NIAGARA POWER PROJECT

RELICENSING

DETERMINE IF PROJECT OPERATION RESULTS IN SUPERSATURATION OF ATMOSPHERIC GASES IN LOWER NIAGARA RIVER

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Prepared by:

Parametrix, Inc.

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EXECUTIVE SUMMARY

The New York Power Authority (NYPA) is engaged in the process of gathering natural resource data, including water quality information in the lower Niagara River, and the potential influence that the Niagara Power Project (Project) operations (which includes both the Robert Moses Niagara Power Plant [RMNPP] and the Lewiston Pump Generating Plant [LPGP]) have on water quality as part of Project relicensing. This report presents the results and discussion of a field study of total dissolved gas (TDG) saturation levels occurring in the lower river, as they relate to naturally occurring background levels and Project operations.

TDG supersaturation occurs when entrained atmospheric gases (air) pass into solution in greater amounts than the water would normally hold at surface pressure. At hydroelectric projects, this increased transfer of air into solution can occur as water passes through high head spillways and plunges into the tailrace, subjecting the entrained air to greater hydrostatic pressures produced by depth. Since the Niagara Project does not have a spillway, supersaturation does not occur as a result of spillage. Supersaturation can also be produced when water passes through hydroelectric turbines, if a sufficient amount of air is entrained in the turbine flow.

While TDG supersaturation has been identified as an issue of concern at hydroelectric facilities, it also occurs naturally at waterfalls. The TDG saturation levels occurring downstream of dams and waterfalls are determined by the depth of the downstream pool, the volume of water (and air) that plunges into the pool, the amount of mixing that may occur with other sources of unsaturated water, and the gas dissipation (degassing) rate downstream. Degassing typically occurs more rapidly in shallow, turbulent river reaches that mix the flow and brings more of the water volume to the surface where the hydrostatic pressure is lower, which allows degassing to occur. Deep or less turbulent downstream river reaches or reservoirs have little degassing potential, and allow elevated TDG saturation levels to persist.

Elevated TDG saturation levels can result in an increased incidence of the signs of gas bubble disease (GBD) in fish and other aquatic biota. This disease is typically exhibited by the formation of gas

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bubbles within the tissue and circulatory systems of aquatic organisms, similar to the "Bends" experienced by some scuba divers, which under extreme conditions can lead to mortality.

Based on laboratory studies, the U.S. Environmental Protection Agency (USEPA) water quality standard for TDG is 110% of saturation, to protect aquatic life. However, meeting this criterion at hydroelectric facilities is often difficult when substantial amounts of river flow are spilled at the project, or at an upstream project or waterfall.

While the approximate 300 ft of head at the RMNPP suggests that Project operations have the potential for increasing TDG downstream, the absence of a spillway greatly reduces the potential for air entrainment. Since air is not injected into the turbine units to reduce cavitation at the RMNPP or LPGP, there is no known mechanism for entrainment of substantial amounts of air in either the RMNPP or LPGP discharge. TDG supersaturation is expected to occur naturally downstream of Niagara Falls (Falls), which is located about 5.3 miles upstream from the RMNPP discharge. This report summarizes the results of a study of TDG saturation levels in the lower Niagara River, and the potential influence of the Project on these levels.

After a reconnaissance survey to assess the general distribution of TDG concentration in the RMNPP tailrace area, three monitoring stations were selected that represented: (1) the ambient TDG saturation levels just upstream of the RMNPP tailrace that are affected by discharge over the Falls, (2) the levels contained in the RMNPP turbine discharge plume (which includes LPGP discharge), and (3) a downstream location consisting of the mixed discharges of the Falls, RMNPP, and the Sir Adam Beck Power Plant. These locations were monitored during one summer period (tourist season) and one autumn period (non-tourist season), which represent two different flow regimes in the river established by International Treaty. The International Treaty sets minimum water volumes passing the Falls during these two seasons, which affects the amount of water available for diversion by the Project, and the resulting Project operating conditions. During each monitoring period, data were collected for approximately six days at all three stations using continuously recording data loggers.

Significantly higher levels of TDG saturation were found in the Niagara River between the Falls and the RMNPP discharge, than downstream from the RMNPP tailrace. These differences were

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consistent during both monitoring periods. The TDG levels upstream of the RMNPP tailrace were consistently greater than 122% of saturation during the tourist season monitoring period (averaging 127.2%), while TDG levels about a mile or more downstream were consistently below 119% of saturation (averaging 114.2%). At the same time, TDG levels recorded in the RMNPP turbine discharge plume were consistently below 108% of saturation (averaging 103.5%). Similar differences between stations were observed in November (non-tourist season), although the TDG levels at all locations were typically at least 3% of saturation lower than in August. These results show that Project discharge was consistently below the USEPA water quality standard during both the tourist and non-tourist sampling periods.

The significant decrease in TDG levels at all of the monitoring locations downstream of the RMNPP also indicates that Project operations do not produce an increase in TDG levels in the lower Niagara River. Rather, the TDG levels observed in the lower Niagara River are produced primarily by discharge over the Falls. Project operations have a beneficial effect by reducing TDG levels that naturally occur in water resulting from discharge at the Falls. The average reduction during the tourist season was 12.9% of saturation (8-16% range), and 14.7% of saturation during the non-tourist season (range 9-18%). Spatial and temporal trends in the data confirm that Project discharge has low TDG concentrations that effectively dilute the high TDG levels occurring from discharge over the Falls. The low TDG levels observed in the discharge plumes of both the RMNPP and Sir Adam Beck projects, during the August and November sampling events, indicate that both projects likely contribute to the dilution of TDG levels occurring in the lower Niagara River.

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ABBREVIATIONS

Project Related

LPGP	Lewiston Pump Generating Plant
NPP	Niagara Power Project (including LPGP and RMNPP facilities)
NYPA	New York Power Authority
RMNPP	Robert Moses Niagara Power Plant

Agencies

FERC	Federal Energy Regulatory Commission
USEPA	United States Environmental Protection Agency

Units of Measure

C	Celsius, Centigrade
cfs	cubic feet per second
k	kilo (prefix for one thousand)
MW	megawatt

Environmental

DO	dissolved oxygen

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GBD	gas bubble disease
TDG	total dissolved gas
TGP	total gas pressure

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1.0 INTRODUCTION

The New York Power Authority (NYPA) is engaged in the process of gathering natural resource data, including water quality information in the lower Niagara River, and the potential influence that Niagara Power Project (Project) operations (which includes both the Robert Moses Niagara Power Plant [RMNPP] and the Lewiston Pump Generating Plant [LPGP]) have on water quality as part of Project relicensing. This report presents the results and discussion of a field study of total dissolved gas (TDG) saturation levels occurring in the lower river, as they relate to naturally occurring background levels and Project operations.

1.1 Project Features and Operations

The Project was licensed to the Power Authority of the State of New York (now the NYPA) in 1957. Construction of the Project began in 1958, and electricity was first produced in 1961. The Project has twin intakes located approximately 2.6 miles upstream from Niagara Falls (Falls) (Figure 1.1-1). Water entering these intakes is routed around the Falls via two large low-head conduits to the 1.8-billion-gallon RMNPP forebay, located on the east bank of the Niagara River, about 4.5 miles downstream from the Falls. The RMNPP has approximately 300 ft of head, with 13 turbines that generate electricity from water stored in the forebay and discharge into the Niagara River. The 1,880-MW (firm capacity) RMNPP is one of the largest non-federal hydroelectric facilities in North America. The LPGP is located at the east end of the RMNPP forebay, where during non-peak power generating conditions (i.e., at night and on weekends), water is pumped from the RMNPP forebay (via 12 LPGP pumps) into the 22-billion-gallon Lewiston Reservoir, which lies east of the plant. During peak generating conditions (i.e., daytime Monday through Friday), the pumps are reversed for use as generators, and water is allowed to flow back through the plant, producing electricity. Thus, the RMNPP forebay serves as the LPGP tailwater, and the Project consists of two power plants (RMNPP and LPGP) and associated conduits and reservoirs. As such, the discharge from RMNPP represents the combined influence of both power plants on the water conditions in the lower Niagara River.

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For purposes of generating electricity from the Niagara River, two seasons are recognized: tourist and non-tourist seasons. By international treaty, at least 100,000 cfs must be allowed to flow over the Falls during the tourist season (April 1 – October 31) during daytime and early evening hours, and at least 50,000 cfs at all other times. Canada and the United States are entitled by international treaty to produce hydroelectric power with the remainder, sharing equally. Canada produces power at the two Sir Adam Beck powerhouses, located opposite the RMNPP on the lower Niagara River.

