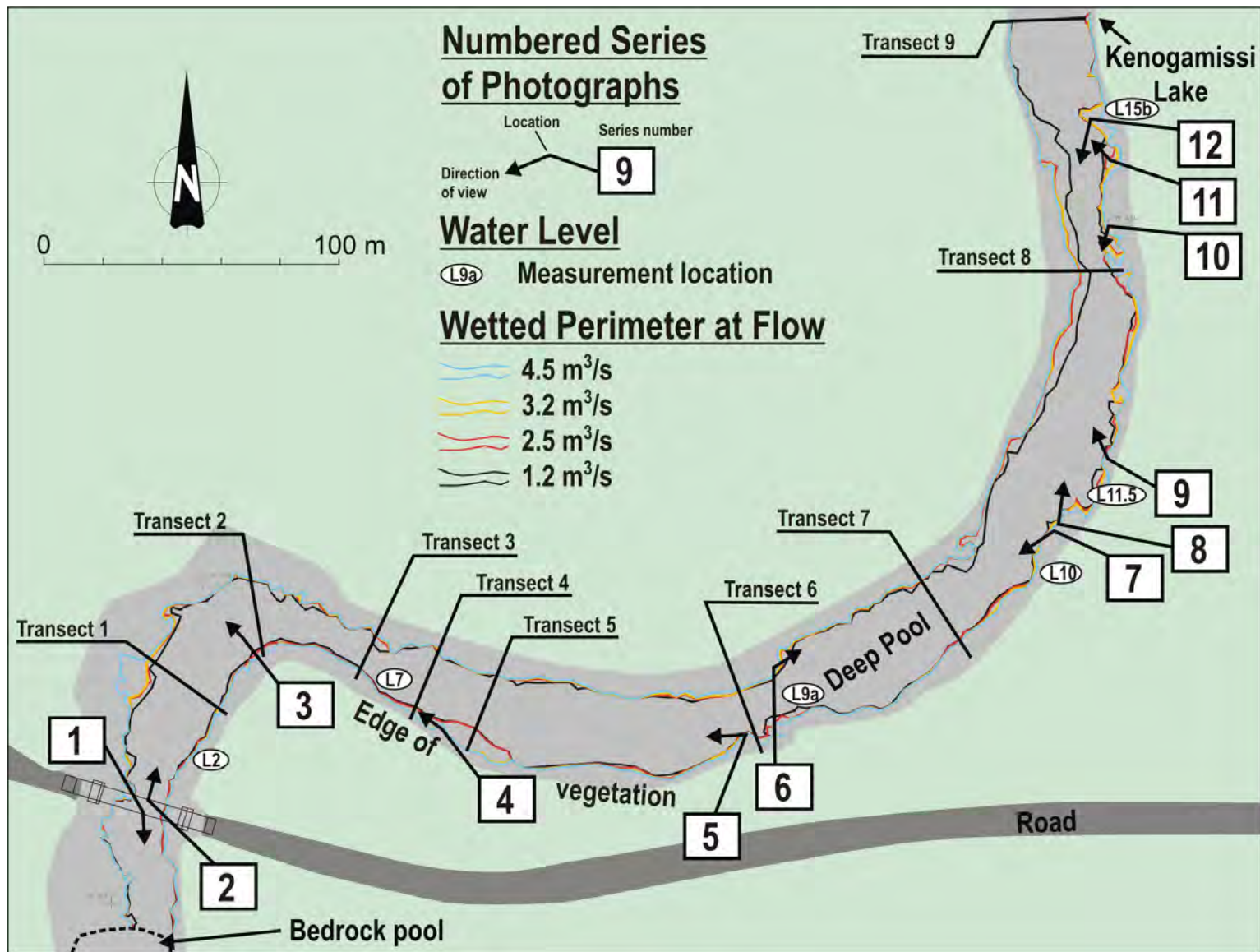


Figure 3: Wetted perimeter and the locations of photograph series and depth and velocity transects within the study area.

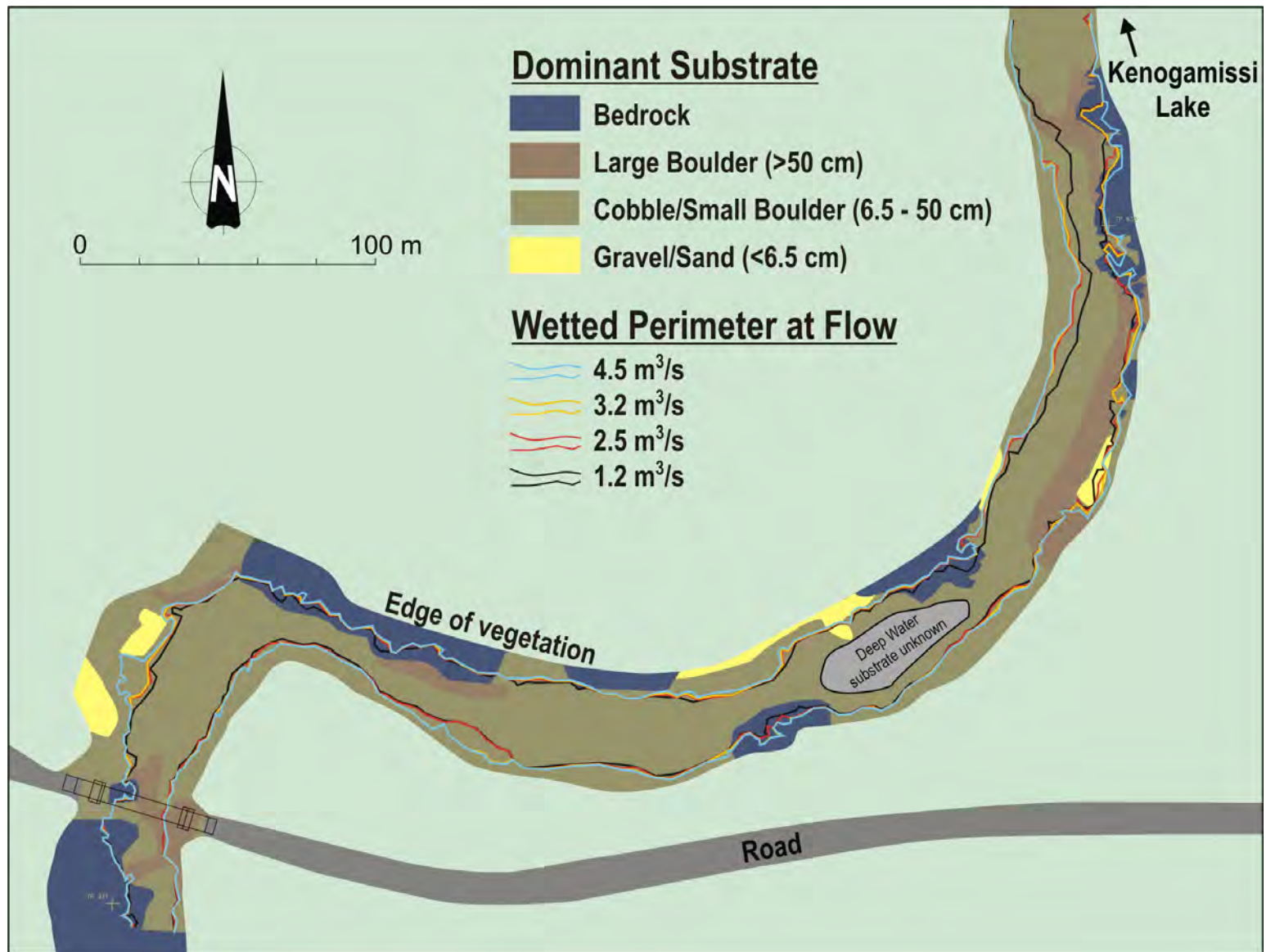


Figure 4: Wetted perimeter and substrate classification within the study area.

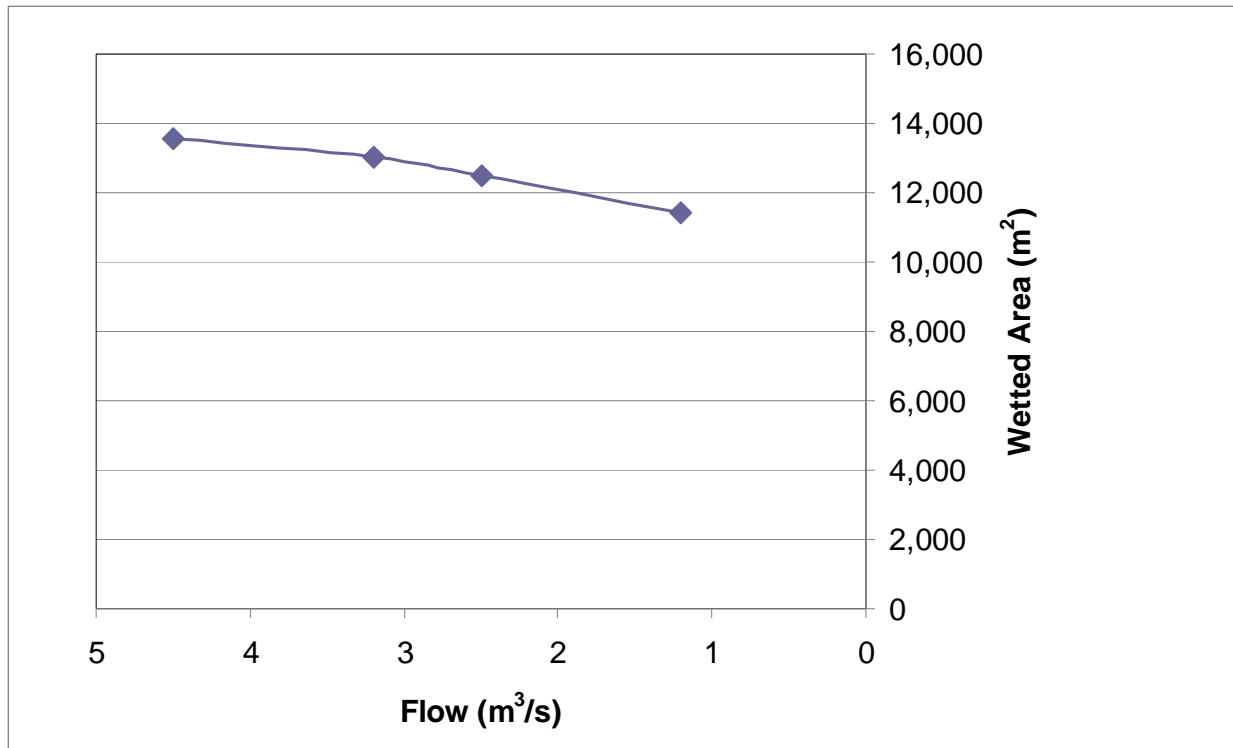


Figure 5: Flow (m³/s) versus wetted habitat area (m²).

5.3 Water depth and flow velocity

The results of the flow velocity and depth measurements are provided in Appendix C, with the transect locations shown in Figure 3. Some discrepancies are apparent in the graphs of water depth shown in Appendix C, but most are minor and are the result of the slight differences in transect position between each demonstration flow (Wayne Burchat, Hydro Engineering Division, OPG. Personal communication). Though the location of each transect was precisely marked on shore and surveyed, the tow path across the river varied somewhat due to the action of flow upon the pontoon-mounted ADCP, tautness of rope, etc. There is a major discrepancy in the data in transect 3, however, where the depth profile at 4.5 m³/s is significantly shallower than those at lesser flows. It is thought that the initial depth profile at this transect was positioned incorrectly (Wayne Burchat, Hydro Engineering Division, OPG. Personal communication). In the individual graphs for each demonstration flow in Appendix C, that include the velocity averages, the distance (x) axis is compressed compared to the combined graph at the top of each page, and the depth graph has a straight line at each end that rises to zero. These are artifacts of the analysis software.

The water level measurements taken at six locations along the length of the study area, downstream of the road bridge (Figure 6), and the depth graphs in Appendix C for each of the nine transects, indicate that water depth does not decrease drastically with flow. The Appendix C graphs indicate that the river always remains deep enough to provide habitat and fish passage.

However, one of the consequences of the necessary change from the proposed use of measurement rod and velocity meter within selected transects to using the ADCP, is that no depth measurements are available for the more turbulent and shallower riffles within the study area. To judge impacts upon water depth in these shallower riffles we are left with the visual assessment as recorded in the photographs provided in Appendix B, which indicate that water depth appears to have remained adequate. Barriers to fish movement were not observed during any of the demonstration flows.

Average velocities, within vertical panels across each transect at the four demonstration flows, are provided in Appendix C. The average and range of flow velocity for each transect and demonstration flow are summarized in Table 2 and graphed in Figure 7, to provide a measure of the trend in velocity change relative to flow. As would be expected, generally there is a decline in flow velocity with decreasing flow. Figure 7 shows how Transects 3 and 9, which are at the transition between upstream riffles and a downstream pool (transect 3) or lake (transect 9), suddenly drop in velocity as the lower river flow is overcome by the back water effect from the downstream flatwaters. The sudden drop in flow velocity at transect 7, which is within a pool near its outflow, shows the effect of the slower pool conditions extending into the upper end of the downstream riffle at lower demonstration flows. Transects 1 and 2 show how the velocity actually increased when channel width decreased because of the cross-sectional form of the channel at these two locations. Transects 4, 5, 6 and 8 are in slow riffles or runs at locations not affected as much by upstream or downstream channel morphology, and show a more gradual and even decrease in velocity.

While Figures 6 and 7 show that depth and velocity generally decrease with flow, the variation in changes in velocity and depth, and in particular the counter-intuitive flow velocity changes seen at some transects (Figure 7: transects 1 and 2), are a result of the very dynamic and complex interactions between flow, velocity, channel form and substrate composition, that are at play in this natural river.

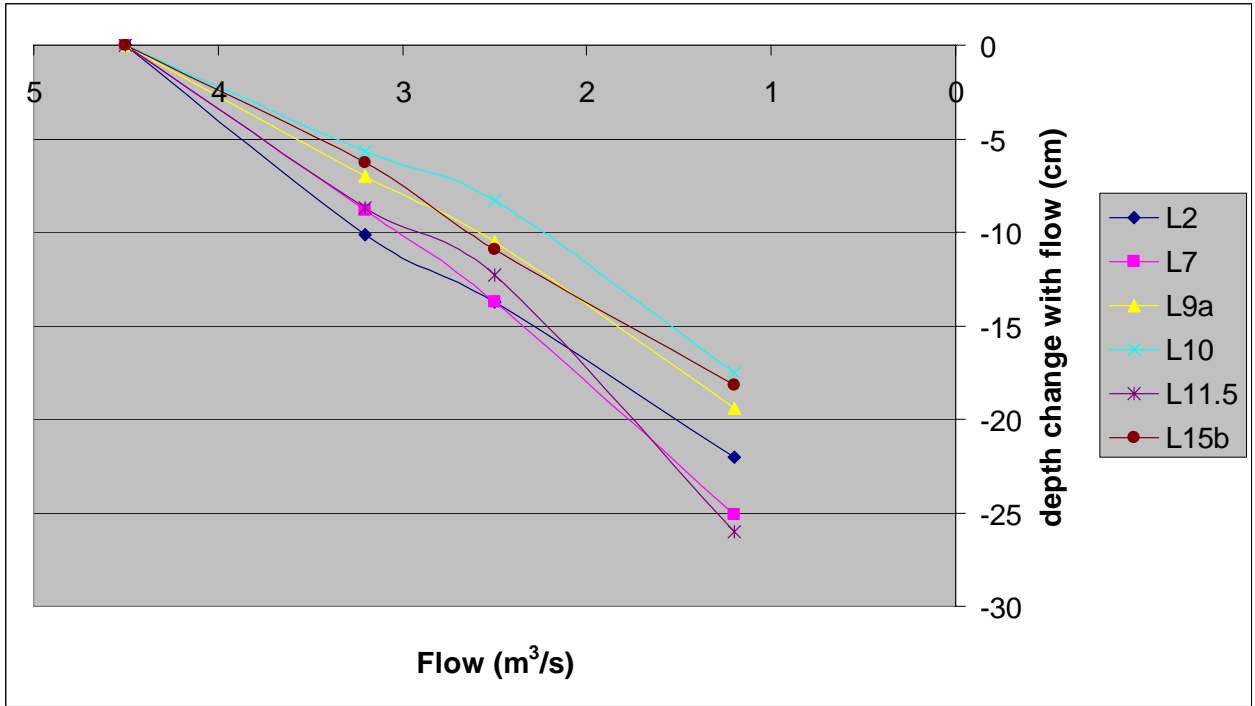


Figure 6: Flow (m³/s) versus change in water level (cm). Measurement locations shown in Figure 3.

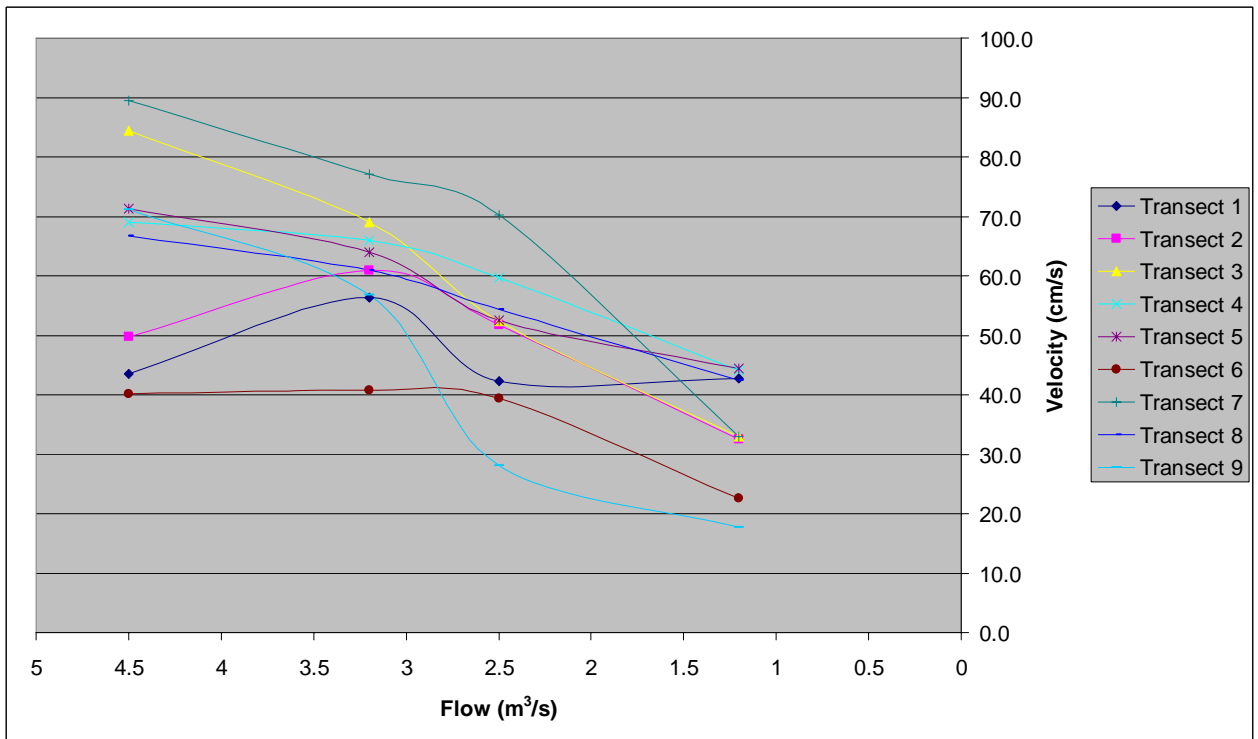


Figure 7: Flow (m³/s) versus average velocity (cm/s) at nine transects. Transect locations shown in Figure 3.

Table 2: Average and range of mean flow velocities (cm/s) summarized from Appendix C for each demonstration flow (4.5, 3.2, 2.5, and 1.2 m³/s) in each transect.

Transect 1	4.5	3.2	2.5	1.2
Average	43.5	56.4	42.3	42.7
Minimum	28.5	55.6	33.9	30.0
Maximum	53.3	57.3	50.4	50.9
Transect 2	4.5	3.2	2.5	1.2
Average	49.8	60.9	51.8	32.6
Minimum	25.9	44.4	27.8	20.7
Maximum	73.0	69.5	69.3	46.7
Transect 3	4.5	3.2	2.5	1.2
Average	84.5	69.1	52.3	33.0
Minimum	67.4	60.0	27.8	23.8
Maximum	106.0	77.3	66.7	37.9
Transect 4	4.5	3.2	2.5	1.2
Average	69.0	65.9	59.7	44.1
Minimum	56.3	56.4	48.1	16.8
Maximum	80.0	76.9	70.8	60.8
Transect 5	4.5	3.2	2.5	1.2
Average	71.2	64.0	52.5	44.5
Minimum	62.8	59.2	47.7	41.4
Maximum	77.2	67.1	56.4	47.9
Transect 6	4.5	3.2	2.5	1.2
Average	40.2	40.8	39.3	22.7
Minimum	29.7	20.8	17.8	16.7
Maximum	52.2	57.0	57.5	26.8
Transect 7	4.5	3.2	2.5	1.2
Average	89.5	77.0	70.3	33.0
Minimum	71.9	65.4	64.4	18.9
Maximum	103.8	85.3	75.2	43.4
Transect 8	4.5	3.2	2.5	1.2
Average	66.8	60.9	54.4	42.4
Minimum	40.3	35.5	34.0	29.3
Maximum	91.5	83.3	92.5	55.5
Transect 9	4.5	3.2	2.5	1.2
Average	71.2	56.7	28.2	17.8
Minimum	62.7	43.8	21.1	14.4
Maximum	83.8	67.7	32.3	22.4

5.4 Photographs

Approximately 1200 digital photographs were taken from selected locations within the study area to record the condition of the Mattagami River during the four demonstration flows. A selection of these photographs are provided in Appendix B to show the habitat characteristics at twelve representative vantage points that occurred during the four demonstration flows. The locations of the photographic vantage points are shown in Figure 3. Two photographs (2-1 and 8-1) from May 2, 2006, when river flow was estimated by stoplog operations to be approximately $12 \text{ m}^3/\text{s}$, have been included to provide a comparison between the minimum operational flow of the proposed GS, which it is assumed will be around $12 \text{ m}^3/\text{s}$, and the demonstration flows in this study.

These photographs illustrate the role that channel morphology plays in determining the extent of habitat loss with decreasing flow. For example, photograph series 3, 4 and 10 show the more extensive loss of nearshore habitat that can occur in channels that have a gently sloping side and a significantly deeper mid-channel, while photograph series 1, 5 and 7 show that nearshore habitats are not easily lost in channels that are relatively flat in cross section, though individual rocks within the channel are increasingly exposed. Photograph series 6 shows the very small amount of nearshore habitat lost within the deep pool as flow decreased.

These photographs provide some indication of what was observed during each demonstration flow. Habitat components were not lost with the reduction of flow, though habitat area was somewhat diminished. The character of the study area habitat did not appear to change drastically over the first three demonstration flows of 4.5 , 3.2 , and $2.5 \text{ m}^3/\text{s}$, and this is apparent in the photographs. However, the character of the river was very different when the river was reduced to the $1.2 \text{ m}^3/\text{s}$ demonstration flow, as it appeared to make the transition from a small river to a “babbling brook”.

5.5 The river channel between the bedrock pool and the road bridge

Photograph series 1 (Appendix B) shows the habitat and fish passage potential in the short section of river that connects the bedrock pool to habitats downstream of the road bridge. The surveyed cross-sections that were undertaken on December 11, 2006, were taken at the same datum (and by the same surveying team) as the field survey for this investigation, and it was therefore possible to combine the water level of the $1.2 \text{ m}^3/\text{s}$ demonstration flow with the 2006 cross-sections (Appendix D).

Cross-sections 4 and 5 are rather deep, as they appear to be in the portion of channel that is transitioning from pool to riffle (Appendix B: Photograph 1-4). Cross-sections 1 to 3 are shallower, and appear to be within the faster flowing section that slopes downstream from the bedrock pool (Appendix B: Photograph 1-4). Cross-sections 1 to 3 are also fairly flat, as also shown in photograph series 1 (Appendix B) and also indicated in the rather consistent wetted

perimeter at this location regardless of the demonstration flow (Figure 3). Cross-section 3 is the shallowest, with a maximum depth of 37.4 cm at the 1.2 m³/s demonstration flow, which we therefore consider to be the “bottleneck” location to apply an adequate depth to allow the passage of small fishes to and from the bedrock pool. Since the slope of the watercourse where these five cross-sections are positioned appears to be moderate, we will assume that water depth will be roughly proportional to (flow)^{2/3} because of the open-channel hydraulics. By our calculation, a 0.2 m³/s flow will therefore result in a water depth at this location of approximately 11 cm.

6.0 CONCLUSIONS

6.1 Ecological flow downstream of the proposed GS

The findings of this study that contribute to the determination of an appropriate ecological flow are:

- The results of the wetted perimeter measurements show that habitat area declined by approximately 16% as a result of a 73% reduction in flow. Habitat area declined by approximately 4% when flow was reduced from 4.5 m³/s to 3.2 m³/s, by an additional 4% when flow was reduced from 3.2 m³/s to 2.5 m³/s, and by a further 9% when flow was reduced from 2.5 m³/s to 1.2 m³/s.
- No unique substrate types were eliminated from the wetted habitat, and all substrate types present in the study area appeared to be impacted by declining flow in a manner that was generally proportional to their abundance.
- Water depth did not decrease drastically with flow. For demonstration flows down to 2.5 m³/s, most areas within the wetted perimeter appeared to maintain water depths that are sufficient for the proper functioning of flowing habitats. Only at the 1.2 m³/s demonstration flow, did water depth, as shown in the series of photographs in Appendix B, appear to significantly affect the character of the shallow habitats. This is also reflected in flow velocity measurements, which demonstrated a significant slowing of average velocities at the 1.2 m³/s demonstration flow. This may be due, in part, to the increased effect of substrate generated turbulence and friction that occurs as a greater proportion of the water column in shallow conditions is influenced by the closer proximity to the substrate.
- Average water velocities generally decreased moderately with discharge, though Figure 7 illustrates the variation in velocity changes that can occur through the complex interactions between flow, velocity, channel form and substrate composition, that can occur in a natural channel.
- The photographs provide an indication of what was observed during the demonstration flow assessment. That the character of the Mattagami River within the study area did not

change appreciably from the 4.5 to the 2.5 m³/s demonstration flows, but that at some point between the 2.5 and 1.2 m³/s demonstration flows, its character changed decisively.

Based upon these findings, the 2.5 m³/s demonstration flow is assessed to be adequate to maintain the existing habitat components and habitat character within the study area. In consideration of the fact that habitat changed little between the 3.2 and 2.5 flows, and that the 1.2 m³/s flow at which significant changes in habitat were observed is less than half of the 2.5 m³/s flow, we believe that 2.5 m³/s will safely protect the habitat components and character within the study area. We therefore recommend that 2.5 m³/s be accepted as the minimum ecological flow for the Mattagami River, downstream of the proposed GS to Kenogamissi Lake.

6.2 Ecological flow to maintain the bedrock pool and its connection to downstream habitats

The bedrock pool located upstream of the road bridge is not considered critical habitat. Field investigations have established that its substrate is primarily bedrock, though there are some patches of sand, gravel and cobble scattered over the bottom. The high flow velocities through this pool during periods of elevated river flow have probably contributed to the lack of granular substrates here. Fishes may migrate into this pool during higher flows, and it is certainly possible that small fishes, such as logperch (*Percina caprodes*) which have been observed in the pool, may permanently reside there or occasionally move between the pool and downstream habitats. Fish cannot move upstream beyond the pool due to high velocities.

By our calculation, a 0.2 m³/s flow released from the Mattagami Lake Dam will result in a minimum water depth of approximately 11 cm within the channel between the bedrock pool and the road bridge, that would be sufficient for the movement of small fishes during periods when no excess water is being spilled through the dam. This flow is also judged to be adequate for the maintenance of water quality within the bedrock pool. We therefore recommend that 0.2 m³/s be accepted as the ecological flow to be released from the vicinity of the Mattagami Lake Dam, to maintain aquatic habitat, fish passage and water quality within the Mattagami River, upstream of the proposed GS to the Mattagami Lake Dam.

7.0 REFERENCES

- Ontario Power Generation Inc., Tembec Industries, Brookfield Power and Ontario Ministry of Natural Resources (OPG *et al.*). 2006. Mattagami River System Water Management Plan. Final Report.
- Railsback, S.F., and J. Kadvany. 2008. Demonstration flow assessment: judgement and visual observation in instream flow studies. *Fisheries*. 33(5): 217-227.
- Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. *J. of Geology*. 30: 377-392.

Appendix A

**Flow assessment study
terms of reference**

MEETING - Proposed Mattagami Lake Dam Generating Station

Date

July 15, 2008.

Purpose

To develop a reasonable means of evaluating the impacts of potential ecological flows below the proposed Mattagami Lake Dam Generating Station (GS), that is both acceptable and defensible to Ontario Power Generation (OPG), and is scientifically supportable.

Background

Based upon previous meetings between MNR and OPG, it was felt that some issues related to determining the appropriate ecological flow value may be resolved by determining a mutually acceptable method of habitat assessment under various flow regimes. To this end, this meeting between Jamie Mucha (MNR Biologist) and George Coker (Biologist representing OPG) was conducted.

Results of meeting

1. Initial discussion revolved around the types of information and analyses required for OPG to be able to evaluate the impacts of various ecological flows below the Mattagami Lake Dam. OPG should have a clear, science-based justification, before recommending an ecological flow. To this end the merits of flow modelling vs. direct field observation and judgement-based assessment were discussed, with the aid of a recently published paper entitled "Demonstration Flow Assessment: Judgment and Visual Observation in Instream Flow Studies" (*Fisheries* Vol 33: No 5, May 2008). It was decided that a Demonstration Flow Assessment, combined with basic measurements of habitat, were suitable to assess the complex pool/run/riffle/rapid habitat between the Mattagami Lake Dam and Kenogamissi Lake, under the relatively small range of flow to be assessed (i.e. 1 to 5 m³/s).
2. It was agreed that the period of time for which low flow may be of concern during some years is from the end of the walleye incubation period (mid to the end of June) until the fall when flows begin to naturally increase. While no sport fish are known to utilize the river for spawning during this summer period, the river supports a diversity of benthic invertebrates, as well as some small species of fish, that provide forage for certain terrestrial animals, birds, and downstream fishes. To preserve these river functions, the ecological flow should be sufficient to maintain the existing diversity of habitats that occur in this section of the Mattagami River during this period. There will be two ecological flow values established: one for the area between the existing dam and the proposed GS to maintain the habitat within the pool located upstream of the bridge, and; another ecological flow value for the habitat downstream of the proposed GS to Kenogamissi Lake. The protocol described later in this document will address the flows between the proposed GS and Kenogamissi Lake only.
3. The determination of an appropriate summer ecological flow will be based primarily upon the maintenance of habitat components, with secondary emphasis upon wetted perimeter.

4. In consideration of the above points, the following timelines and methods are proposed to determine an appropriate ecological summer flow for the river downstream of the Mattagami Lake Dam.
 1. Jamie Mucha and George Coker will go to the Mattagami Lake Dam site for a day during the period August 5 - 8, 2008, to fine-tune the field methods outlined in this document. In preparation for this one day field visit, we request that OPG plan to reduce the river flow below the Mattagami Lake Dam to the extent possible. It may be necessary to draw-down the upstream lake immediately prior to the field visit, so that a one day window of minimal flow can be provided.
 2. The primary field assessment should be scheduled for approximately three consecutive days in early September. The following components are proposed, and the required technical support is noted.
 - The substrate must be mapped and spatially referenced so that subsequent measurements of water depth and wetted perimeter can be precisely overlaid with substrate type. Details of this component will be refined during the field visit in early August, however, it will likely entail the delineation of substrate patches with particular ranges of particle size using the Wentworth scale (e.g. boulder, cobble, gravel). The flow in the river will be reduced to as low as possible, and a field crew with total station instrumentation will map the substrate under the direction of the biologists on the first day. Flagged reference points (numbered wood stakes or trees marked with flagging tape) should also be set up along the river in preparation for the subsequent visual observations. This substrate mapping component could be undertaken earlier, immediately after the early August field visit, if need be.
 - The first demonstration flow will likely begin on the second field day, and should target a flow of at least 5 m³/s (the DFA recommends beginning with the flow that would be there in the absence of the proposed development – in this case, the regulated Q80 flows averaged for July/August/September is 5.40 cms). Once the flow is stabilized throughout study area, the precise flow value must be determined. A crew using a Total Station will then delineate the wetted perimeter, working from upstream to downstream. While the wetted perimeter is being delineated, Jamie Mucha and George Coker will visually evaluate the habitat quality and function of each habitat component (a habitat component is an individual pool, run, riffle, or rapid), temporarily marking reference locations or particular habitat components with wire push-stakes (or something similar) and flagging tape. A two person support crew (e.g. C. Portt and Associates staff Jim Reid and Rebecca Dolson) will accompany Jamie Mucha and George Coker to measure transects for velocity and depth at select locations. Photographs and video will also be taken at selected reference points.
 - This procedure will be repeated for a minimum of two additional demonstration flows, targeting 3 to 4 m³/s, and 2 to 3 m³/s, in descending order. If the flow increments provided by the stoplog operations allow for a fourth or fifth demonstration flow within the range of 1 to 6 m³/s, and it is felt that additional information would be useful (e.g. at flows of less than 2 m³/s), then the option of

undertaking these additional demonstration flows should be considered. It is estimated that at least two demonstration flows per day will be possible.