1.2 Total Dissolved Gas Processes

Total dissolved gas supersaturation occurs when entrained air passes into solution in greater amounts than the water would normally hold at surface pressure. This increased transfer of air into solution is due to greater hydrostatic pressures produced by the depth of the receiving water. Supersaturation occurs when water plunges into the downstream pool or tailrace, and entrains substantial volumes of air to depth. The increased pressure associated with depth, causes more air to pass into solution, supersaturating the water with oxygen, nitrogen and other minor atmospheric gasses. Supersaturation can also be produced when water passes through hydroelectric turbines, if a sufficient amount of air is entrained in the turbine flow.

While TDG supersaturation has been identified as an issue of concern at hydroelectric facilities, it also occurs naturally at waterfalls. Waterfalls often act like a dam spillway if the water plunges into a deep downstream pool. The TDG saturation levels occurring downstream of dams and waterfalls are determined by the depth of the downstream pool, the volume of water (and air) that plunges into the pool, the amount of mixing that may occur with other sources of unsaturated water, and the gas dissipation rate (degassing) downstream. Degassing typically occurs more rapidly in shallow, turbulent river reaches that mix the flow and bring more of the water volume to the surface where the hydrostatic pressure is lower, thus allowing degassing to occur. These physical characteristics also result in greater mixing rates which also facilitate increased degassing, or increased dilution. Deep or less turbulent downstream river reaches or reservoirs typically have little degassing potential, and allow elevated TDG saturation levels to persist.

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Elevated TDG saturation levels can result in an increased incidence of the signs of gas bubble disease (GBD) in fish and other aquatic biota. This disease is typically exhibited by the formation of gas bubbles within the tissue and circulatory systems of aquatic organisms, similar to the "Bends" experienced by some scuba divers, which under extreme conditions can lead to mortality.

The U.S. Environmental Protection Agency (USEPA) water quality standard for TDG is currently set at 110% of saturation, to protect aquatic life. The TDG criterion is based on laboratory studies that produced GBD in fish by exposing them to supersaturation conditions at confined depths of less than 3 ft. Because the biological effects of TDG supersaturation are reduced by depth, this criterion is conservative (overestimates biological effects) when applied to natural situations where fish commonly occupy depths substantially greater than 3 ft.

Meeting the 110% criterion is difficult at high head hydroelectric facilities that spill substantial amounts of river flow, or at hydroelectric projects that receive supersaturated water from an upstream hydroelectric project or waterfall. Supersaturated water conditions can persist where relatively deep reservoirs or rivers offer less-effective gas dissipation than in shallow and turbulent river reaches. Thus, it is often challenging for a hydroelectric project to demonstrate that normal operations do not produce or contribute to the TDG supersaturation levels that may be present in the river.

The relatively deep forebay and tailrace areas of the Project, along with the approximate 300 ft of hydraulic head of the RMNPP suggests that Project operations have the potential for increasing TDG downstream, although the absence of a spillway minimizes this potential. However, TDG supersaturation is expected to naturally occur downstream from the Falls, located about 5.3 miles upstream of the RMNPP discharge.

Extensive research during the 1960s and 1970s determined that periods of spillage through the sequence of Columbia River hydroelectric projects can cause TDG supersaturation that can lead to fish mortalities (Ebel et al. 1975, Weitkamp and Katz 1980). The visible signs of GBD and the potential effects on survival of exposed fish have been well documented, primarily by controlled exposure investigations under laboratory conditions (Dawley and Ebel 1975, Nebeker and Brett 1976, Weitkamp

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1976, Weitkamp and Katz 1980), but also in a few field efforts (Ryan et al. 2000, Weitkamp et al 2003). However, most of these investigations restrict fish movement to relatively shallow depths, thereby maximizing the effects of elevated TDG saturation levels by preventing hydrostatic compensation. The hydrostatic pressure provided by depth, reduces the effective TDG level actually experienced by fish at a rate of about 10% of saturation for every 3 ft of depth. For example, under TDG levels of 120% of saturation, a fish at a depth of six feet actually experiences the equivalent of 100% TDG concentration, compared to the 120% of saturation experienced by a fish at the surface. In addition, the effects of elevated TDG saturation levels are also influenced by the duration of exposure (Hans et al. 1999, Weitkamp et al. 2003). At TDG levels of 120-125% of saturation an exposure of one to several weeks may produce only minor signs of GBD in fish remaining at shallow depths. However, a short exposure of one or two days at 130-140% TDG may produce mortalities.

While the biological implications of TDG supersaturation occurring in riverine environments with free-swimming fish are relatively uncertain, since they are so difficult to study, extensive evaluations throughout the country have produced little evidence to suggest that substantial harm is caused to fish at TDG levels of 120% of saturation or less (Ryan et al. 2000, Backman and Evans 2002, Weitkamp et al. 2003). Therefore, exceeding the water quality standard by 10% of saturation typically results in no long-term measurable biological effects. In addition, depending on fish depth distribution behavior, the effects of even 130% TDG saturation can result in only minor biological effects (Weitkamp et al. 2003). Understanding the TDG supersaturation conditions in a river, its contributing factors, and the behavior of the aquatic biota is necessary to assess the potential or actual biological effects of the TDG supersaturation conditions.

1.3 Study Area

The study area described in this report encompasses the waters of the lower Niagara River from just upstream of the RMNPP tailrace to just downstream of the Niagara Gorge, near the southern border of the Village of Lewiston (Figure 1.3-1). The area upstream of the RMNPP tailrace was included to document ambient conditions, while the tailrace and downstream areas represent the Project effect and mixed waters, respectively. Although the operation of the Sir Adam Beck project on the lower Niagara

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River can also affect downstream TDG saturation levels, this influence is not specifically investigated in this report.

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Volume 2
Section: Determine if Project Operation Results in Supersaturation of Atmospheric Gases in Lower Niagara River

FIGURE 1.1-1

NIAGARA RIVER PROJECT AREA

[NIP – General Location Maps]

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FIGURE 1.3-1

TOTAL DISSOLVED GAS MONITORING STATIONS

[NIP – General Location Maps]

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2.0 OBJECTIVES

The objectives of this study are to:

- measure TDG saturation levels in the lower Niagara River both upriver and downriver of the RMNPP and determine the contribution of the Project to downriver TDG saturation levels;
- assess these TDG saturation levels during two seasons with distinctly different river flow requirements, and,
- if levels of dissolved gases are significantly higher downriver of the RMNPP and the Sir Adam Beck Plant than upriver, assess the potential for GBD to occur in fishes of the lower Niagara River and, the relative contribution of Project operations to that potential.

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3.0 METHODS

Three methods were used to assess the TDG saturation levels in the lower Niagara River in 2003. First a reconnaissance survey was conducted in the lower river to determine the general distribution of TDG saturation levels throughout the study area. This information was used to select appropriate monitoring locations for additional evaluation. The second method was to manually monitor TDG saturation levels simultaneously at the selected monitoring locations from boats, during specific time periods expected to represent maximum effects from Project operations. The third method was to deploy fixed monitoring equipment at these same monitoring locations to assess TDG saturation levels relative to a wider range of Project operations.

These locations were monitored in August (tourist season) and November (non-tourist season), which represent two different flow regimes in the river established by international treaty. The international treaty sets minimum water volumes passing the Falls during these two seasons, which affects the amount of water diverted to the Project, and the resulting Project operating conditions.

3.1 Reconnaissance Survey

The initial reconnaissance survey was conducted from three boats, chartered through a local fishing guide service. The TDG saturation levels were measured at various locations in the lower Niagara River, upstream and downstream from the RMNPP (see Figure 1.3-1). Measurements were made with a Hydrolab Datasonde Model 4a water quality probe and a surveyor SVR4 datalogger, with the probe attached to a rope with a 12-lb lead ball at the end. The probe measures total gas pressure (TGP) in the water, which is then divided by the barometric pressure and the resulting ratio is converted to a percentage to determine the percent TDG saturation value. Hourly barometric pressure measurements were obtained from the weather station at the Niagara Airport and adjusted for the elevation difference between the river and the airport. (Note: Percent TDG saturation levels are generally reported in the report since this is what affects fish physiology and the EPA has established guidelines for this parameter. However, TGP is used in reference to the data actually measured by the instruments used in this evaluation.) In addition to measuring TGP, the monitoring probe was set up to measure and record

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temperature, and depth. The monitoring probe was suspended at about 3 ft depth for 5 to 10 minutes at each station, until the reading remained steady for at least 2 minutes. The measurements were recorded on log sheets, as well as electronically on a SVR4 datalogger. The sampling locations were recorded on aerial photographs of the study area, and the location coordinates were recorded on a hand-held GPS unit. In addition to the usual monitoring depth of about 3 ft, the probe was occasionally lowered to about 10 ft to assess vertical differences in the distribution of TDG in the study area.