3. It is assumed that by the end of the early September field work, the information necessary to adequately assess the impacts of the various potential ecological flows, will have been collected. Once the field work is complete, the methods, field information, field measurements, and other supporting information, along with an analysis of these data that rationalizes the recommended ecological flow, will be provided in a report that will become part of the EA documentation.

Appendix B

Photographs

Photograph 1-1. 4.5 m³/s.
Upstream view from road bridge.



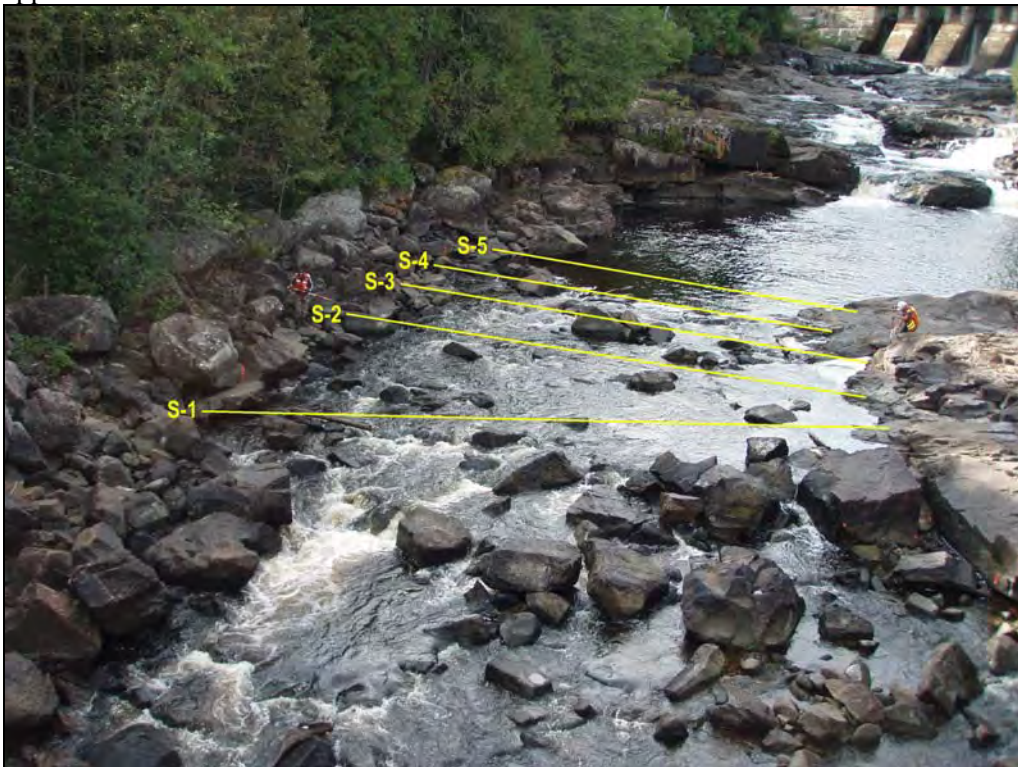
Photograph 1-2. 3.2 m³/s.
Upstream view from road bridge.



Photograph 1-3. 2.5 m³/s.
Upstream view from road bridge.



Photograph 1-4. 1.2 m³/s. Upstream view from road bridge. Showing the approximate location of cross-sections S1-S5.



Photograph 2-1. 12 m³/s.
Downstream view from road bridge. May 2, 2006.



Photograph 2-2. 4.5 m³/s.
Downstream view from road bridge.



Photograph 2-3. 3.2 m³/s.
Downstream view from road bridge.



Photograph 2-4. 2.5 m³/s.
Downstream view from road bridge.



Photograph 2-5. 1.2 m³/s.
Downstream view from road bridge.



Photograph 3-1. 4.5 m³/s.

Riffles at first bend in river downstream of the road bridge.



Photograph 3-2. 3.2 m³/s.

Riffles at first bend in river downstream of the road bridge.



Photograph 3-3. 2.5 m³/s.
Riffles at first bend in river downstream of the road bridge.



Photograph 3-4. 1.2 m³/s.
Riffles at first bend in river downstream of the road bridge.



Photograph 4-1. 4.5 m³/s.
Upstream view at approximately 150 m downstream from the road bridge.



Photograph 4-2. 3.2 m³/s.
Upstream view at approximately 150 m downstream from the road bridge.



Photograph 4-3. 2.5 m³/s.
Upstream view at approximately 150 m downstream from the road bridge.



Photograph 4-4. 1.2 m³/s.
Upstream view at approximately 150 m downstream from the road bridge.



Photograph 5-1. 4.5 m³/s.

Upstream view at approximately 250 m downstream from the road bridge.



Photograph 5-2. 3.2 m³/s.

Upstream view at approximately 250 m downstream from the road bridge.



Photograph 5-3. 2.5 m³/s.
Upstream view at approximately 250 m downstream from the road bridge.



Photograph 5-4. 1.2 m³/s.
Upstream view at approximately 250 m downstream from the road bridge.



Photograph 6-1. 4.5 m³/s.
Downstream view along edge of deep pool.



There is no Photograph 6-2 at 3.2 m³/s.

Photograph 6-3. 2.5 m³/s.
Downstream view along edge of deep pool.



Photograph 6-4. 1.2 m³/s.
Downstream view along edge of deep pool.



Photograph 7-1. 4.5 m³/s.

Upstream view of the riffles that are located at the downstream end of the deep pool.



Photograph 7-2. 3.2 m³/s.

Upstream view of the riffles that are located at the downstream end of the deep pool.



Photograph 7-3. $2.5 \text{ m}^3/\text{s}$.
Upstream view of the riffles that are located at the downstream end of the deep pool.



Photograph 7-4. $1.2 \text{ m}^3/\text{s}$.
Upstream view of the riffles that are located at the downstream end of the deep pool.



Photograph 8-1. 12 m³/s. May 2, 2006.
Downstream view of the lower study area.



Photograph 8-2. 4.5 m³/s.
Downstream view of the lower study area.



Photograph 8-3. 3.2 m³/s.
Downstream view of the lower study area.



Photograph 8-4. 2.5 m³/s.
Downstream view of the lower study area.



Photograph 8-5. 1.2 m³/s.
Downstream view of the lower study area.



Photograph 9-1. 4.5 m³/s.
Downstream view within the lower study area.



Photograph 9-2. 3.2 m³/s.
Downstream view within the lower study area.



Photograph 9-3. 2.5 m³/s.
Downstream view within the lower study area.



Photograph 9-4. 1.2 m³/s.
Downstream view within the lower study area.



Photograph 10-1. 4.5 m³/s.
Upstream view within the lower study area.



Photograph 10-2. 3.2 m³/s.
Upstream view within the lower study area.



Photograph 10-3. 2.5 m³/s.
Upstream view within the lower study area.



Photograph 10-4. 1.2 m³/s.
Upstream view within the lower study area.



Photograph 11-1. 4.5 m³/s.

Downstream view of riffles immediately upstream from Kenogamissi Lake.



Photograph 11-2. 3.2 m³/s.

Downstream view of riffles immediately upstream from Kenogamissi Lake.



Photograph 11-3. 2.5 m³/s.

Downstream view of riffles immediately upstream from Kenogamissi Lake.



Photograph 11-4. 1.2 m³/s.

Downstream view of riffles immediately upstream from Kenogamissi Lake.



Photograph 12-1. 4.5 m³/s.
Upstream view from near Kenogamissi Lake.



Photograph 12-2. 3.2 m³/s.
Upstream view from near Kenogamissi Lake.



Photograph 12-3. 2.5 m³/s.
Upstream view from near Kenogamissi Lake.

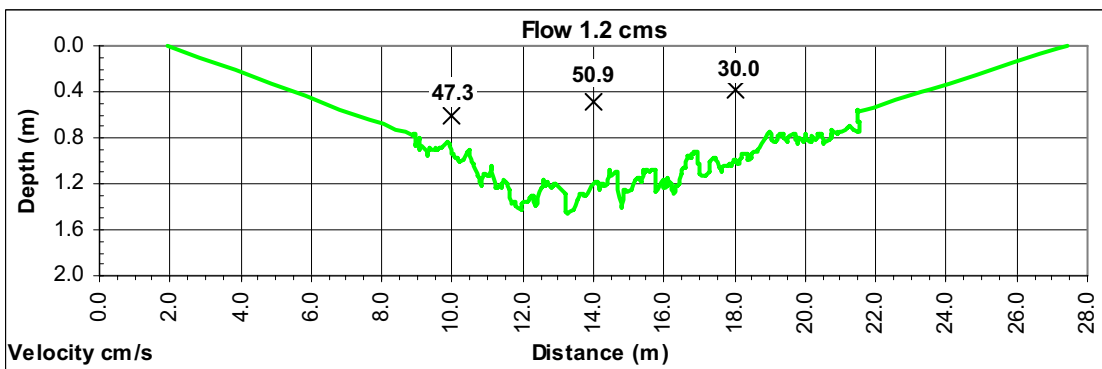
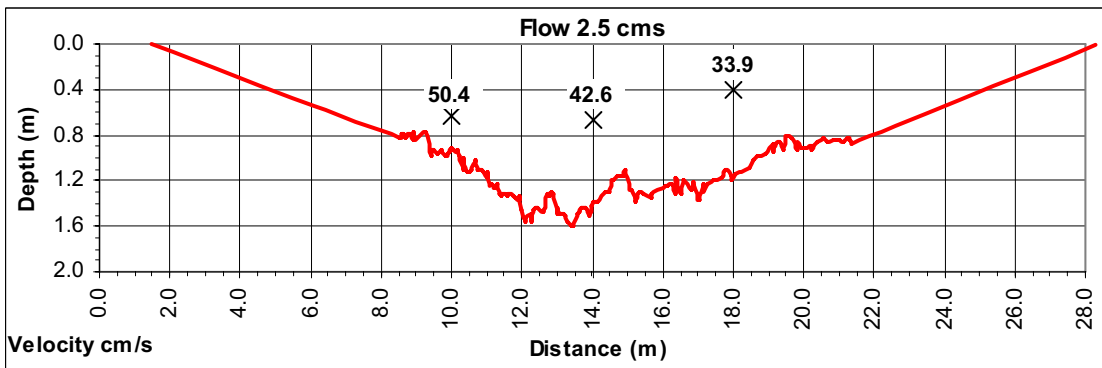
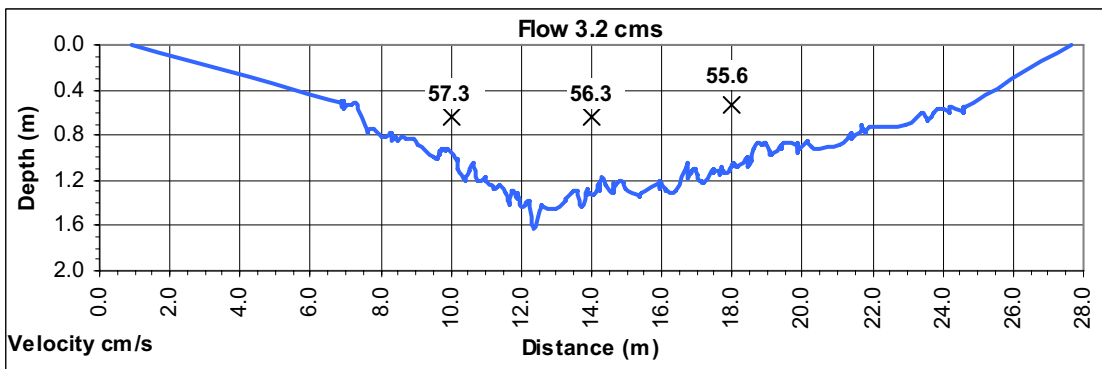
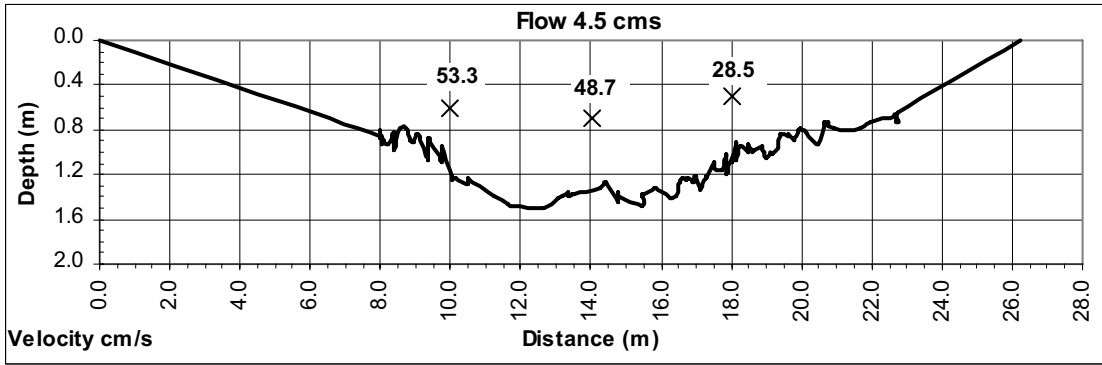
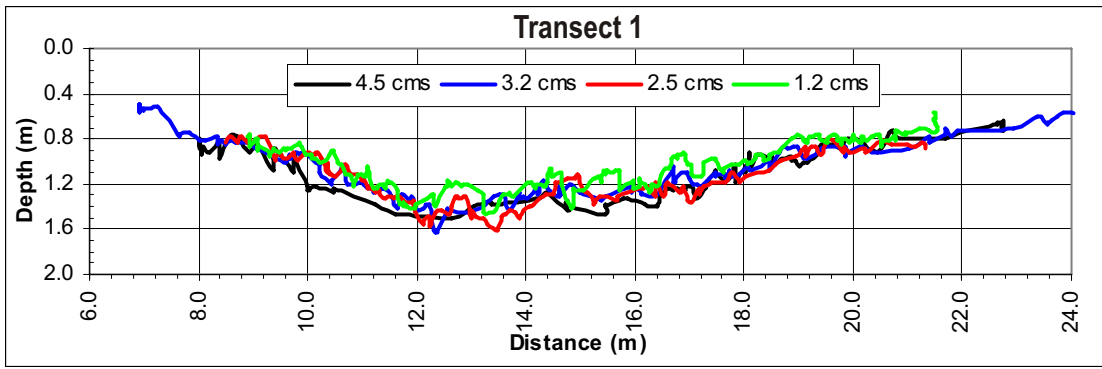