A sampling design was established to assess the distribution of TDG upstream and downstream of the RMNPP and Sir Adam Beck projects. The intent was to conduct transect monitoring profiles across the river at locations:

- just upstream from the projects to assess ambient TDG saturation levels,
- immediately downstream from the RMNPP and Sir Adam Beck Plants to assess TDG saturation levels produced in water passing through the powerhouses, and
- at several locations well downstream from the projects to assess the cumulative effects of both hydroelectric facilities on TDG saturation levels in the lower Niagara River.

3.2 Manual Monitoring

After reviewing the distribution of TDG concentrations, measured during the reconnaissance survey, three representative stations were selected for additional monitoring, to document the potential effects of RMNPP operations on the TDG saturation levels in the lower Niagara River. These three monitoring stations represented: (1) the ambient TDG saturation levels affected by discharge over the Falls and other upstream sources, (2) the levels contained in the direct discharge plume from the RMNPP, and (3) a downstream location representing the mixed discharges of the Falls, RMNPP, and the Sir Adam Beck Power Plant. TDG saturation levels were also periodically measured at some of the other reconnaissance survey locations, during subsequent monitoring efforts, to verify that the TDG distribution remained similar to that observed during the reconnaissance survey.

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This monitoring was conducted following the same methods as the reconnaissance survey, except that simultaneous measurements were obtained at the three representative monitoring sites using three Hydrolab probes and three boats. The three probes consisted of two Hydrolab Datasonde 4a and one Hydrolab minisonde 4a units, with surveyor SVR4 dataloggers. The boats were either anchored in place, or maintained in position under power. The probes were suspended at a depth of about 3 ft and the data loggers set to record TGP data, date, time, temperature, depth, barometric pressure and dissolved oxygen every 5 minutes. The measurements of these parameters were also recorded in field logs, along with GPS coordinates and other observations.

This manual monitoring occurred during the two specific time periods of interest, representing different river flow and Project operating conditions. The first monitoring period was in the morning (dawn to about 0800), when river flow and power plant discharge are both typically low (around 50,000 cfs each). The second monitoring period (1600 to dusk) was conducted when river flows were about 100,000 cfs and power plant discharge is typically greater than 50,000 cfs. Although the river flow regime is similar every day of the week, the RMNPP is operated differently on the weekend. Overall, power generation is typically substantially lower on the weekend than during the week. As a result, Project operations on the weekend were expected to have less influence on TDG saturation levels in the lower Niagara River, so manual monitoring was targeted at weekdays only.

3.3 Continuous Monitoring

Because the manual monitoring could not be conducted at night (for safety reasons), there were limited opportunities to gather TDG information during the two identified time periods of interest. To gather additional data for these two time periods, as well as at other times of the day and night, the Hydrolab probes were placed inside PVC protective housings and anchored to the bottom at each of the three monitoring stations. Prior to, and immediately after deployment, the probes were suspended from the boat at a depth of about 3 ft to verify that the TDG measurements obtained on the bottom were similar to those obtained in the water column (at 3 ft). Each probe was programmed to record TGP, date and time, temperature, depth and dissolved oxygen every 5 minutes.

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3.4 Quality Control

Each of the monitoring probes were checked, serviced and calibrated, by manufacturer trained technicians, immediately prior to the field monitoring efforts, and checked at the beginning and end of each deployment to ensure that they remained in calibration. Calibration verification consisted of deploying all the probes at the same location and depth, to compare readings between instruments (including TGP, temperature and depth). In addition, replicate measurements were obtained at all three monitoring stations, with a different probe than the one used or deployed at that station. To verify that TGP measurements obtained during the continuous monitoring effort from the river bottom were similar to those occurring in the water column, TGP saturation was measured at about 3 ft of depth, prior to and immediately following probe deployment.

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4.0 RESULTS

4.1 Reconnaissance Survey

The reconnaissance survey was conducted on August 18, 2003, between 1100 and 1600. Average hourly discharge from the RMNPP was between 69,300 and 75,700 cfs during the survey. While this was near the peak discharge on that day, peak discharge on subsequent weekdays tended to be slightly higher (Figure 4.1-1). TDG saturation levels were determined at three locations across the river, along a transect line about 1300 ft upstream from the RMNPP tailrace (Stations 1, 2, and 3) between 1155 and 1230 hrs (see Figure 1.3-1). These stations were expected to represent the ambient TDG saturation levels entering the study area from upstream sources, including the Falls. Station 1 was located near the center of the channel, at the edge of the strongest currents, because it was not practical to maintain the monitoring probe at the desired depth of about 3 ft in the direct current. Station 2 was approximately mid-way between the center of the channel and the U. S. shoreline, while Station 3 was about 30 ft from the Canadian shoreline (also at the edge of the swift flows). The TDG saturation levels ranged between 125.9% and 127.2% of saturation at all three stations (Figure 4.1-2 and Table 4.1-1). In addition to the measurements at 3 ft of depth, measurements were obtained from about 10 ft at Stations 2 and 3. At both of these stations, the TDG saturation levels were only slightly higher (0.3% of saturation) at the greater depth.

After completing the first transect, upstream of the RMNPP tailrace, the boat was allowed to drift downstream from Station 2 to a point just upstream of the Lewiston/Queenston Bridge. During the drift, TDG saturation levels declined from 127.3% to 109.9% of saturation. However, only a slight decline in TDG was observed until the boat was downstream of the RMNPP discharge tailrace.

Station 4 was located about 30 ft from the U.S. shoreline and about 500 ft downstream of the RMNPP, in the turbine discharge plume. This Station was intended to assess the TDG saturation levels produced by water passing through the RMNPP. The TDG saturation levels ranged between 96.8% and 97.7% of saturation (see Figure 4.1-2). Station 5 was located about 30 ft from the Canadian shoreline, just upstream of the upper Sir Adam Beck power plant and opposite turbine unit 6 of the RMNPP. TDG

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saturation levels at this Station ranged between 126.9% and 127% of saturation, similar to the ambient levels recorded upstream of the Project at Stations 1, 2, and 3 (see Table 4.1-1). Station 6 was also located along the Canadian shoreline, between the tailraces of the two Sir Adam Beck powerhouses, and had a TDG saturation level of 110.3% of saturation. Station 7 was located just upstream of the Lewiston/Queenston Bridge, along the Canadian shoreline, and had a TDG saturation level of 109.1% of saturation. Five other stations were monitored downstream of the bridge, at least 8,000 ft downstream of the RMNPP (see Figure 1.3-1), in areas expected to represent a uniform mixture of water from the two hydroelectric projects and water from upstream of the projects. TDG saturation levels at these five locations (Stations 8 through 12) ranged between 111.4% and 111.9% of saturation. The TDG saturation level at Station 12, located about 30 ft off the U.S. shoreline and about 8,000 ft downstream of the RMNPP was 111.4% of saturation. The same TDG saturation level was measured at a point directly opposite of Station 12, about 30 ft from the Canadian shoreline (Station 11). A second measurement at about 10 ft deep at Station 11 was only slightly higher (0.2% of saturation) than the measurement at 3 ft.

Based on the results of the reconnaissance survey three stations (Station 2, 4, and 12) were selected for additional monitoring. All three stations were along the U.S. shoreline. Station 2 represented the ambient TDG saturation levels entering the study area from upstream, as all upstream measurements were within 1.6% of saturation of the measurement at Station 2. Station 12 was selected because it adequately represented the horizontal and vertical distribution of TDG about 1.5 miles downstream of RMNPP, with all saturation measurements taken across the river at this location within 0.5% of saturation of each other. Although the TDG saturation levels recorded at Station 4 were unique (below saturation), this Station was located in the direct discharge plume from RMNPP, and thereby represents the direct contribution of the power plant on downstream TDG saturation levels. While some mixing of discharge water with ambient water from upstream of the project could have occurred at this location, locations closer to the RMNPP discharge were neither practical, nor safe. In addition, any mixing may have occurred with the higher ambient saturated water that could have resulted in higher saturation measurements than in the discharge water.

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4.2 Manual Monitoring

Manual monitoring was conducted on August 19 and 20, 2003, from three boats positioned at Stations 2, 4 and downstream at either Station 9 (August 19) or Station 12 (August 20). The monitoring location was changed because Station 12 was determined to be a more secure location for the subsequent deployment of a continuous monitoring probe. The intent of the manual monitoring effort was to simultaneously measure the TDG saturation levels at these three stations during the two primary sampling periods (dawn to about 0800, and 1600 to dusk). The results of the manual monitoring were similar to those observed during the reconnaissance survey (Table 4.2-1, Appendix A). After the evening monitoring on August 19, 2003, the probes were deployed on the river bottom to test the feasibility of continuous monitoring of TDG saturation levels at Stations 2, 4 and 12. The probes were retrieved the following morning and used for manual monitoring during the morning and evening of August 20, 2003. The results on August 20, 2003, were similar to those of the previous two monitoring efforts (see Table 4.2-1).

4.3 Continuous Monitoring

After verifying the feasibility of deploying the monitoring probes on the river bottom, three Hydrolab sensors were deployed at the manual monitoring stations identified above, to acquire a longer time series of TDG data in the lower Niagara River, including some weekend data. As with the manual monitoring, measurements at Station 2 represented the ambient TDG saturation levels affected by discharge over the Falls, Station 4 represented the direct influence of the NPP discharge, and Station 12 represented the mixed discharges of the Falls, NPP, and the Sir Adam Beck Power Plants. Continuous TDG monitoring was conducted during both the tourist and non-tourist sampling periods, at the three representative monitoring locations (Appendix B).

4.3.1 Tourist Season Sampling Period

Although the TDG monitoring probes were deployed on the evening of August 19, 2003, and retrieved the following morning, the primary continuous monitoring effort occurred between 1800 on August 20, 2003, and 1700 on August 24, 2003. Throughout this continuous monitoring period, hourly

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average TDG saturation levels were consistently higher at Station 2 (122.3-129.4%) than at either Station 4 (100.0-107.4%) or Station 12 (110.0-118.1%) (Figure 4.3.1-1). The TDG saturation levels at each of these three stations were similar to the TDG saturation levels measured during the reconnaissance survey and manual monitoring efforts (see Table 4.2-1).

The continuous monitoring period included several days of weekday operations at the RMNPP, and two weekend days. Peak daily RMNPP discharge on the three weekdays was greater (90,700-98,800 cfs) than peak discharge on the weekend days (58,400-81,500 cfs) (see Figure 4.1-1). Peak discharge typically occurred during daylight and early evening hours, with the maximum discharge (98,800 cfs) occurring during the 2100 hour of August 21, 2003 (Figure 4.3.1-2). Substantially lower discharge typically occurred between midnight and 0800 during the weekdays, and throughout much of the weekend. However, because some high flows occurred briefly on the weekend, the overall discharge ranges were only slightly different, ranging from 30,600 to 98,800 cfs during the weekdays, and 26,000 to 81,500 cfs on the weekend.

Paired-Sample T-test analyses were conducted on the hourly average TDG data from the three monitoring stations to determine if the mean TDG saturation levels were significantly different from one another. For these tests, data from the two time periods of primary interest (0400-0800, and 1600-2100 hrs), collected during the weekdays, resulted in sample sizes (hourly averages) of 17 for the morning period, and 19 for the evening period (Table 4.3.1-1). The data were analyzed for normality to determine if a parametric T-test or a non-parametric Signed-Rank test was most appropriate, using a Shapiro-Wilk test. The data for all stations during the two time periods were normally distributed, so a paired T-test was selected (Table 4.3.1-2). The mean TDG saturation levels at each of the stations were significantly different ($p<0.0001$) from each other during both the morning and evening time periods.

Weekend data were analyzed for both normality and differences in mean TDG saturation levels between stations. However, because the available data only consisted of two weekend days, the sample sizes were limited to 10 hourly averages each for the morning and evening periods. Once again, the data for each of the stations passed the normality test, and the means were also significantly different ($p<0.0001$) (see Table 4.3.1-2). No substantial differences were observed between the mean weekday and weekend TDG saturation levels for either the morning or evening periods (see Table 4.3.1-1).

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A distinct diel pattern in TDG saturation levels was evident at the Station 2 in August, with the lowest TDG saturation levels occurring between 0400 and 0900 on most days (Figure 4.3.1-3). It is likely that this fluctuation pattern is due to changes in water volume passing over the Falls. No obvious diel pattern was observed at Station 4, while only a slight diel fluctuation occurred at Station 12, particularly on the weekend. However, the hourly variations were greater at Stations 4 and 12, confounding the identification of a diel pattern. The TDG saturation levels at Stations 4 and 12 tended to be slightly higher when RMNPP discharge was low, although this pattern was not consistent from day to day.

Slight diel fluctuations were also observed in the water temperatures at each of the three TDG monitoring stations. While these fluctuations tended to occur at about the same time at Stations 2 and 12, similar temperature changes at Station 4 appeared to occur slightly earlier (Figure 4.3.1-4). This, along with the consistently higher water temperatures (average of about 0.3° C warmer), suggests that the Station 4 probe was sampling a water mass distinct from the main river flow (e.g., RMNPP discharge).

The three Hydrolab fixed location monitors were equipped with depth sensors, and recorded changes in water depth relative to their deployment location. Changes in depth within the study area are affected by river flows entering the study area, discharge from RMNPP, discharge from the two Sir Adam Beck plants, as well as the cross sectional area of the river at different locations. Water level changes throughout the continuous TDG monitoring period were similar for Stations 2 and 4 (daily fluctuations of as much as 6 ft), while the fluctuations at Station 12 were less than about 1.5 ft (Figure 4.3.1-5). The slight changes in depth at Station 12 are likely due to the location of this Station near the point where the Niagara River substantially widens. Therefore, incremental changes in flow would result in less of a vertical change in depth at this location, compared to the more constricted channel cross-sections in the vicinity of Stations 2 and 4. However, no substantial differences were observed in TDG saturation levels with water depth during manual monitoring efforts.

4.3.2 Non-Tourist Season Sampling Period

Non-tourist season TDG monitoring occurred between November 4 and 10, 2003, at two of the same monitoring locations used during the tourist season sampling period (Stations 2 and 4). However, the furthest downstream monitoring location was moved from near the U.S. shoreline (Station 12) to near

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the Canadian shoreline (Station 11), because of the relatively high level of fishing activity in the vicinity of Station 12. The mooring lines for the monitors are prone to being snagged by fishing lures, so moving the downstream Station to the opposite shoreline was expected to reduce the likelihood of someone tampering with the equipment. Based on reconnaissance survey, there was no substantial difference between the TDG saturation levels recorded at Stations 11 and 12. The maximum difference in TDG saturation levels recorded at Stations 11 and 12 during the August reconnaissance survey was 0.6% and 0.7% of saturation. A similar difference (0.7%) was observed during the non-tourist season sampling. The lateral distribution of TDG saturation in the vicinity of the other two monitoring stations was also checked during the non-tourist season sampling effort (November). Although the TDG measurements at most locations were lower than observed in August, the overall TDG distribution pattern was similar.

Throughout the November monitoring period, average hourly TDG saturation levels were consistently higher at Station 2 (115.4-123.8% of saturation) than at either Station 4 (96.2-102.9% of saturation) or Station 11 (103.0-111.6% of saturation) (Figure 4.3.2-1). Although the same overall pattern of TDG distribution was observed in August and November, the average TDG saturation levels were 3.5 to 7.2% of saturation lower at each Station in November, as compared to August.

The continuous monitoring period included five weekdays and two weekend days. Peak daily RMNPP discharge on the five weekdays (91,000-101,600 cfs) was similar to peak discharge on the weekend days (93,800-96,900 cfs) (Figure 4.3.2-2). Peak discharge typically occurred during daylight and early evening hours on all days, with maximum discharge (101,600 cfs) occurring during the 1700 hour of Friday, November 7, 2003 (Figure 4.3.2-3). Substantially lower discharge typically occurred between midnight and 0800, and during the day on Saturday.