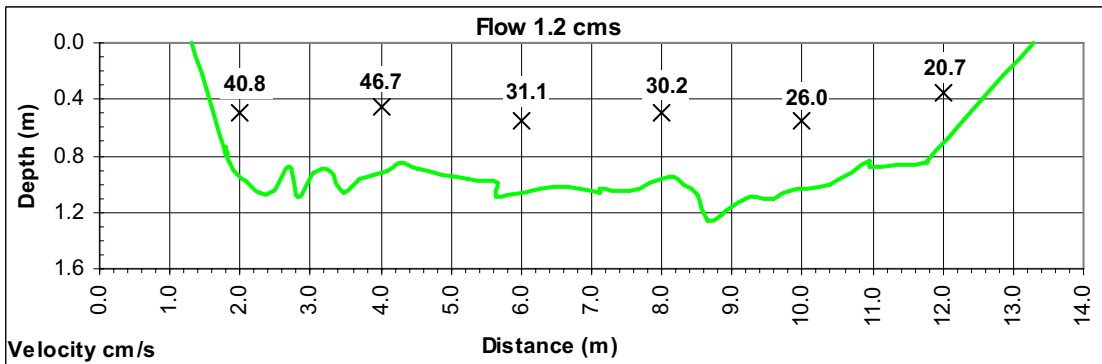
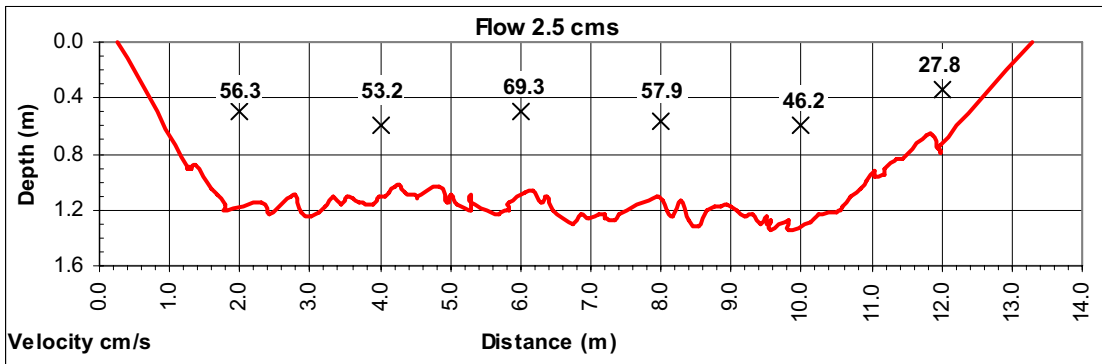
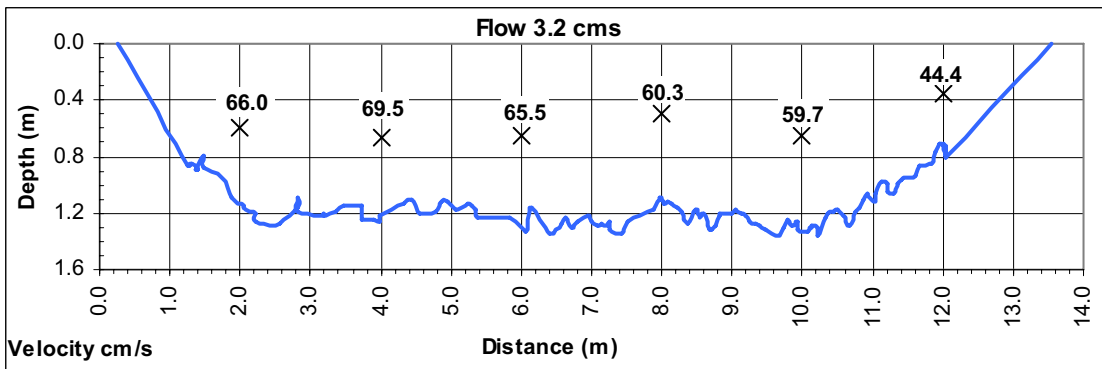
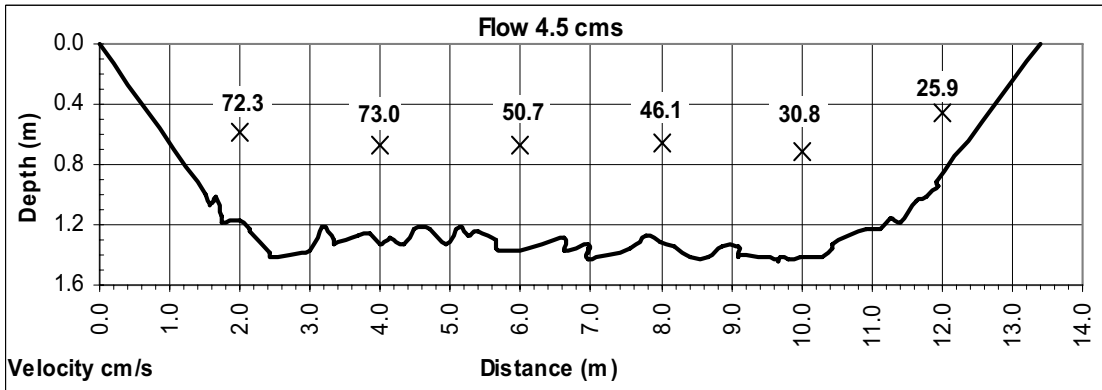
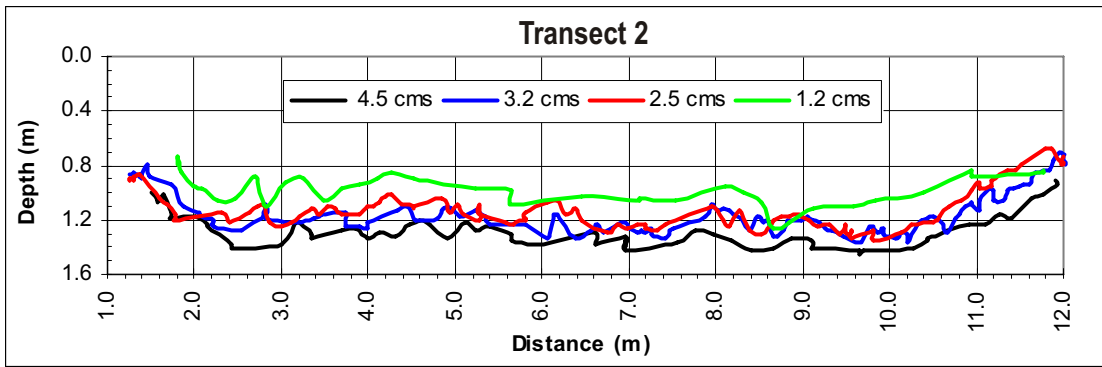
Photograph 12-4. 1.2 m³/s.
Upstream view from near Kenogamissi Lake.

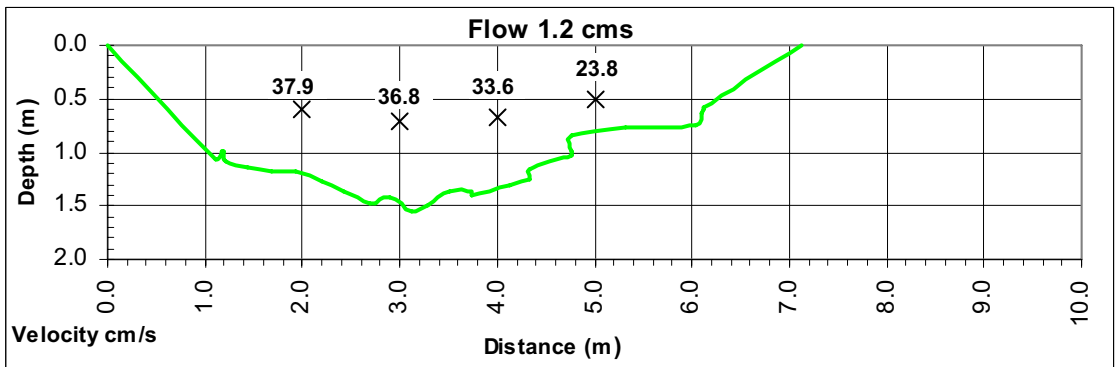
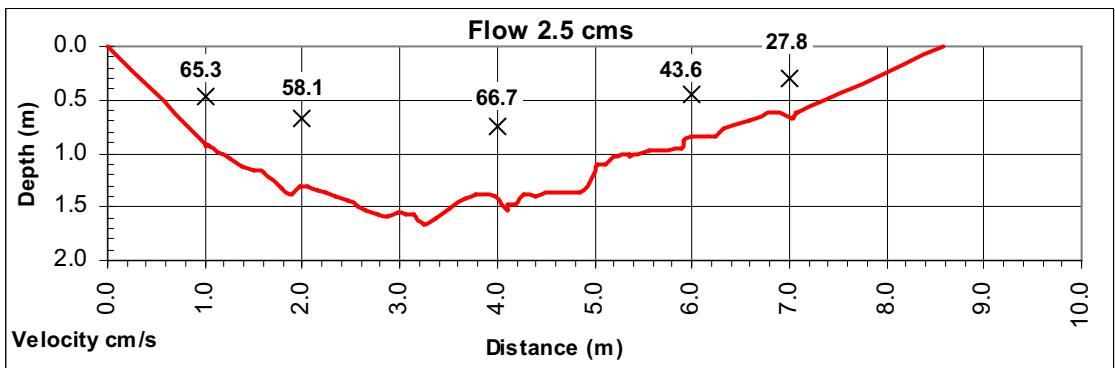
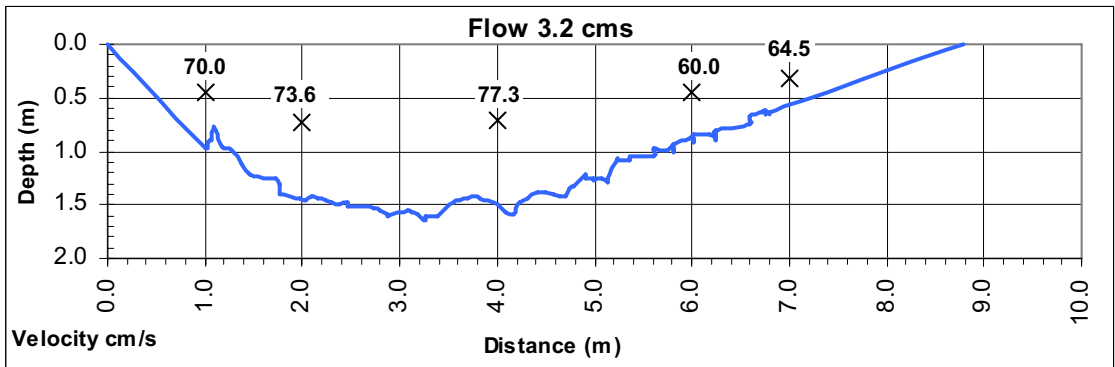
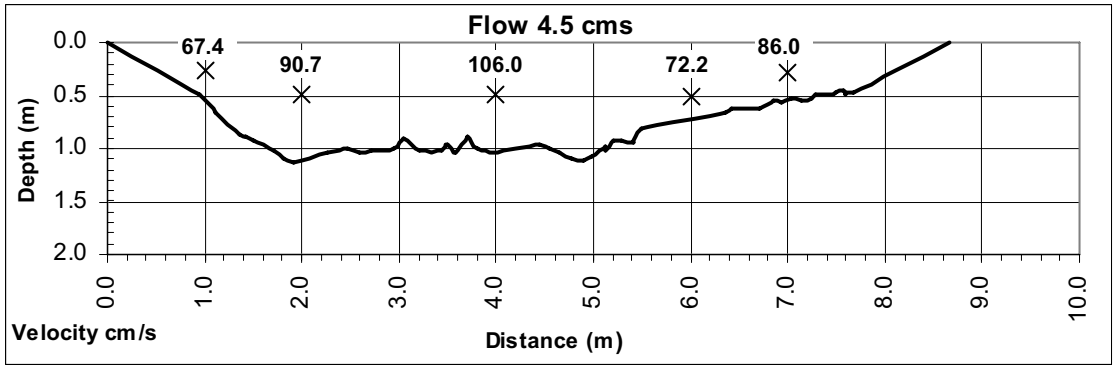
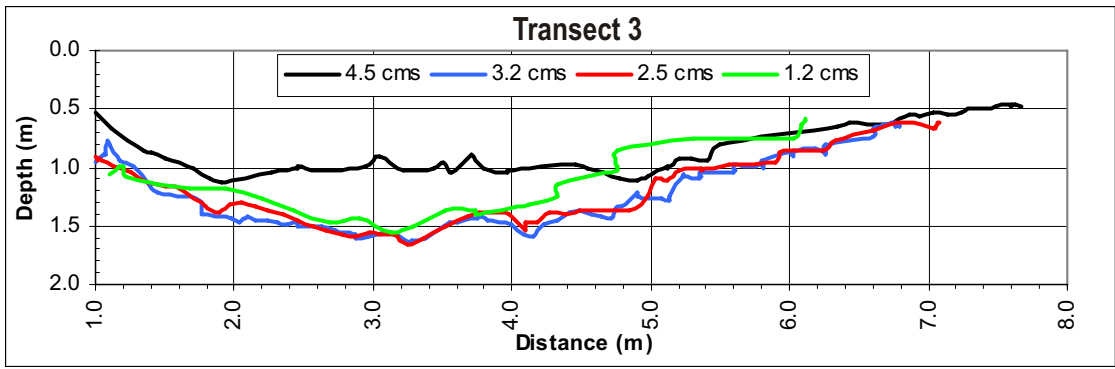


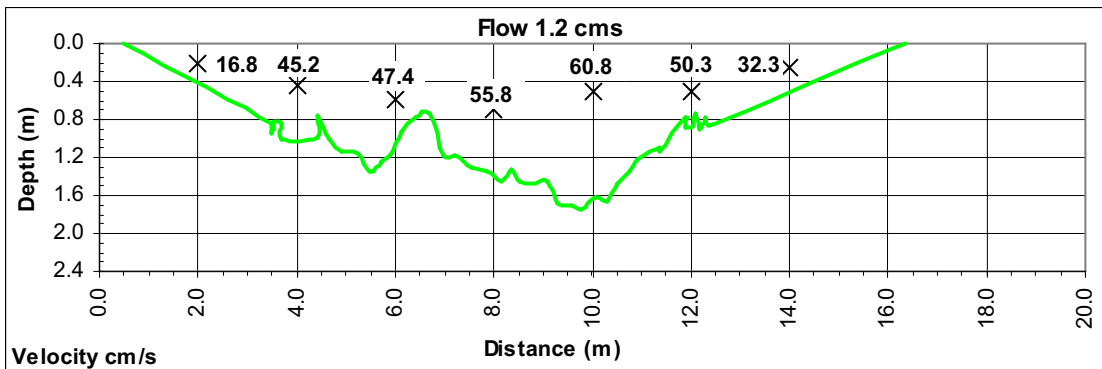
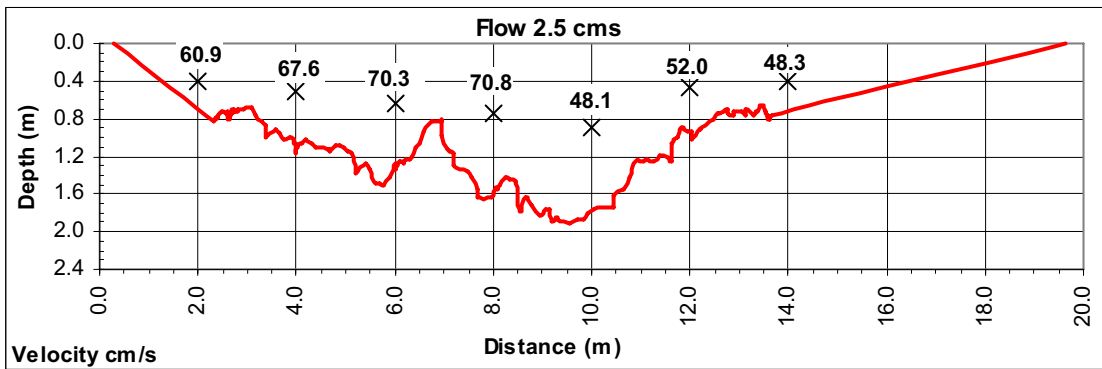
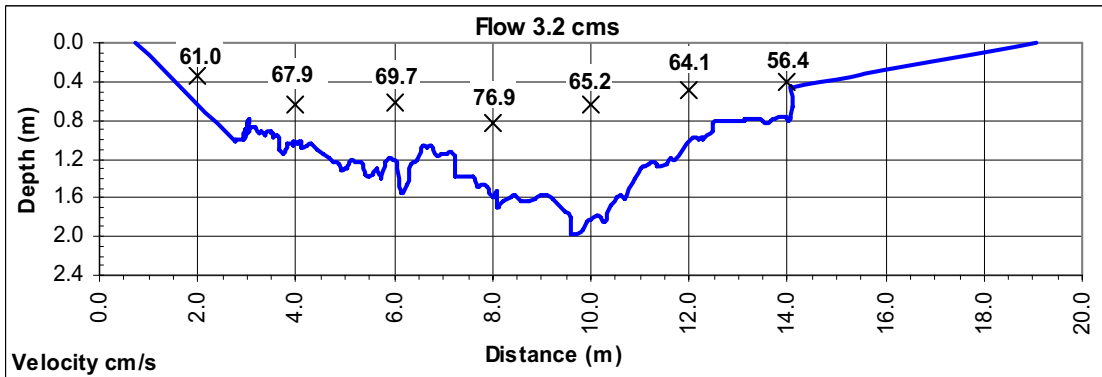
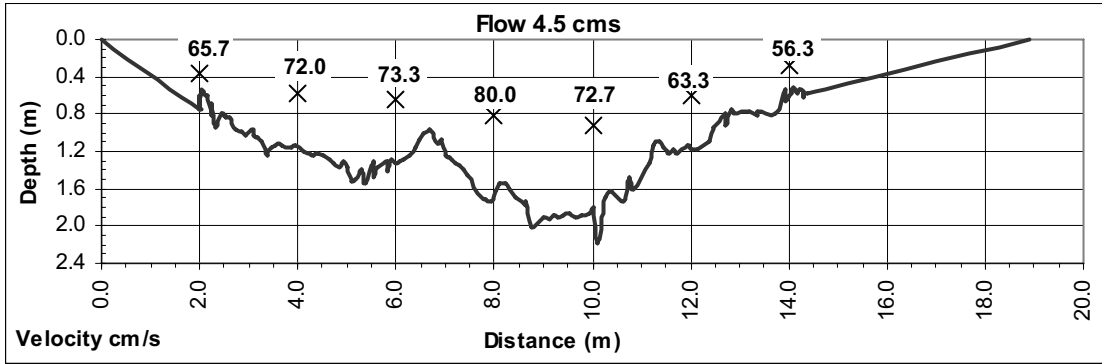
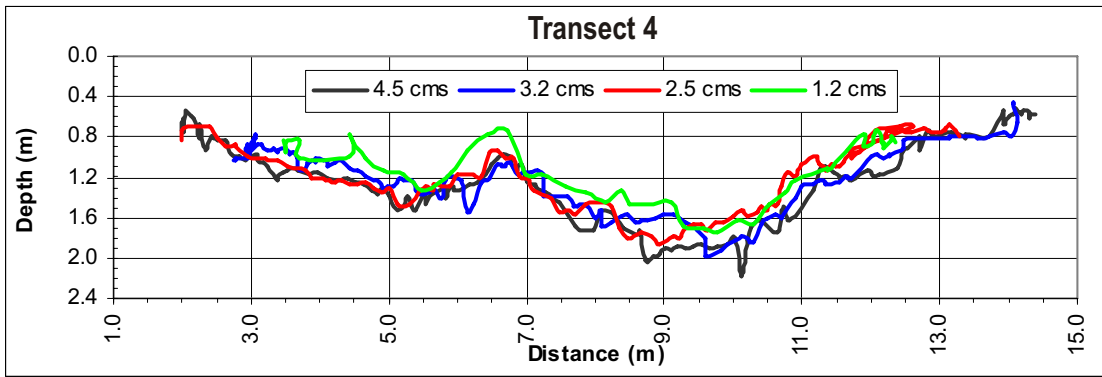
Appendix C

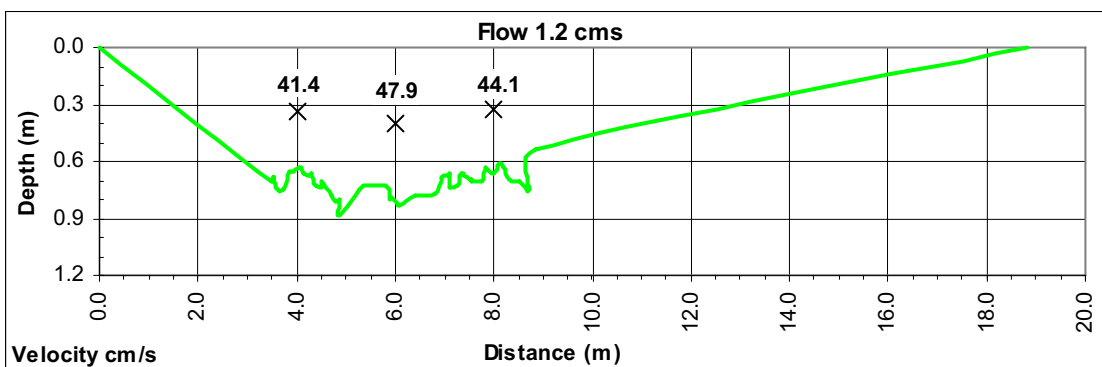
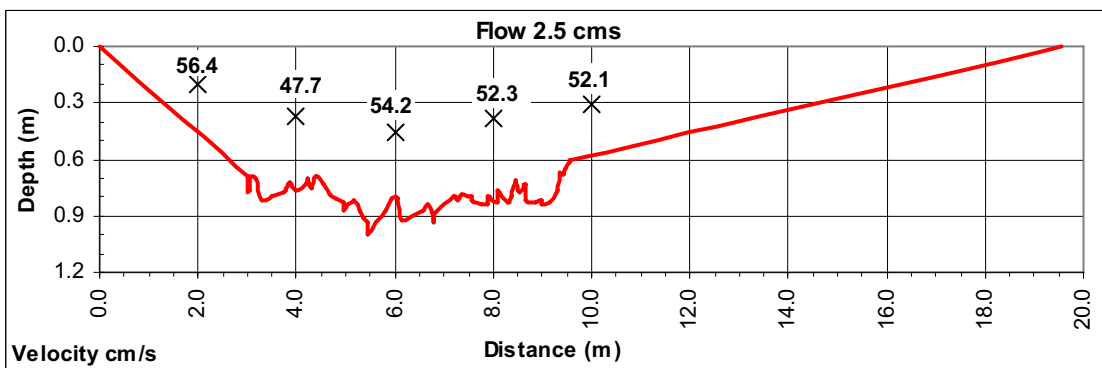
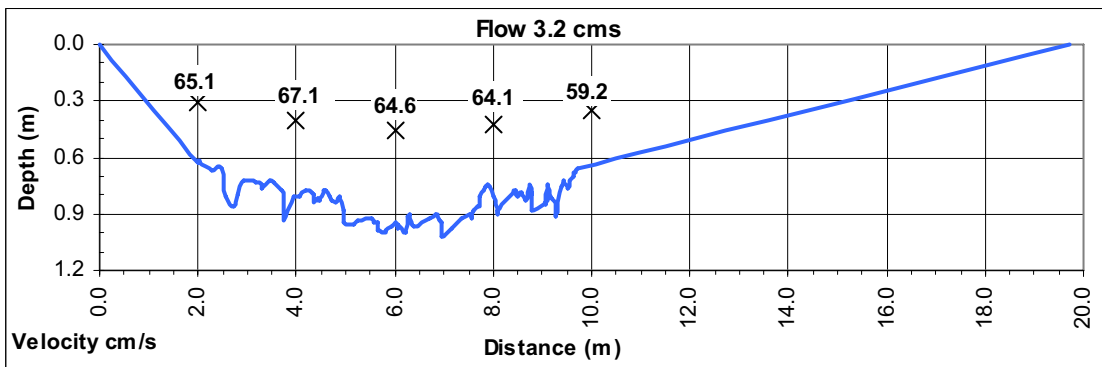
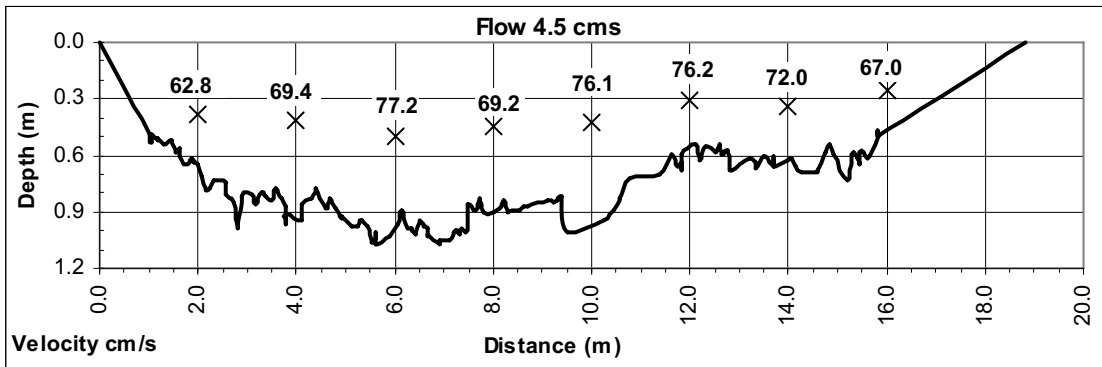
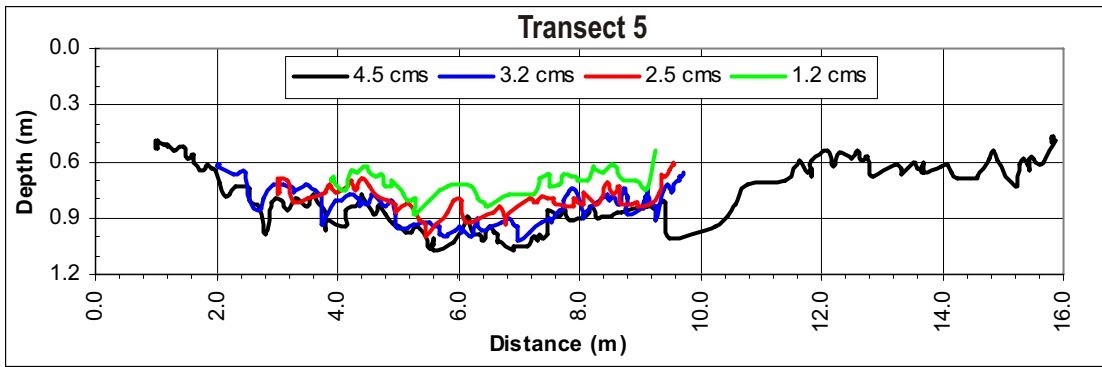
Transect cross-sections

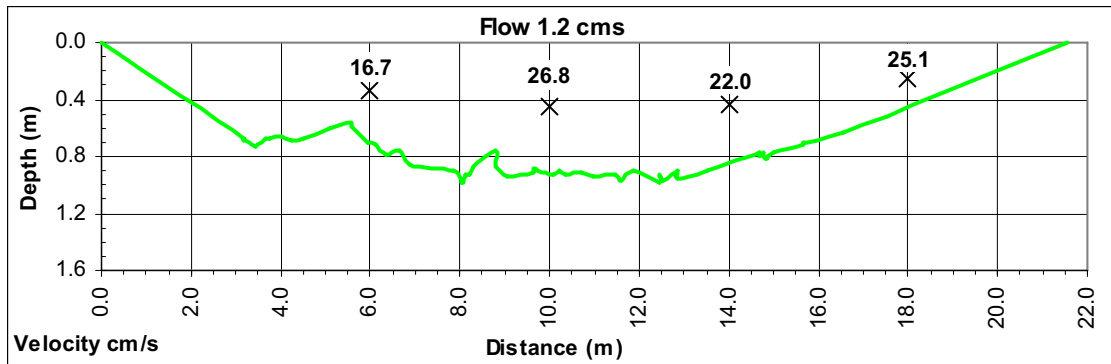
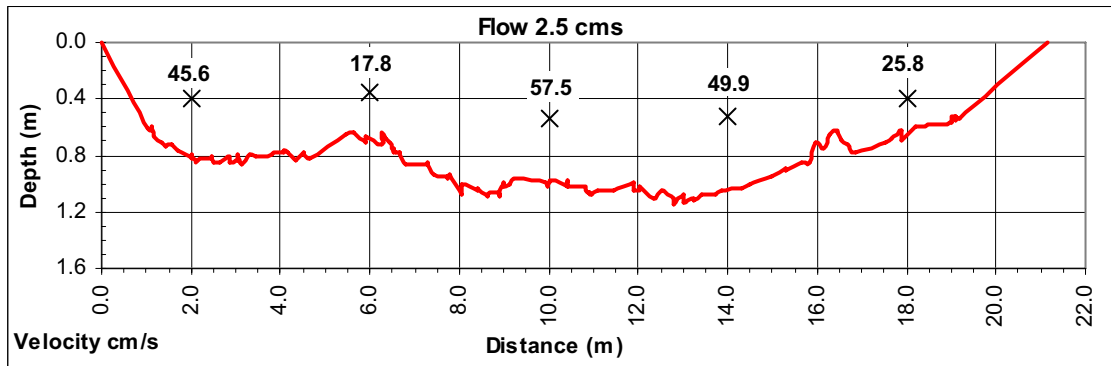
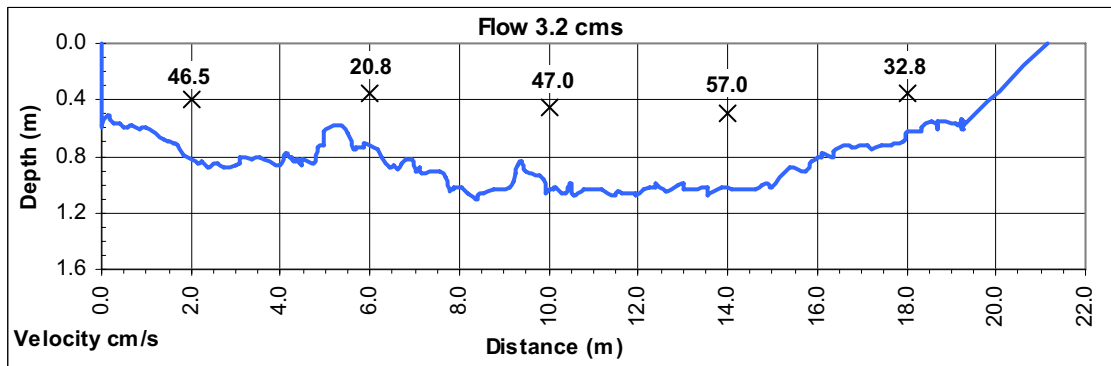
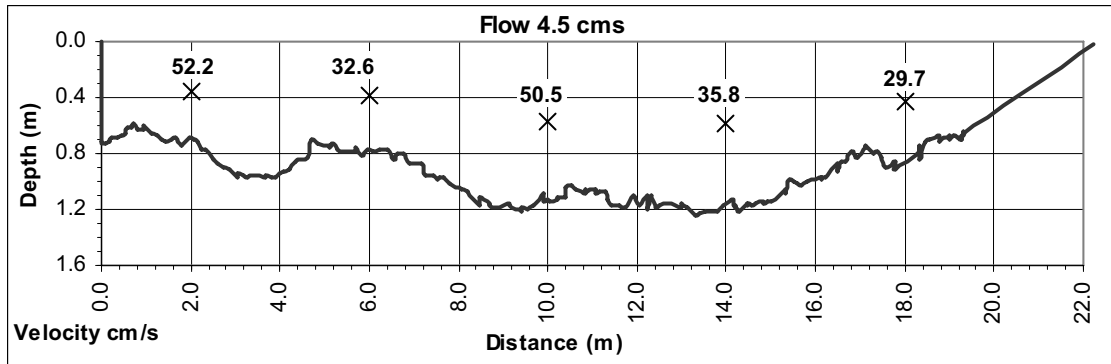
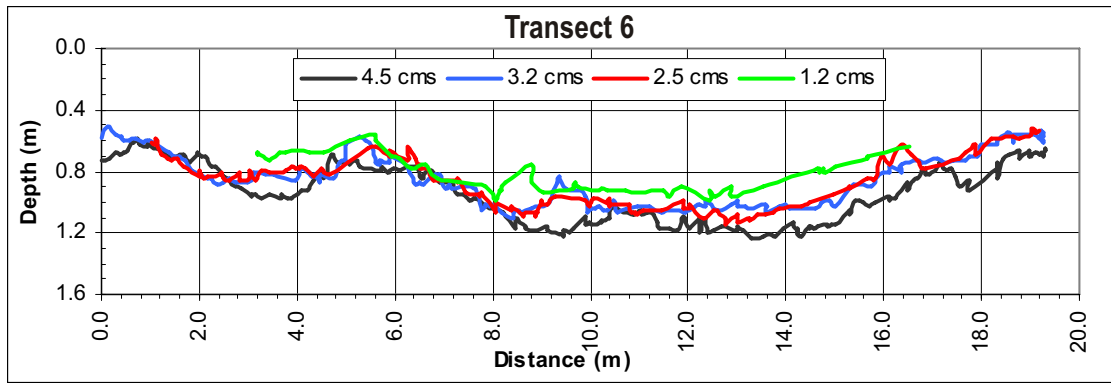