The TDG data were analyzed for normality to determine if a parametric Paired-Sample T-test or a Signed-Rank test was most appropriate to determine significant differences in mean TDG saturation levels at the three monitoring stations, during the two pre-established time periods of interest (0400-0800 and 1600-2100). The analyses included sample sizes of 20 hourly averages for both the weekday morning and evening periods (Table 4.3.2-1). Shapiro-Wilk normality test determined that four of the six weekday Station comparisons were normally distributed, indicating that a Paired Sample T-test was appropriate, while the other two comparisons were analyzed using a Signed-Rank test (Table 4.3.2-2).

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Regardless of the test, the mean TDG saturation levels at each of the stations were significantly different ($p<0.0001$) from each other during both the weekday morning and evening periods.

Weekend data were also analyzed for both normality and significant differences between stations, but because of only two weekend days of data, the sample sizes were 10 hourly averages for the morning and evening periods. All of the weekend data were normally distributed, and the means significantly different ($p<0.0001$) from each other, except for the comparison of Stations 4 and 11 during weekend mornings. This latter comparison was analyzed using a signed-rank test, and was significantly different, but at a lower probability level ($p<0.006$) (see Table 4.3.2-2).

As in August, smaller hourly TDG variations were observed at the upstream monitoring Station (Station 2), compared to the variations at the two downstream stations. Peak daily TDG saturation levels at Stations 4 and 11 also tended to occur when RMNPP discharge was lowest. Unlike August however, diel fluctuations were less distinct at Station 2, and more distinct at the other two (downstream) stations (Figure 4.3.2-4). The lack of a distinct diel fluctuation pattern at Station 2 in November, compared to August, is likely due to the consistent flow over the Falls during the non-tourist season.

Also unlike the August data, there was no distinct pattern in water temperature fluctuations at the three stations, except that temperatures generally declined through the monitoring period at all three stations (Figure 4.3.2-5). While the Station 11 probe was not equipped with a depth sensor during the November sampling event, the relative water depths at the other two stations fluctuated in similar fashion, although the fluctuations were not as great as observed in August (Figure 4.3.2-6). In addition, a distinct change occurred in the Station 2 depth measurements at about 0400 on November 9, 2003, when it appeared that the Station 2 probe depth decreased by about 1.5 ft. It is suspected that the probe was somehow moved to a shallower location at that time, because the depths continued to fluctuate in a similar manner at both stations. In addition, the Station 2 probe appeared to be closer to shore when it was retrieved, and no difference was found between the depth measurements of the two probes during the post-retrieval side by side comparison check. There was also no obvious change in the other measurement parameters on November 9, 2003.

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4.4 Quality Control

Side-by-side comparisons of TDG measurements from each monitoring probe were conducted at the boat ramp dock at Lewiston, before and after equipment deployment. The probes were deployed off the dock at about 3 ft of depth and allowed to equilibrate for about 10 minutes, or until the TDG measurements remained unchanged for at least 2 minutes. The results showed close agreement between the TDG saturation levels recorded on all three monitoring probes (Table 4.4-1). The side-by-side comparisons showed a maximum difference of 1.4% of saturation among the three probes on August 20, 2003 and 0.1% of saturation on August 24, 2003. Similarly, the maximum difference observed in November was 0.5% of saturation. As a result, all of the side-by-side comparisons were within the accuracy parameters for the meters (± 2% of saturation).

The continuous monitoring stations were checked for any vertical TDG saturation differences in August and November. Similar TDG saturation levels were recorded on probes held at about 3 ft deep, as those recorded at about the same time on the probes deployed on the bottom during continuous monitoring. This verification was conducted prior to deploying the continuous monitoring probes, and at the time they were retrieved. Differences ranged between 0.1 and 1.2% of saturation, with an average difference of 0.4% of saturation during the summer monitoring period. Differences in November ranged between 0.1 and 3.0% of saturation, for an average difference of 1.9% of saturation.

Verification that the three locations selected for manual or continuous monitoring, continued to adequately represent the TDG saturation levels in various sections of the lower Niagara River, was accomplished by periodically measuring TDG levels at other locations adjacent to the monitoring stations (e.g., transect monitoring locations). These periodic transect location measurements (including the three monitoring stations) were similar to those observed during the reconnaissance transect survey (Table 4.4-2). The TDG saturation levels recorded at the three reconnaissance survey locations upstream of the RMNPP (representing TDG saturation levels entering the study area) ranged between 124.7 and 125.6% of saturation on August 20, 2003, and between 125.3 and 127.6% of saturation on August 24, 2003. These were similar to those observed at these sites during the reconnaissance survey (125.9-127.5% of saturation). While the TDG saturation levels were lower during the November sampling event, the relative uniform distribution across the river was similar (121.1-121.4% of saturation). A similar uniform

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distribution was also observed at the furthest downstream monitoring locations (Stations 11 and 12), with TDG saturation levels of (106.7-108.0% of saturation). As in August, the TDG saturation levels recorded in the direct discharge plume from RMNPP (Station 4) were near or below saturation. The maximum TDG differences across the river, at the furthest downstream monitoring area (Stations 10, 11, and 12), were 2.6% of saturation in August, and 0.8% of saturation in November.

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TABLE 4.1-1

MONITORING DEPTHS AND TDG MEASUREMENTS AT THE RECONNAISSANCE SURVEY MONITORING LOCATIONS, RELATIVE TO THE RMNPP TAILRACE

Station	Location (Relative to RMNPP)		GPS Coordinates (decimal minutes)		Depth (ft)	% TDG
1	1,300 ft upstream	Mid-Channel	43.00142	79.00051	1.0 - 2.6	125.9 - 127.1
2	1,300 ft upstream	U.S. Shore	43.00141	79.00051	2.6	127.2
2	1,300 ft upstream	U.S. Shore	43.00141	79.00051	9.2	127.5
3	1,300 ft upstream	Canadian Shore	43.00142	79.00053	2.3	127.0
3	1,300 ft upstream	Canadian Shore	43.00142	79.00053	10.2	127.3
4	450 ft downstream	U.S. Shore	43.00154	79.00047	2.0 - 3.9	98.6 - 97.7
5	Opposite Unit 6 (upstream of Beck Plant)	Canadian Shore	43.00148	79.00050	0.7 - 1.6	126.9 - 127.0
6	1,200 ft downstream	Canadian Shore	43.00158	79.00050	2.6	110.3
7	3,200 ft downstream	Canadian Shore	43.00156	79.00053	3.0	109.1
8	5,000 ft downstream	U.S. Shore	43.00162	79.00052	2.3	111.7
9	6,000 ft downstream	U.S. Shore	43.00165	79.00053	3.0	111.9
10	6,000 ft downstream	Mid Channel	43.00167	79.00055	2.6	111.9
11	7,000 ft downstream	Canadian Shore	43.00172	79.00059	2.6	111.4
11	7,000 ft downstream	Canadian Shore	43.00172	79.00059	9.5	111.6
12	7,000 ft downstream	U.S. Shore	43.00172	79.00054	3.6	111.4

Notes: Descriptive identification of locations sampled during the TDG reconnaissance survey conducted in the lower Niagara River on August 18, 2003, along with the recorded TDG levels (% of saturation) and sampling depths (see Figure 1.3-1). The data show that TDG saturation levels were substantially higher at stations either upstream of (Stations 1, 2 and 3), or outside the influence of discharge from the RMNPP tailrace (Station 5), compared to those downstream of the Project.

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TABLE 4.2-1

TDG SATURATION LEVELS MEASURED DURING THE AUGUST RECONNAISSANCE SURVEY, COMPARED TO MANUAL MONITORING RESULTS

Station	Reconnaissance Survey (% TDG)	Dawn-0800 (% TDG)		Dusk-1600 (% TDG)	
		August 19	August 20	August 19	August 20
2	127.2- 127.5	124.3 – 125.9	124.0 – 126.1	127.7 – 127.9	126.5 – 127.1
4	98.6 - 97.7	100.9 – 108.8	102.5 – 103.1	101.3 – 101.5	102.7 – 104.0
12	111.4	114.8 – 116.0	111.2 – 113.3	114.6 – 115.0	112.4 – 112.9

Notes: Comparison of TDG saturation levels recorded during the reconnaissance survey (August 18, 2003) with those recorded simultaneously at three monitoring stations, during the two specific time periods of interest (dawn to 0800 and 1600-dusk) on August 19 and 20, 2003. The Station 2 measurements represent the ambient TDG saturation levels affected by discharge over the Falls and other upstream sources, Station 4 levels represent the concentration in the direct discharge plume from the RMNPP, and Station 12 the levels resulting from the mixed discharges of the Falls, RMNPP, and the Sir Adam Beck Power Plant. The results show the relatively consistent TDG saturation levels, at three monitoring stations and the substantially higher levels upstream of the Project, compared to downstream of the Project discharge location.