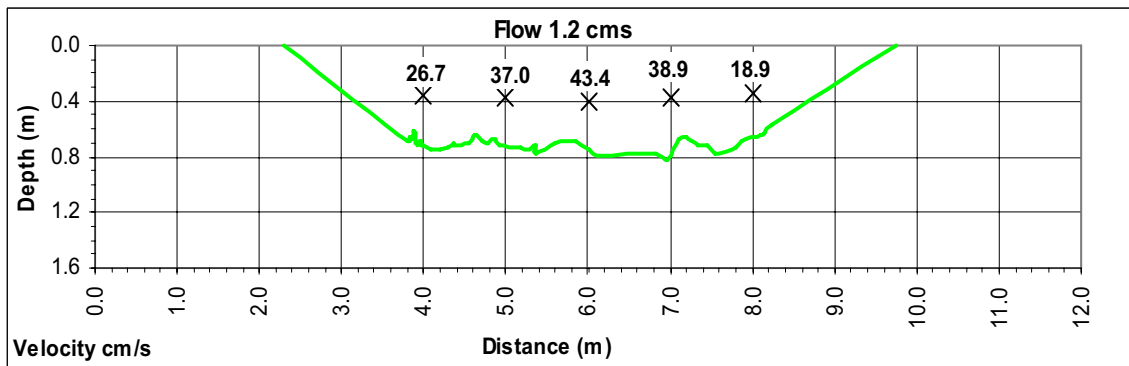
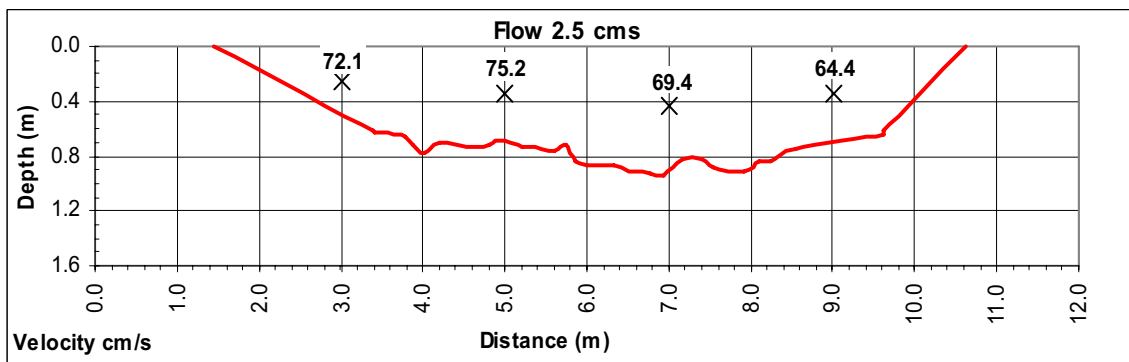
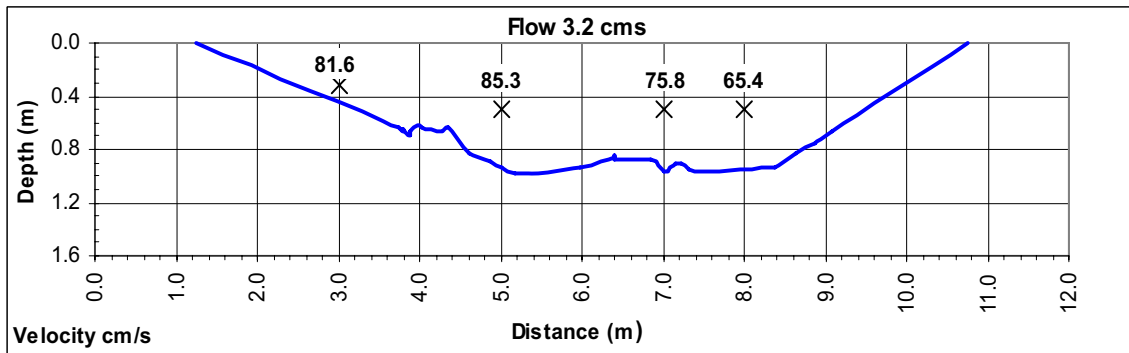
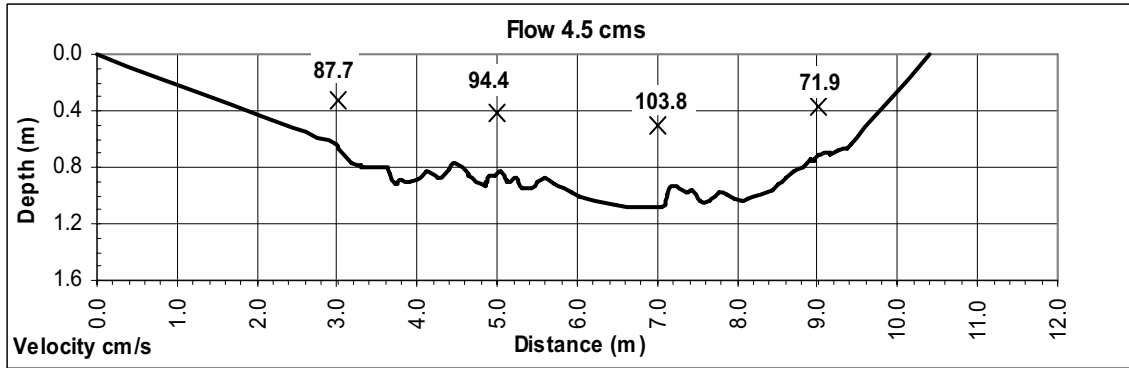
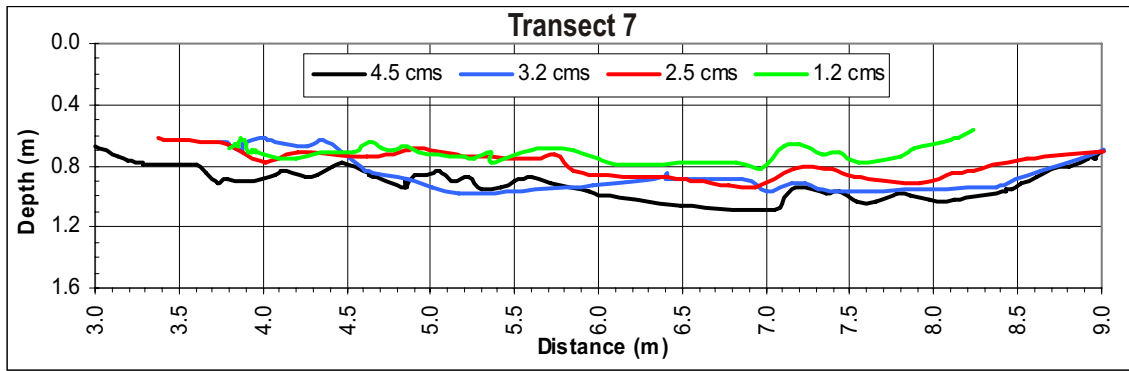


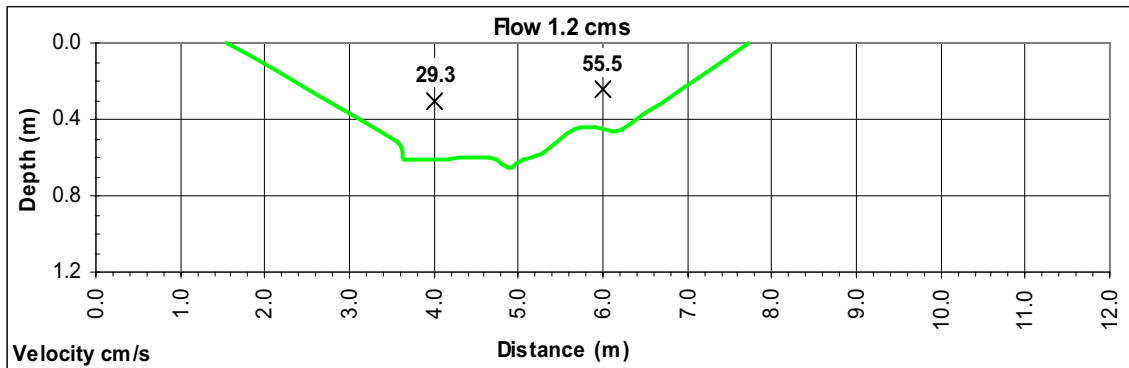
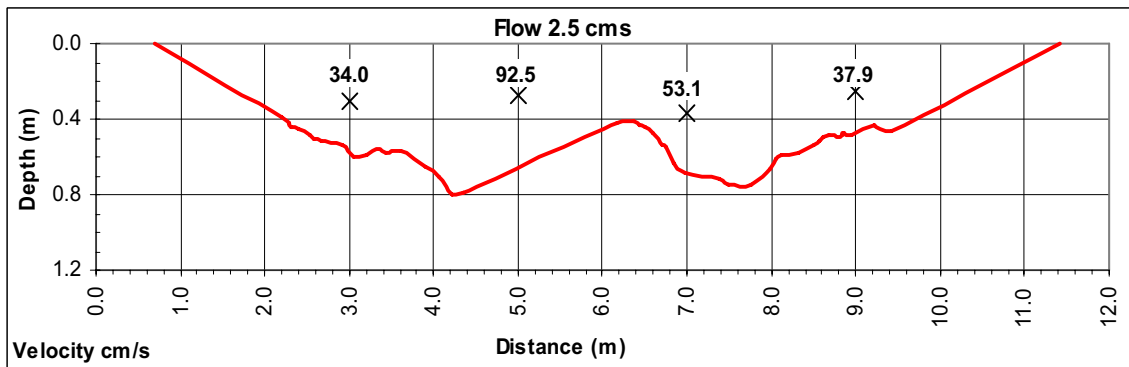
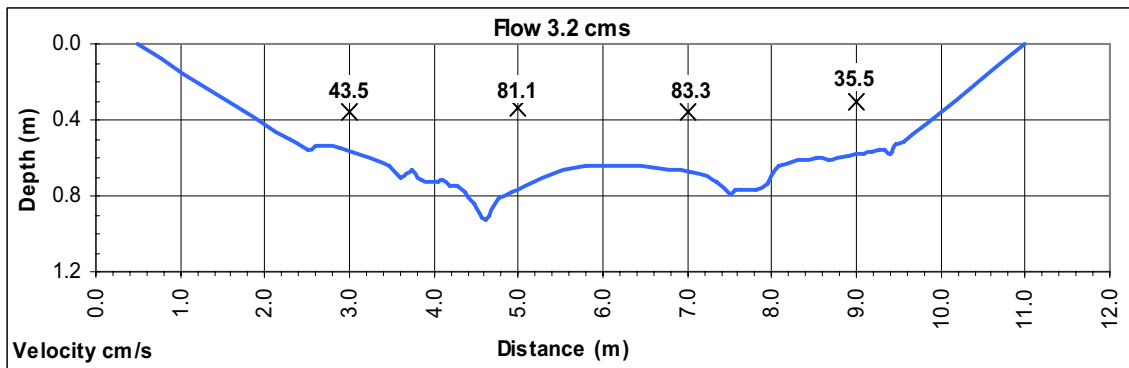
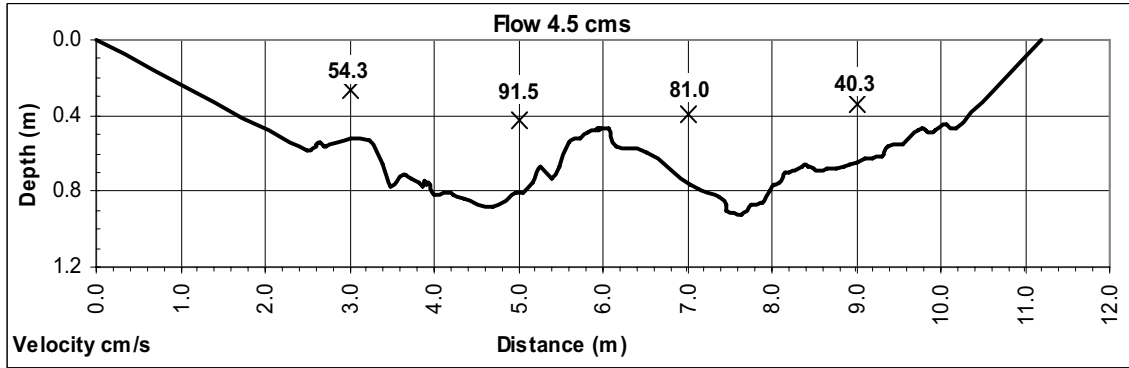
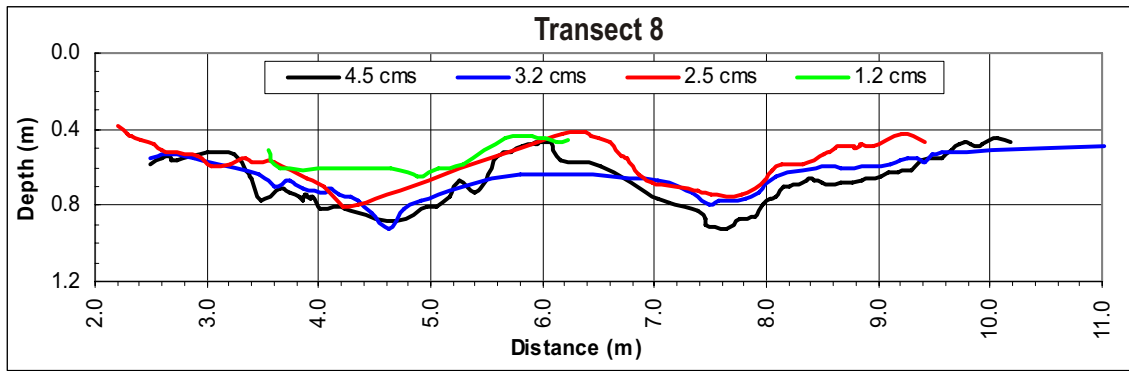


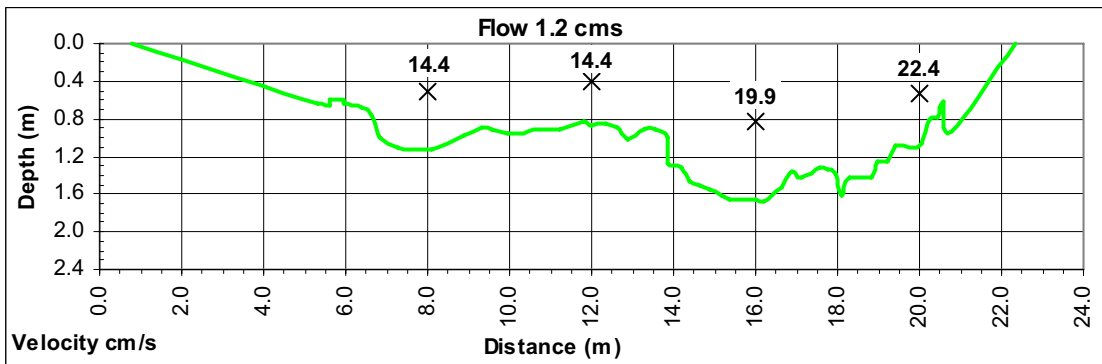
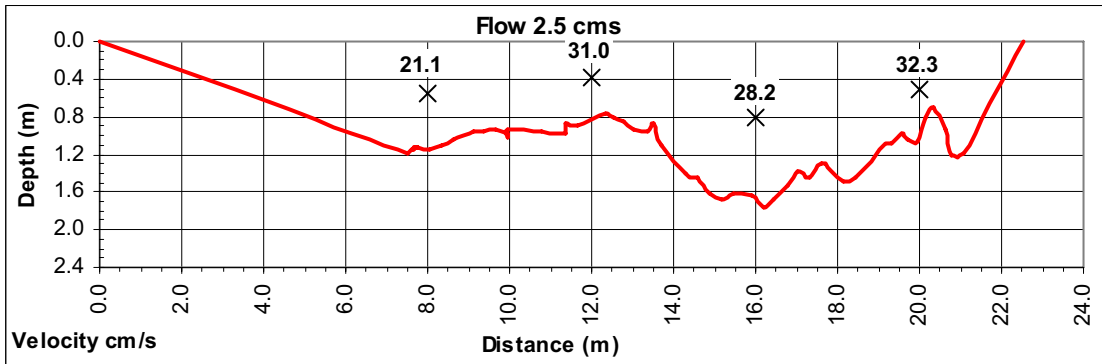
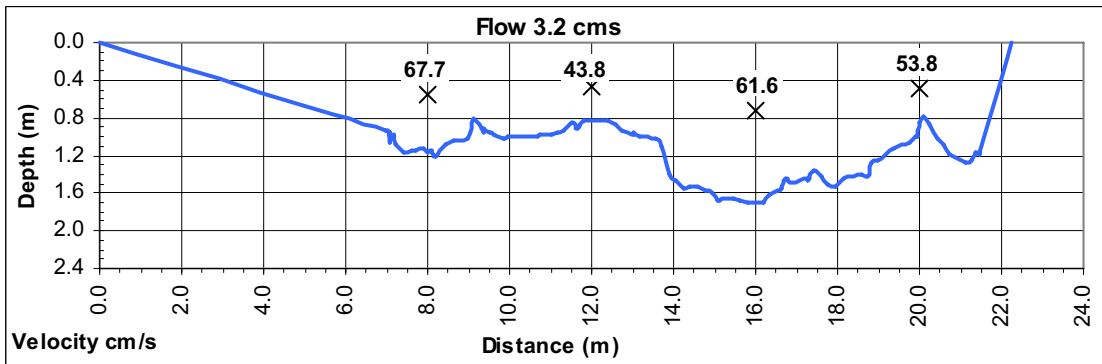
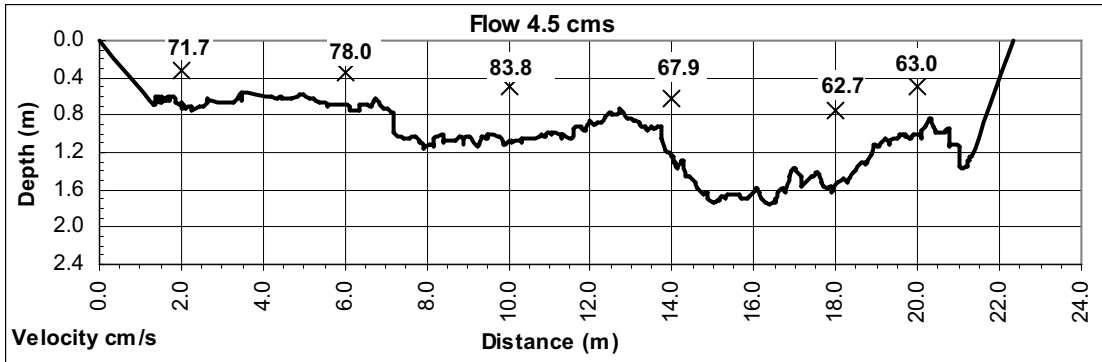
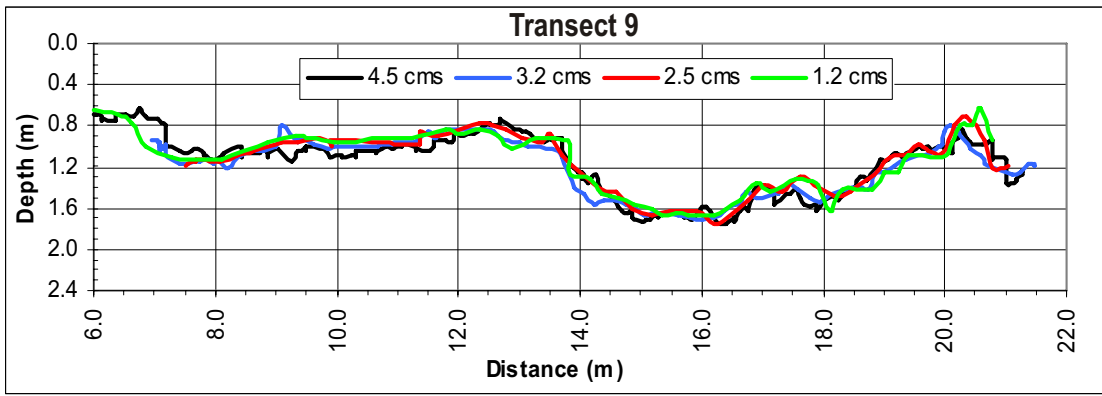