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TABLE 4.3.1-1

RANGE, MEAN, AND STANDARD DEVIATION OF TDG DATA COLLECTED DURING THE AUGUST 2003 SAMPLING PERIOD, AND USED FOR PAIRED T-TEST ANALYSIS

Sampling Period	Station	Sample Size (n)	Total Dissolved Gas (% of Saturation)			
			Minimum	Maximum	Mean	Standard Deviation
Weekday AM	2	17	123.6	125.5	124.5	0.64
	4	17	101.0	106.3	103.5	1.50
	12	17	111.4	116.0	113.1	1.50
Weekday PM	2	19	126.3	127.9	127.3	0.52
	4	19	102.2	104.0	102.9	0.43
	12	19	112.5	116.3	113.9	1.31
Weekend AM	2	10	121.6	124.9	123.3	1.14
	4	10	100.6	105.2	102.7	1.34
	12	10	110.9	113.1	112.1	0.70
Weekend PM	2	10	127.6	128.5	128.1	0.30
	4	10	101.6	104.8	103.2	1.13
	12	10	113.2	117.8	115.7	1.40

Notes: Description of the data used to determine significant differences in the mean hourly average TDG saturation levels recorded at three locations in the lower Niagara River in August 2003. The TDG data sets were separated by station, by the two time periods of interest (dawn to 0800 and 1600-dusk), and by weekday or weekend days.

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TABLE 4.3.1-2

RESULTS OF PAIRED T-TEST ANALYSIS OF DIFFERENCES IN MEAN TDG SATURATION LEVELS BETWEEN SAMPLING STATIONS, FOR MORNING (AM) AND EVENING (PM) SAMPLING PERIODS, DURING WEEKDAY AND WEEKEND DAYS, AUGUST 2003

Sampling Period	Station Comparison	Sample Size (n)	Normality	T-Test Probability	Significant Difference
Weekday AM	2 vs. 4	17	0.318	<0.0001	Yes
	2 vs. 12	17	0.156	<0.0001	Yes
	4 vs. 12	17	0.562	<0.0001	Yes
Weekday PM	2 vs. 4	19	0.427	<0.0001	Yes
	2 vs. 12	19	0.349	<0.0001	Yes
	4 vs. 12	19	0.169	<0.0001	Yes
Weekend AM	2 vs. 4	10	0.379	<0.0001	Yes
	2 vs. 12	10	0.130	<0.0001	Yes
	4 vs. 12	10	0.798	<0.0001	Yes
Weekend PM	2 vs. 4	10	0.336	<0.0001	Yes
	2 vs. 12	10	0.987	<0.0001	Yes
	4 vs. 12	10	0.724	<0.0001	Yes

Notes: Results of the statistical analyses to determine the significant differences in the mean hourly average TDG saturation levels recorded at three locations in the lower Niagara River in August 2003. All the data sets were normally distributed, allowing a Paired Sample T-Test to assess statistical differences. The results indicate that the TDG saturation levels were statistically different between all three monitoring stations, during both time periods of interest, and during weekday or weekend days. Thus, TDG saturation levels upstream of the Project were significantly greater than the downstream locations for all time periods analyzed.

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TABLE 4.3.2-1

RANGE, MEAN, AND STANDARD DEVIATION OF TDG DATA COLLECTED IN NOVEMBER 2003, AND USED FOR PAIRED T-TEST ANALYSIS

Sampling Period	Station	Sample Size (n)	Total Dissolved Gas (% of Saturation)			
			Minimum	Maximum	Mean	Standard Deviation
Weekday AM	2	20	120.5	122.1	121.1	0.41
	4	20	98.2	102.9	100.5	1.38
	11	20	105.6	111.6	107.7	1.70
Weekday PM	2	20	121.0	123.8	121.8	1.02
	4	20	98.1	100.6	99.3	0.71
	11	20	104.6	107.6	105.9	0.85
Weekend AM	2	10	115.4	120.6	118.1	1.64
	4	10	96.7	101.3	99.1	1.46
	11	10	104.4	107.9	106.7	1.01
Weekend PM	2	10	119.8	121.1	120.6	0.55
	4	10	96.4	98.3	97.3	0.63
	11	10	103.6	106.0	104.4	0.69

Notes: Description of the data used to determine if there were significant differences in the mean hourly average TDG saturation levels recorded at three locations in the lower Niagara River in November 2003. The TDG data sets were separated by station, by the two time periods of interest (dawn to 0800 and 1600-dusk), and by weekday or weekend days.

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TABLE 4.3.2-2

ANALYSIS OF DIFFERENCES IN MEAN TDG SATURATION LEVEL BETWEEN SAMPLING STATIONS, FOR MORNING (AM) AND EVENING (PM) SAMPLING PERIODS, DURING WEEKDAY AND WEEKEND DAYS, NOVEMBER 2003

Sampling Period	Station Comparison	Sample Size (n)	Normality	T-Test Probability	Significant Difference
Weekday AM	2 vs. 4	20	0.458	<0.0001	Yes
	2 vs. 11	20	0.045	<0.0001[a]	Yes
	4 vs. 11	20	0.961	<0.0001	Yes
Weekday PM	2 vs. 4	20	0.195	<0.0001	Yes
	2 vs. 11	20	0.110	<0.0001	Yes
	4 vs. 11	20	0.038	<0.0001[a]	Yes
Weekend AM	2 vs. 4	10	0.742	<0.0001	Yes
	2 vs. 11	10	0.499	<0.0001	Yes
	4 vs. 11	10	0.038	<0.006[a]	Yes
Weekend PM	2 vs. 4	10	0.573	<0.0001	Yes
	2 vs. 11	10	0.128	<0.0001	Yes
	4 vs. 11	10	0.433	<0.0001	Yes

[a]Probability determined through Signed-Rank Test

Notes: Results of the statistical analysis to determine the significant differences in the mean hourly average TDG saturation levels recorded at three locations in the lower Niagara River in November 2003. All but three of the data sets were normally distributed, allowing a Paired Sample T-Test to assess statistical differences; the others were analyzed with a Signed-Rank test. The results indicate that the TDG saturation levels were statistically different between all three monitoring stations, during both time periods of interest, and during weekday or weekend days. Thus, TDG saturation levels were significantly greater upstream of the Project, than downstream.

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TABLE 4.4-1

TDG SATURATION LEVELS RECORDED DURING THE SIDE-BY-SIDE QUALITY CONTROL EVALUATION, BY THE THREE DIFFERENT HYDROLAB MONITORING PROBES USED IN AUGUST AND NOVEMBER 2003

Date	Time	Station 2 Probe (% TDG)	Station 4 Probe (% TDG)	Station 11 or 12 Probe (% TDG)
8/20	AM	111.7	111.9	113.1
8/20	PM	112.6	112.1	112.5
8/24	PM	114.9	115.0	115.0
11/4	AM	107.0	107.1	106.9
11/10	AM	105.9	105.7	105.4

Notes: TDG measurements obtained from three separate monitoring probes, deployed at the same time and location. The results verify the calibration of the three probes, and the overall precision of the monitoring equipment used to simultaneously record TDG saturation levels at three separate monitoring locations. The comparisons were conducted at the Lewiston Marina dock, with the probes suspended at a depth of about 3 ft. Station 12 was replaced by Station 11 in the November sampling, although each station represents a similar mix of TDG concentrations from the different upstream sources.

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TABLE 4.4-2

PERIODIC TDG SATURATION LEVELS MEASURED AT THE RECONNAISSANCE SURVEY MONITORING LOCATIONS, IN AUGUST AND NOVEMBER 2003

Station	Date					
	8/18	8/19	8/20	8/24	11/4	11/10
1	125.9 - 127.1	- - -	126.2 - 126.6	127.6	121.7	120.3
2	127.2 - 127.5	125.6 - 128.2	125.6 - 127.3	126.4 - 127.2	121.2	120.8
3	127.0 - 127.3	- - -	125.8 - 127.8	125.3 - 127.0	121.1	121.1
4	97.7 - 98.6	103.0 - 103.4	101.3 - 102.7	101.9 - 102.8	101.1	97.7
5	126.9 - 127.0	- - -	- - -	- - -	121.7	121.2
6	110.3	106.6	105.9	107.5 - 108.0	105.2	105
7	109.1	- - -	- - -		- - -	105.3
8	111.7 – 111.9	- - -	- - -		- - -	104.7
9	111.9	115.3 - 116.1	- - -		- - -	- - -
10	111.9	- - -	109.6 - 112.8	113.3 - 113.9	106.5	105.1
11	111.4 - 111.6	- - -	111.1 - 112.1	113.7 - 113.8	107.6	105.2
12	111.4	113.3	112.3 - 113.2	113.1 - 113.9	106.8	105.6

Notes: TDG measurements recorded at the twelve reconnaissance survey stations, on 8/18/03, compared to periodic measurements recorded at these same locations during the August and November 2003 sampling periods. The results show the consistently high TDG saturation levels upstream of RMNPP, the low TDG saturation levels in the RMNPP discharge plume, and the somewhat intermediate TDG saturation levels downstream of the mixing zone for these different water masses. The results also support the selection of Stations 2, 4 and 12, to represent the various TDG concentrations in the river.

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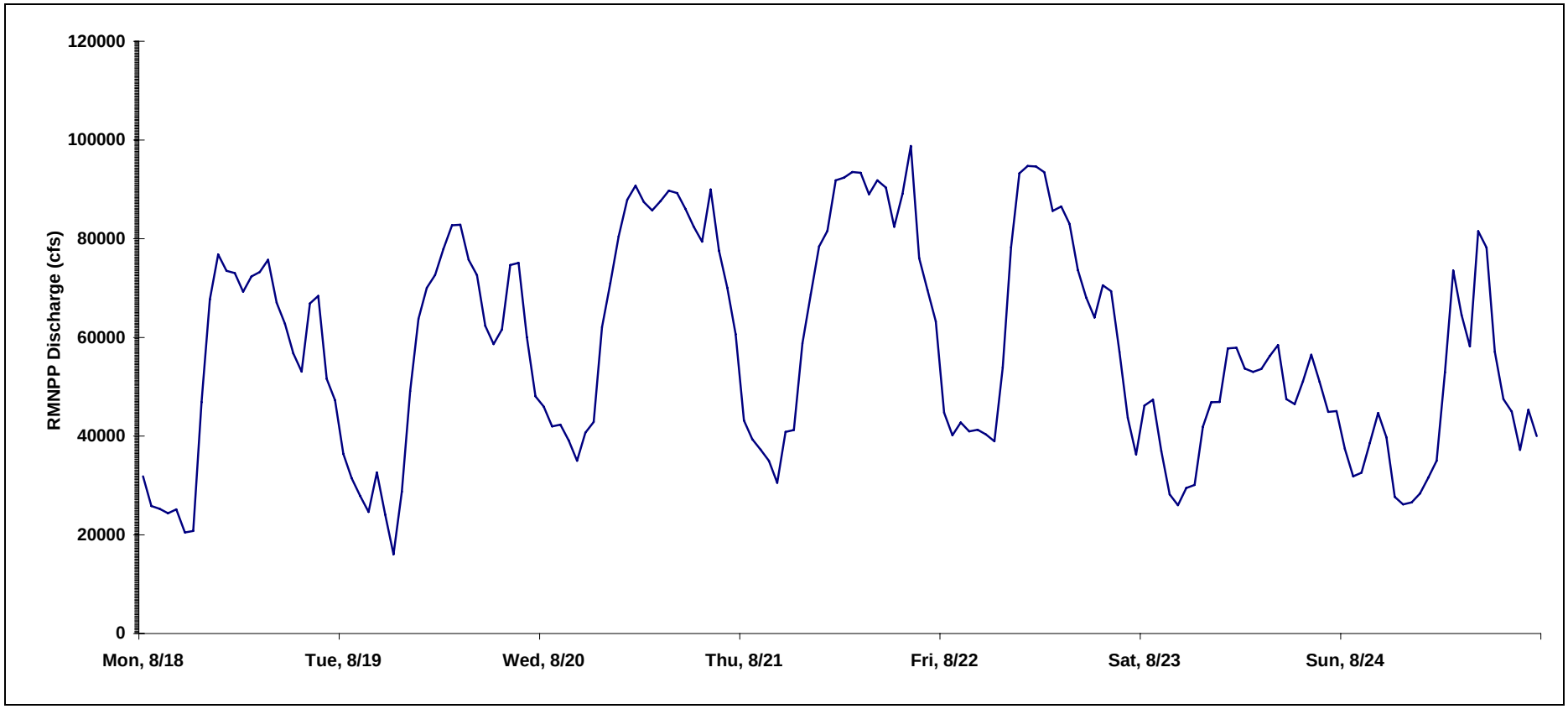
FIGURE 4.1-1

RMNPP DISCHARGE DURING THE TOURIST SEASON SAMPLING PERIOD, 2003



Notes: Hourly average discharge in cubic feet per second (cfs) from the Robert Moses Niagara Power Plant during the August (tourist season) TDG sampling period. The plot shows the relatively uniform discharge pattern during the weekdays (8/18-8/22) compared to the weekend.

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This material is contained in:
Volume 2
Section: Determine if Project Operation Results in Supersaturation of Atmospheric Gases in Lower Niagara River

FIGURE 4.1-2

RECONNAISSANCE SURVEY TOTAL DISSOLVED GAS SATURATION MEASUREMENTS

[NIP – General Location Maps]

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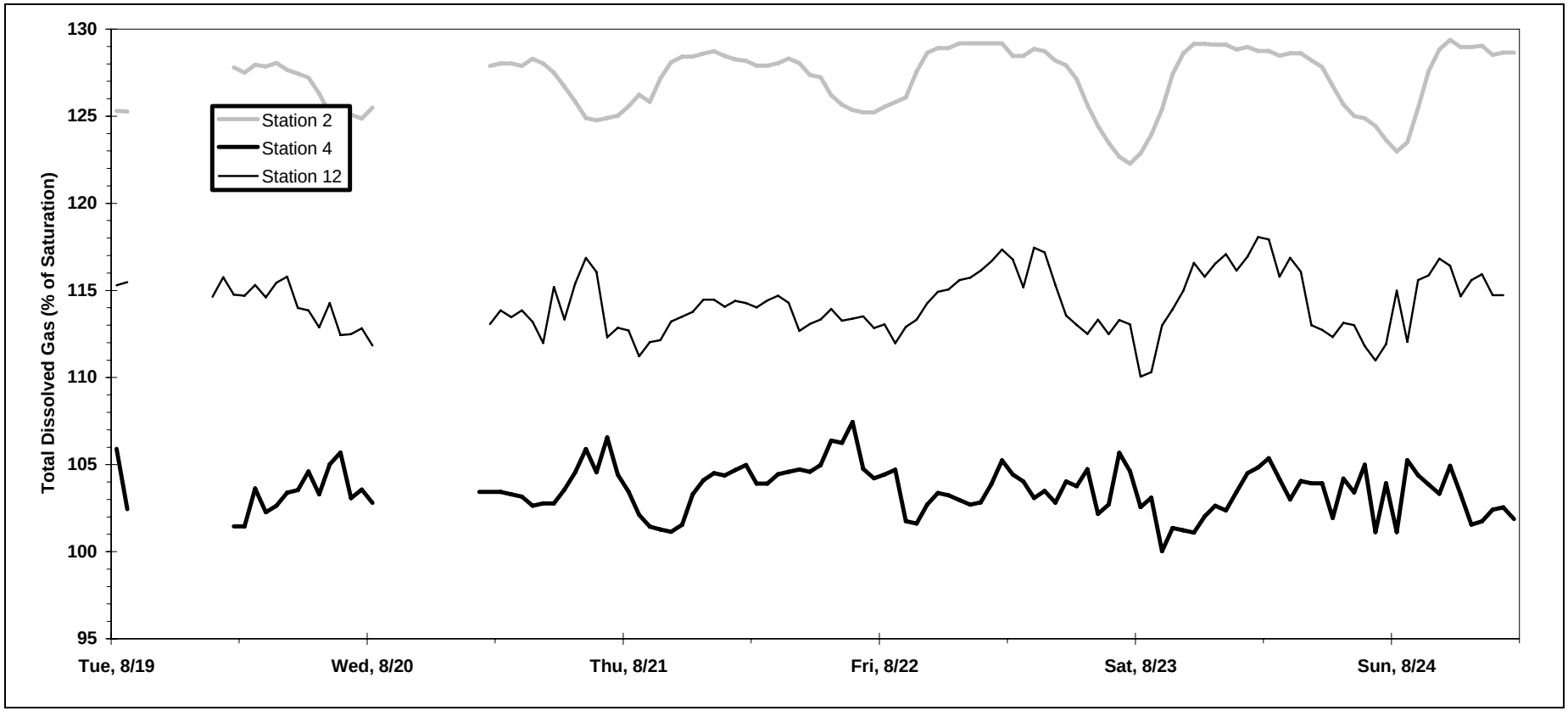
FIGURE 4.3.1-1

HOURLY AVERAGE TOTAL DISSOLVED GAS LEVELS AT THREE STATIONS BETWEEN AUGUST 19 AND 24, 2003



Notes: Hourly average TDG levels measured at various locations in the Project area in August (tourist season). The data show that the lowest TDG levels occur in the RMNPP discharge plume (Station 4), and the highest levels occur from sources upstream of the Project (Station 2). The TDG levels at Station 12 illustrate the apparent dilution effects of the RMNPP and Sir Adam Beck Plant discharges.