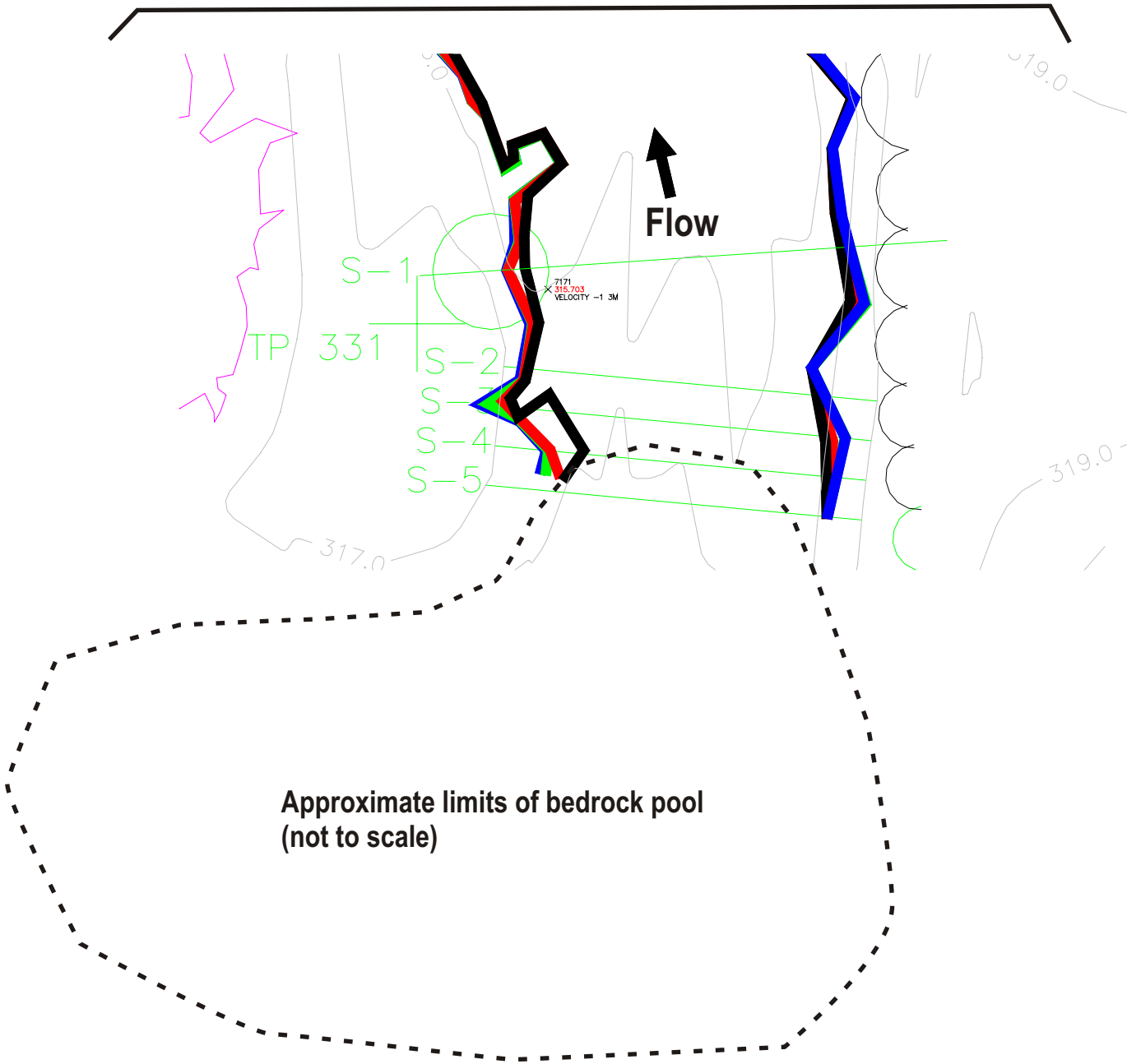




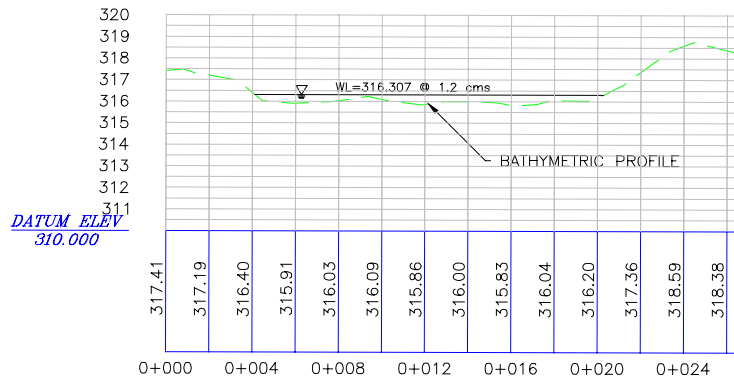
Appendix D

**Transect cross-sections
at outlet of bedrock pool**

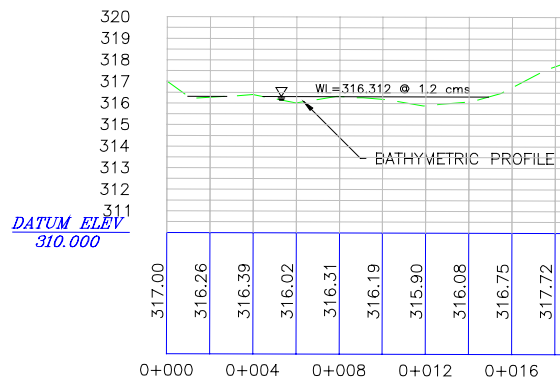
Approximate location of road bridge (not to scale)



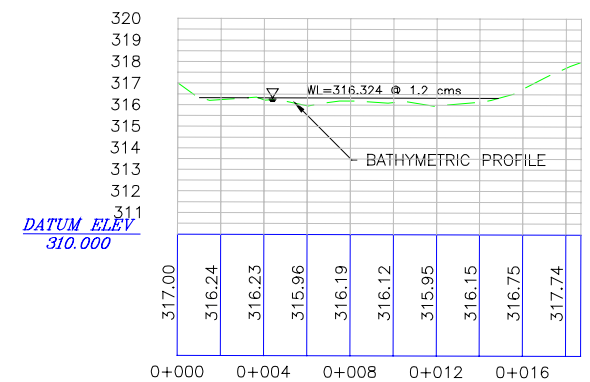
Plan view of the portion of river channel at the downstream side of the bedrock pool that is located upstream of the road bridge, showing the surveyed locations of the cross-sections. The approximate positions of the road bridge and the bedrock pool are shown for reference. Photograph 1-4 in Appendix B shows the approximate locations of these cross-sections, overlain on the photograph.



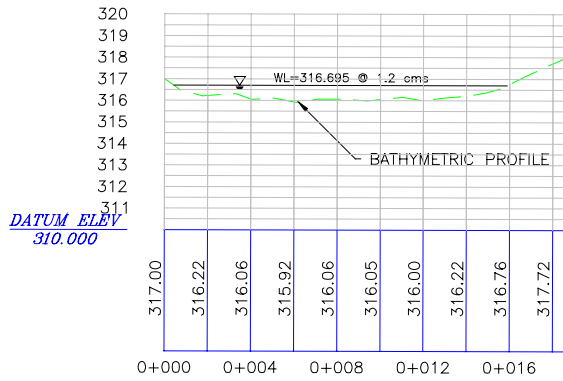
Section S-1



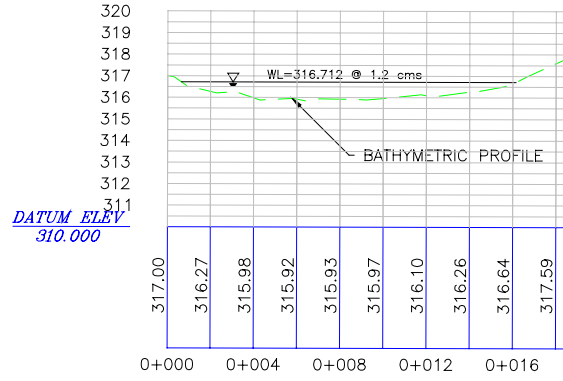
Section S-2



Section S-3



Section S-4



Section S-5

APPENDIX D
PHOTOGRAPHS OF HABITAT AND RIVER FLOW

Photograph 1.

View upstream from the road bridge. December 11, 2006. Approximately $2.4 \text{ m}^3/\text{s}$.



Photograph 2.

View upstream from the road bridge. August 28, 2007. Approximately $7 \text{ m}^3/\text{s}$.



Photograph 3.

View upstream from the road bridge. June 21, 2006. Approximately 13.3 m³/s.



Photograph 4. Directions of photographs 6, 7 and 8 are shown in red.
View downstream from the road bridge. December 11, 2006. Approximately 2.4 m³/s.



Photograph 5.
View downstream from the road bridge. May 2, 2006. Approximately 12 m³/s.



Photograph 6.
View upstream along shallow west side of the pool located downstream of the road
bridge. August 28, 2007. Approximately $7 \text{ m}^3/\text{s}$.



Photograph 7.

View downstream from upper pool. December 11, 2006. Approximately $2.4 \text{ m}^3/\text{s}$.



Photograph 8. Direction of Photograph 7 shown in red.

View downstream from end of upper pool. August 28, 2007. Approximately $7 \text{ m}^3/\text{s}$.



Photograph 9.

View downstream from upper pool. December 11, 2006. Approximately $2.4 \text{ m}^3/\text{s}$.



Photograph 10.

View downstream from upper pool. May 2, 2006. Approximately $12 \text{ m}^3/\text{s}$.



Photograph 11. View upstream between the upper and lower pools.
December 11, 2006. Approximately $2.4 \text{ m}^3/\text{s}$.



Photograph 12. View upstream between the upper and lower pools.
June 21, 2006. Approximately $13.3 \text{ m}^3/\text{s}$.



Photograph 13. View downstream towards the lower pool.
December 11, 2006. Approximately $2.4 \text{ m}^3/\text{s}$.



Photograph 14.
View downstream towards the lower pool. May 2, 2006. Approximately $12 \text{ m}^3/\text{s}$.



Photograph 15.

View upstream of the lower pool. December 11, 2006. Approximately $2.4 \text{ m}^3/\text{s}$.



Photograph 16.

View upstream of the lower pool. June 21, 2006. Approximately $13.3 \text{ m}^3/\text{s}$.



Photograph 17. Direction of Photograph 18 shown in red.
View downstream from the lower pool. December 11, 2006. Approximately 2.4 m³/s.



Photograph 18.
View across river below the lower pool. August 28, 2007. Approximately 7 m³/s.



Photograph 19.

View downstream from the lower pool. May 2, 2006. Approximately 12 m³/s.



APPENDIX E
**PRE- AND POST-CONSTRUCTION FISHERIES MONITORING FOR THE
PROPOSED MATTAGAMI LAKE DAM HYDROELECTRIC DEVELOPMENT**

Pre- and Post-Construction Fisheries Monitoring for the Proposed Mattagami Lake Dam Hydroelectric Development

April 28, 2010.

This document details the proposed monitoring program, along with the background information, for the proposed Mattagami Lake Control Dam Hydroelectric Development. The primary purpose of this monitoring plan is to identify any detrimental effects from the construction and operation of the proposed generating station (GS) upon the spawning habitats utilized by walleye and lake whitefish, as well as general habitat conditions in the river, and to explore further mitigating strategies where warranted.

1) Background: Fisheries Studies conducted in 2006, 2007, 2008, 2009 and 2010

The section of Mattagami River between the road bridge, located downstream of the Mattagami Lake Dam, and Kenogamissi Lake is an important walleye and lake whitefish spawning area for the commercially and recreationally important populations of these two fishes in Kenogamissi Lake. For this reason it is essential that the proposed hydroelectric development at the Mattagami Lake Dam does not have a detrimental effect upon the supporting environmental conditions for spawning at this location.

The proposed hydroelectric development will take water from Mattagami Lake at the dam through a new intake structure, and discharge it through a tailrace immediately downstream of the bridge, within the upstream end of the river section used by walleye and lake whitefish for spawning (Figure 1). The area of spawning habitat affected accounts for approximately 6% of the river used by spawning walleye, and one of the two pools known to be used by lake whitefish for spawning. Mitigation, in the form of tailrace orientation and shape, which have already been incorporated in the plant design, will minimize the potential impacts to the small area affected.

a) Walleye Spawning

Walleye spawning in the Mattagami River downstream of the Mattagami Lake Dam has been observed on behalf of Ontario Power Generation (OPG) in 2006, 2007, 2008, 2009 and 2010. The timing of those observations was determined by contacting the Ministry of Natural Resources (MNR) regarding their spawning observations and water temperature readings at this and other sites in the Timmins area, as well as through water temperature measurements by OPG staff. Walleye typically spawn at water temperatures of 5.6 to 11.1°C (Scott, W. B., and E. J. Crossman. 1973, "Freshwater fishes of Canada", Bull. Fish. Res. Bd. Can. 184, 966p). Once it was established that the spawning run in the vicinity of the study area was underway, the investigation at the Mattagami Lake Dam was scheduled to coincide as closely as possible with the peak of spawning, which was estimated by examining the weather and water temperature trends over the previous few days, and then forecasting the water temperature over the next few days by considering the local weather forecast. It is proposed that this method continue to be used to determine the timing of the annual spawning observations.

On the night of the observations in 2006, 2007, 2008, 2009 and 2010, the Mattagami River between the bedrock pool located upstream of the bridge, and the river mouth at Kenogamissi Lake, was examined after dark but prior to midnight with a 1.0 - 1.5 million candlepower beam, from both banks to as far as possible off shore. The spotlight was used to search for walleye, which are 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. The number of fish observed in a single pass along the shoreline was recorded. If a second or third pass was made, the number of fish observed is recorded separately for each pass. In 2007, 2008, 2009 and 2010 the river was divided into discrete shoreline sections, identified by GPS waypoints, and the number of walleye observed for each single pass in each section was recorded (Figure 1). Note that a different method of tallying walleye was used in 2006, and the portion of river closer to the lake was not examined.

b) Lake Whitefish Spawning

Lake whitefish spawning in the Mattagami River downstream of the Mattagami Lake Dam has been observed on behalf of Ontario Power Generation (OPG) in 2006, 2007, 2008 and 2009. Spawning observations for the fall of 2010 are pending. Whitefish typically begin spawning in the fall when water temperatures drop to 7.8°C. The timing of spawning observations is determined by contacting the MNR and the local fishers, supplemented occasionally by water temperature measurements by OPG staff.

Observations of whitefish in 2006 were attempted by using a one million candlepower beam at night, but only one unidentified fish of the appropriate size was observed. 2006 was apparently not a very good year to observe lake whitefish, as there appeared to be very few fish in the river based upon the poor fishing success of local fishers. However, during a scheduled shutdown of the Mattagami Lake Dam in December 2006, a successful survey for whitefish eggs provided some indication of habitat use by spawning whitefish in this area.

In 2007 the whitefish below the Mattagami Lake Dam were still on the spawning grounds on November 9-10 when the water temperature was 4.7°C, though they were likely near the end of the spawning run at that time as indicated by the fact that the fish examined appeared to have few eggs remaining. The local fishers reported that fishing was the best that it had been in several years, with most people catching their allowable limit (25 fish per day), or close to it. While unsuccessful attempts were again made with a strong flashlight to observe fish at night, an Aquaview™ video system was successfully employed to locate whitefish in the river during daylight hours. The Aquaview™ system is comprised of a compact underwater video camera and a small transportable video monitor, connected via a 150 foot (45.7 m) transmission cable. The camera was suspended from a buoy (large plastic juice or bleach bottle) with the transmission cable, with the distance between the camera and the buoy adjusted to suit the water depth in the river section being examined. The camera and buoy were tossed into the river and allowed to be carried downstream while observations were conducted for whitefish in the video monitor. Then the camera and buoy were reeled-in while observations continued. Approximately six of these deployment runs were conducted at each location, with a sufficient number of contiguous locations examined to cover the entire river length from the bridge downstream to the riffles located immediately downstream of the second pool, as well as the

river mouth at Kenogamissi Lake (Figure 1). Using this method it was determined that the only portions of the river that had high concentrations of lake whitefish were the two pools in which it is thought that spawning takes place.

In 2008 the timing of spawning observations was determined by ongoing contacts with two groups of local fishers, one of which was the same group contacted in 2006 and 2007, and the other was a new contact in 2008 who also assists his father who holds the commercial netting licence on Kenogamissi Lake. Initial attempts by these fishers to capture whitefish failed, which was interpreted by them to be due to the above normal water temperatures during the usual spawning period. When the weather finally became cold, it did so very quickly, and one of the local fishers reported catching only three fish. As in 2007, an Aquaview™ video system was employed to search for whitefish in the river during daylight hours, however, no fish of any species were observed.

In 2009 the timing of spawning observations was determined by contacting the local fisher who assists his father who holds the commercial netting licence on Kenogamissi Lake, and by water temperatures provided by OPG staff. Apparently few fish were captured this year by dipnetters in the river downstream of the Mattagami Lake Dam. As in 2007 and 2008, an Aquaview™ video system was employed to search for whitefish in the river during daylight hours. Whitefish were not observed in the pool that is located immediately downstream of the road bridge, but some were observed in the deeper pool located farther downstream. The water temperature was 5.5°C.

2) Background: Minimum flows

Minimum flows have been agreed to by MNR and OPG to maintain a bedrock pool between the Mattagami Lake Dam and the downstream road bridge, as well as to maintain the habitat in the 550 m stretch of river from the road bridge to Kenogamissi Lake.

To maintain the habitat qualities of the bedrock pool, OPG is committed to providing a minimum flow of 0.2 m³/s to the pool year-round, and monitoring this flow for compliance during the open water season. Monitoring flows as small as 0.2 m³/s during the winter months outside of the open water season will be difficult due to ice cover in the pool and the build-up of ice within the surrounding bedrock chute. To maintain habitat downstream of the proposed GS, MNR and OPG have agreed that OPG will provide a minimum flow of 2.8 m³/s for the duration of the year outside of the walleye spawning, incubation, hatch and dispersal period, and monitor this flow for compliance.

3) Proposal for Fisheries Monitoring Plan

a) Monitoring Plan for Walleye Spawning

We propose that the method of observation used during the pre-construction monitoring in 2006, 2007, 2008, 2009 and 2010, be repeated in years 1, 2, 3, 5, and 7 after the proposed hydroelectric facility's in-service date, subject to approval of the execution of the Project by OPG's Board. It is expected that this will provide a sufficiently long set of post-construction observations to

ascertain if the walleye spawning run has been negatively impacted by the operation of the new power plant. In the event that an environmentally atypical event (e.g. poor weather, unusually high flows, etc.) has rendered any of the facility's in-service monitoring years ineffective, an additional year of in-service monitoring may be suggested. If a problem affecting walleye spawning is identified and additional mitigating actions are required, the number or frequency of in-service monitoring episodes will be adjusted accordingly, in consultation with OPG, Department of Fisheries and Oceans (DFO), and MNR.

We propose that the same method of tallying walleye used in 2007, 2008, 2009 and 2010 be followed in future observations, with additional discrete sections delineated with GPS if walleye are observed in areas where they were absent in previous years. The time of the observations and the water temperature will also be recorded.

b) Monitoring Plan for Whitefish Spawning

We propose that the method used for observations in 2007, 2008 and 2009 be continued each year until the start of construction and, like walleye, be repeated in years 1, 2, 3, 5, and 7 after the proposed hydroelectric facility's in-service date, subject to approval of the execution of the Project by OPG's Board. Similar to the walleye spawning investigation, in the event that an environmentally atypical event (e.g. poor weather, unusually high flows, etc.) has rendered any of the facility's in-service monitoring years ineffective, an additional year of in-service monitoring may be suggested. If a problem affecting lake whitefish spawning is identified and additional mitigating actions are required, the number or frequency of in-service monitoring episodes will be adjusted accordingly, in consultation with OPG, Department of Fisheries and Oceans (DFO), and MNR.

c) Monitoring Plan for Fish Habitat

Coincident with the monitoring of walleye and whitefish spawning, the following components of the monitoring plan for fish habitat will be repeated in years 1, 2, 3, 5, and 7 after the proposed hydroelectric facility's in-service date, subject to approval of the execution of the Project by OPG's Board.

- **Photographic record**

During the minimum flow assessment field work undertaken in September, 2008, a panoramic series of photographs were taken at each of twenty-five locations, recording a view of the entire river from the Mattagami Lake Dam downstream to Kenogamissi Lake. This photographic series was repeated in 2009, and will be repeated at least once per monitoring year during the summer low-flow assessment period in August to early September. These same locations will be employed during all other seasonal investigations when supplemental photographs of habitat conditions are deemed appropriate. Photographs taken over time from the same vantage points are valuable for assessing changes in fish habitat, stream morphology and erosion.

- **Habitat quality**

Field monitoring of habitat quality within the bedrock pool will include a photographic record of the pool conditions from one of the established vantage points discussed above, plus water temperature readings, observations of algae growth, and other possible indicators of water quality. Fish passage upstream to the bedrock pool, upstream of the road bridge, will also be evaluated. This information will be collected during the low-flow habitat evaluation that will likely occur in August or early September.

Field monitoring of habitat quality within the tailrace and downstream to Kenogamissi Lake will include a photographic record of river conditions, taken from the established set of vantage points discussed above, that will readily show the extent of habitat, water depth, and general habitat conditions under low-flow conditions. While the summer low-flow evaluation during the in-service portion of the monitoring plan will target periods of minimum flow (2.8 m³/s) when the GS is shutdown, low river flows that result in the shutdown of the GS may not occur every year. If it is deemed that an insufficient number of observations at river flows of 2.8 m³/s have occurred during the post construction monitoring period, additional monitoring specifically targeting occasions with 2.8 m³/s of flow will be undertaken. The entire river section between the proposed GS and Kenogamissi Lake will be examined for barriers to fish movement and other potential changes that may be related to the operation of the GS.

- **Channel morphology and erosion**

The entire river section between the proposed GS and Kenogamissi Lake will be examined for altered channel morphology and other potential changes that may be related to the operation of the GS. Monitoring changes in channel morphology or rates of erosion will rely mostly upon comparisons made through time using the annual photographic series discussed above. However, in the vicinity of the tailrace where some changes in flow pattern are anticipated when the GS is in-service, a number of steel stakes will be driven into the ground at strategic locations along the river, from which measurements to detect bank erosion will be made. Furthermore, as soon as possible after the proposed tailrace has been constructed and contoured into the riverbed, an as-built bathymetric and substrate survey of the tailrace area and the river channel downstream to immediately below the first bend in the river, will be undertaken to provide a baseline for any future investigations into walleye and whitefish spawning habitat degradation that may be necessary.

d) Reporting

A report presenting the cumulative results of the spawning investigations, from 2006 up to the most recent completed set of results, should be submitted to MNR and DFO by February 28th of the year following a monitoring year. The report should detail the observed environmental conditions in the section of river between the Mattagami Lake Dam and Kenogamissi Lake, present the results of the most recent annual investigation, and compare those results with those of previous investigations. Data on river flow during the walleye spawning and incubation period, and during the lake whitefish spawning period, must be obtained from OPG and included in the report. Summer daily flow data, for the river section downstream of the proposed GS, will

be provided by OPG and summarized in the report. Estimates of inflow to Mattagami Lake, if available, should also be included. A short discussion relating the annual results to the observed environmental conditions, as well as any potential effects due to the construction and operation of the proposed plant, should be included. The report will also include maps that illustrate the location of observations, photographs, measurements, spawning activity, and other pertinent details. Photographs will be included to show general site conditions, or where they can enhance a description. If warranted, recommendations for the mitigation of observed detrimental effects will be included.

Summary table of monitoring events, assuming a December 2014 in-service date.

Timeframe	Walleye spawning	Lake whitefish spawning	Low- flow habitat evaluation	Annual Report
Year 1 pre-construction	May 2010	November 2010	August/early September 2010	February 2011
Year 2 pre-construction	May 2011	Nov 2011	August/early September 2011	Feb 2011
Year 2012 -2014	Construction period No fisheries work	Construction period No fisheries work	Construction period No fisheries work	Construction period No fisheries work
Year 1 in-service period	May 2015	November 2015	August/early September 2015	February 2016
Year 2 in-service period	May 2016	November 2016	August/early September 2016	February 2017
Year 3 in-service period	May 2017	November 2017	August/early September 2017	February 2018
Year 5 in-service period	May 2019	November 2019	August/early September 2019	February 2020
Year 7 in-service period	May 2021	November 2021	August/early September 2021	February 2022

e) Feedback

Between the submission of each monitoring report and the start of the following field season, opportunity exists to discuss and implement any potential changes or adjustments to the upcoming field program, based upon the results reported.

4) Proposal for an Adaptive Management Plan

The adaptive management concept is an important part of the philosophical approach to environmental assessment and monitoring. Consequently, the monitoring plan, and the mitigating measures that may be required, will adapt to site and environmental conditions as they unfold.

The design of the proposed GS and associated works has been adjusted, to the extent possible, to minimize or eliminate potential negative environmental impacts. However, at this point in the monitoring process (pre-construction or baseline monitoring) two potential outcomes have been identified that require an adaptive management strategy. The first potential outcome identified is that a reduction in the area of walleye spawning activity may be observed within the immediate

vicinity of the proposed tailrace. If this occurs, a plan will first be formulated to rectify this situation through habitat enhancement within the area affected. If that is not possible, there are several locations within the downstream river that presently do not provide spawning habitat for walleye, and can potentially be modified to provide compensatory walleye spawning habitat. The second potential outcome identified is that the altered flow pattern in the vicinity of the tailrace may result in the erosion of the shoreline opposite the tailrace. If this occurs, a number of mitigating strategies can be considered, commensurate with the severity of the problem. These can include, but are not limited to: do nothing, shoreline stabilization, and re-contouring of river channel in the vicinity of the tailrace using natural channel design principles. In-water work must comply to the fisheries restrictions at this site. Though it is believed to be unlikely, if other unanticipated impacts to fisheries resources occur, that are clearly the result of the operation of the proposed GS and associated works, mitigation may also be deemed appropriate.

5) Supplemental Benthic Invertebrate data

A pre-construction series of benthic invertebrate samples were collected during the summer low-flow period in 2009 at twelve locations along the Mattagami River, downstream of the proposed GS, and archived for potential future use. At each of the twelve locations, five rocks with a median diameter of approximately 12-15 cm were selected along a gradient perpendicular from shore to as far offshore as could safely be collected while wearing waders, over a depth range of approximately 0.3 to 0.8 m. Each rock was cleaned of all invertebrates using a cotton glove, and the dislodged material was collected in a dipnet with 500 μm mesh and then preserved in 10 percent buffered formalin. We plan to collect a second pre-construction set of samples for archiving in 2010, to bolster the pre-construction dataset. These invertebrate samples are not intended for a detailed study of benthic invertebrate productivity changes as a result of the proposed hydroelectric development, nor will they be collected for that purpose. Should any speculative questions arise later, these samples will serve to provide general benthic information.

Due to site characteristics and the anticipated degree and extent of environmental change as a result of the proposed development, a detailed study of benthic invertebrate production changes would be inconclusive. As the September 2008 minimum flow study showed, the difference between the wetted area at 4.5 cms and 3.2 cms was about a 4% reduction in area, and the difference between 4.5 m^3/s and 2.5 m^3/s was about a 7.9% reduction. Therefore, a flow of 2.8 m^3/s would be about a 6% reduction of area from 4.5 m^3/s . Even when the flow is 12-15 m^3/s , because of the channel shape, the apparent difference between the wetted area at 12-15 m^3/s and that at 4.5 m^3/s is small. In a worst-case scenario, we can assume that all the benthic invertebrates will die within the area that will be dewatered when the flow is reduced to 2.8 m^3/s , and that benthic production will be reduced by this same proportion. However, based upon (1) the minimum flow may not happen some years; (2) if minimum flow does occur it will certainly only occur for some period (short or long or intermittent) during the summer months; (3) the benthic invertebrates of these habitats are adapted to fluctuating flows and therefore some within the dewatered area will escape by either moving vertically down into the substrate or laterally to the wetted portion of stream; and, (4) benthic invertebrate life cycles are such that only some of the community members would be affected, it is speculated that the annual loss of benthic production may range from 0% (for a wetter year) to some proportion that is certainly less than the proportion of area that will be dewatered. Given the small proportion of habitat that

may be affected, the variability of stream communities where flow is also variable, and the additional community variability that occurs as a result of seasonal and weather related influences, it is not believed that even an intensive benthic community study would be able to provide a better estimate of production loss, than what could be done through simple calculation with some basic assumptions. This same argument extends to a small fish component of the monitoring plan, except that some estimate of production loss would be even more difficult to determine, if it occurs at all, because fish can more easily move from the affected area than benthic invertebrates can, and the numbers of small fish appear very low in this section of river (low numbers result in greater uncertainty when estimating populations and biomass).

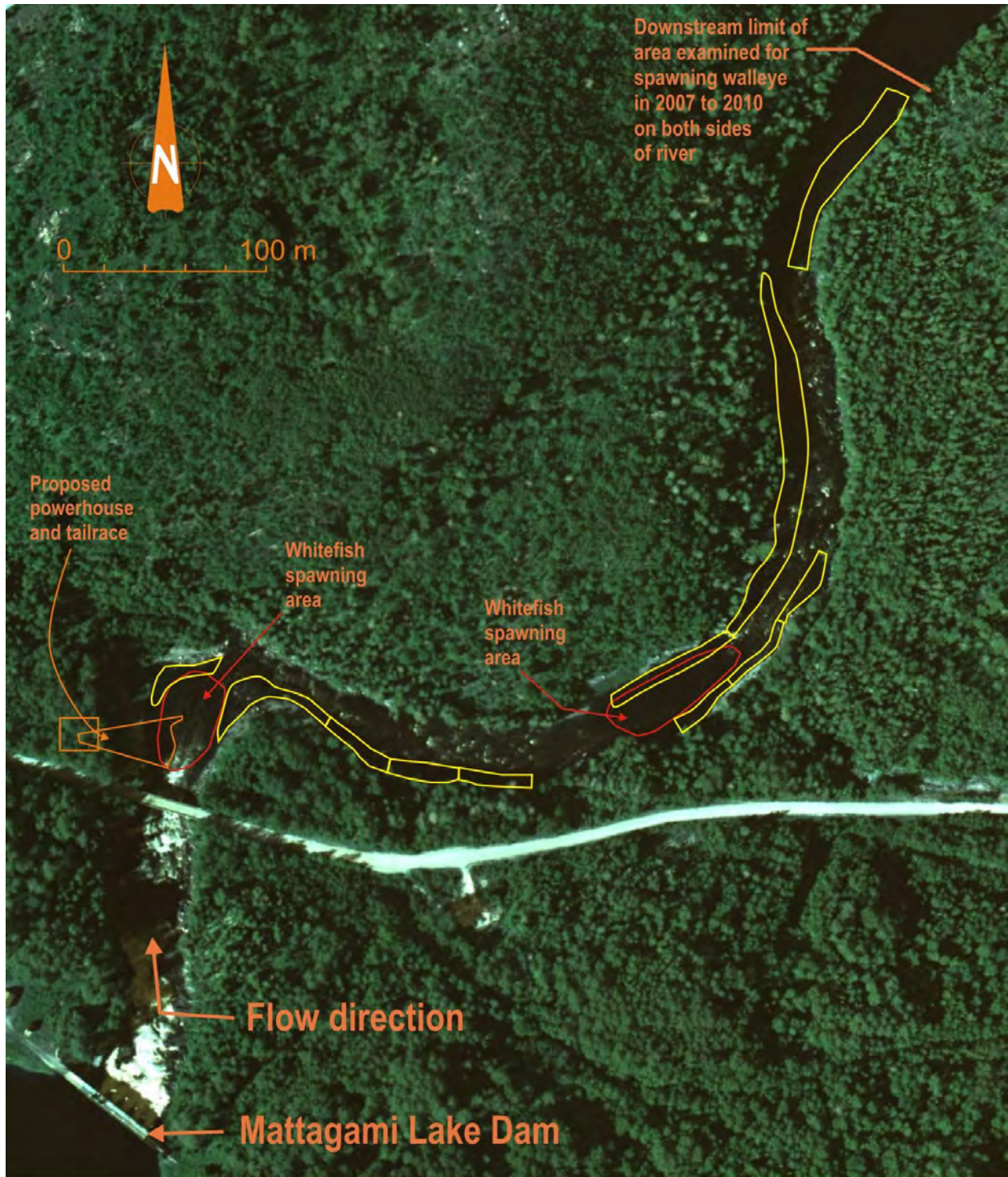


Figure 1: Areas delineated by yellow are sections of habitat in which spawning walleye have been observed in 2007 to 2010. The two pools in which lake whitefish on their spawning run are known to congregate and spawn are delineated in red.