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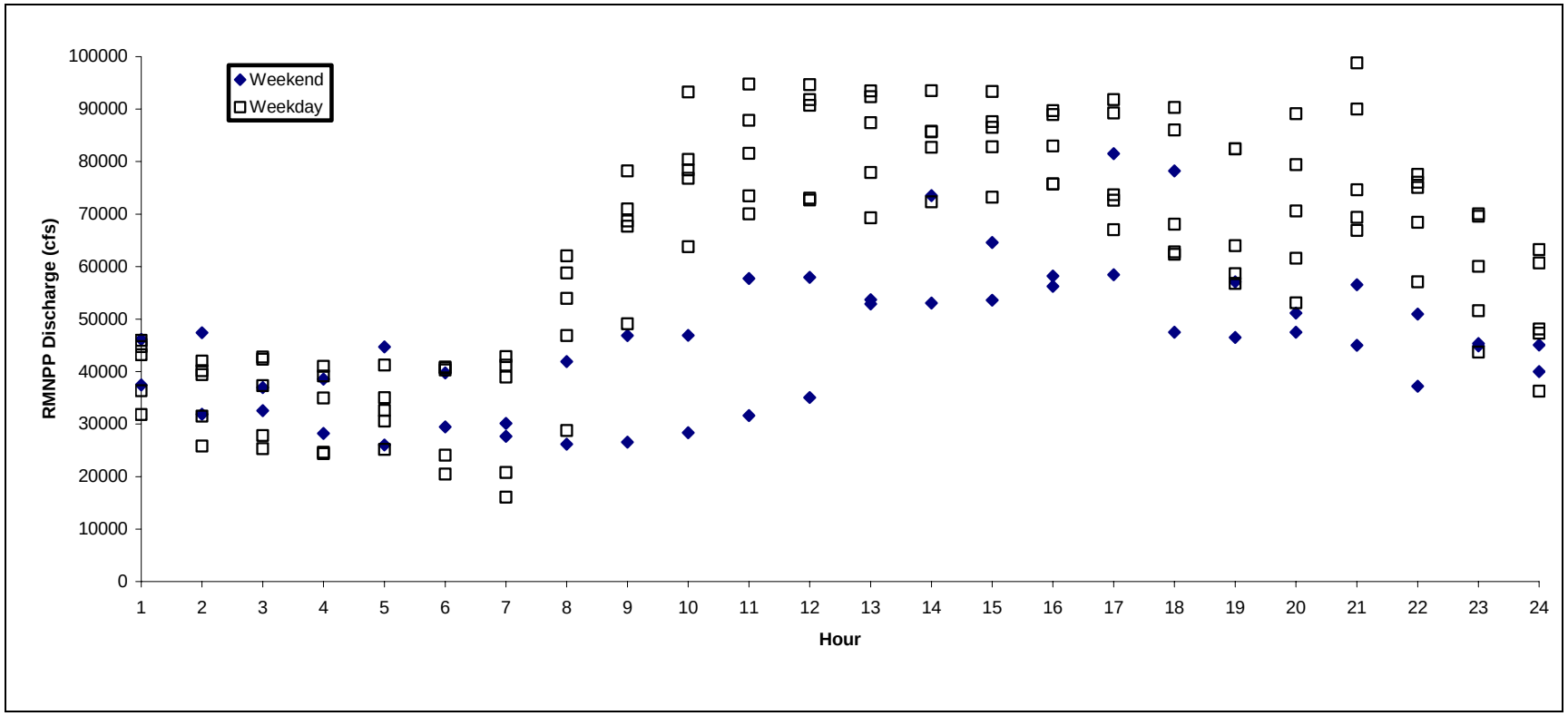
FIGURE 4.3.1-2

WEEKDAY AND WEEKEND HOURLY DISCHARGE FROM THE RMNPP DURING THE TOURIST SEASON SAMPLING PERIOD, 2003



Notes: Range of hourly discharge from the RMNPP during the August (tourist season) TDG sampling period. The data indicate that discharge is lowest between 0100 and 0700 and highest during the day, although considerable hourly variation occurs. The data also show that discharge tends to be higher during the week than the weekend. This supports the separation of TDG analyses, to assess the potential effects of project operations, into early morning/early evening and weekday/weekend time periods.

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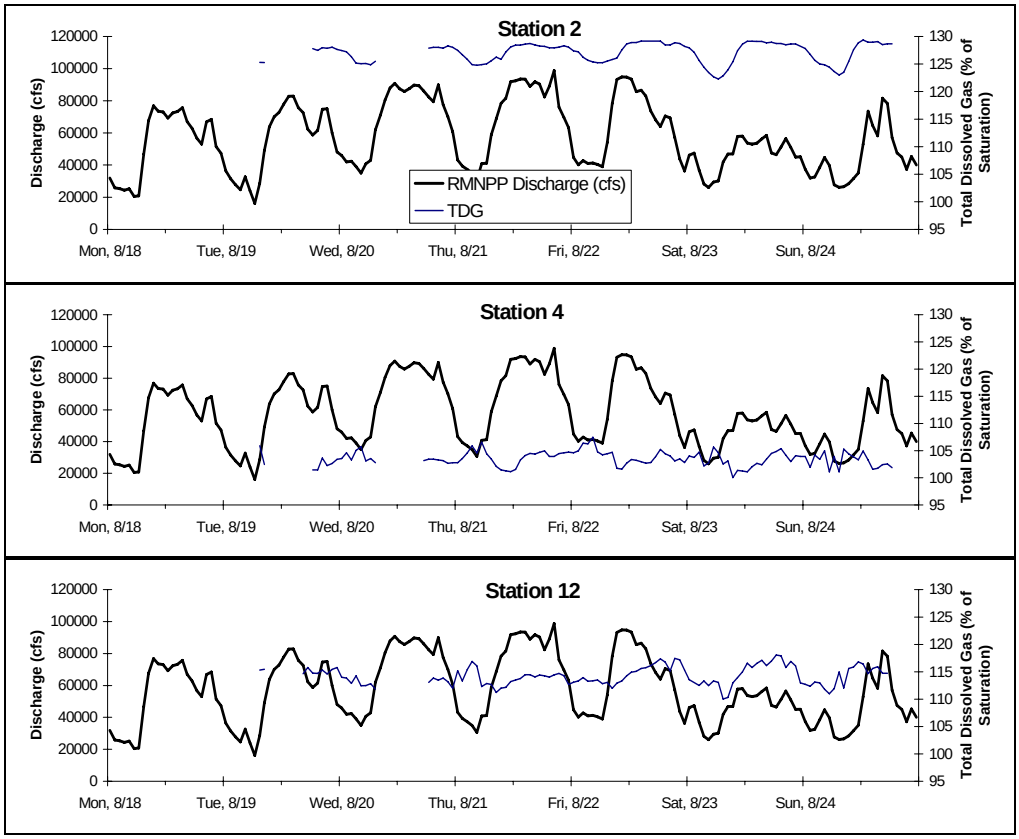
FIGURE 4.3.1-3

HOURLY AVERAGE TOTAL DISSOLVED GAS LEVELS AT THREE MONITORING STATIONS COMPARED TO RMNPP DISCHARGE, AUGUST 2003



Notes: TDG levels recorded at three fixed monitoring stations in the lower Niagara River in August, in relation to fluctuations in RMNPP discharge. While a distinct and regular pattern of TDG fluctuations occur at Station 2, no consistent pattern is obvious at the other stations (except that the TDG levels are substantially lower).

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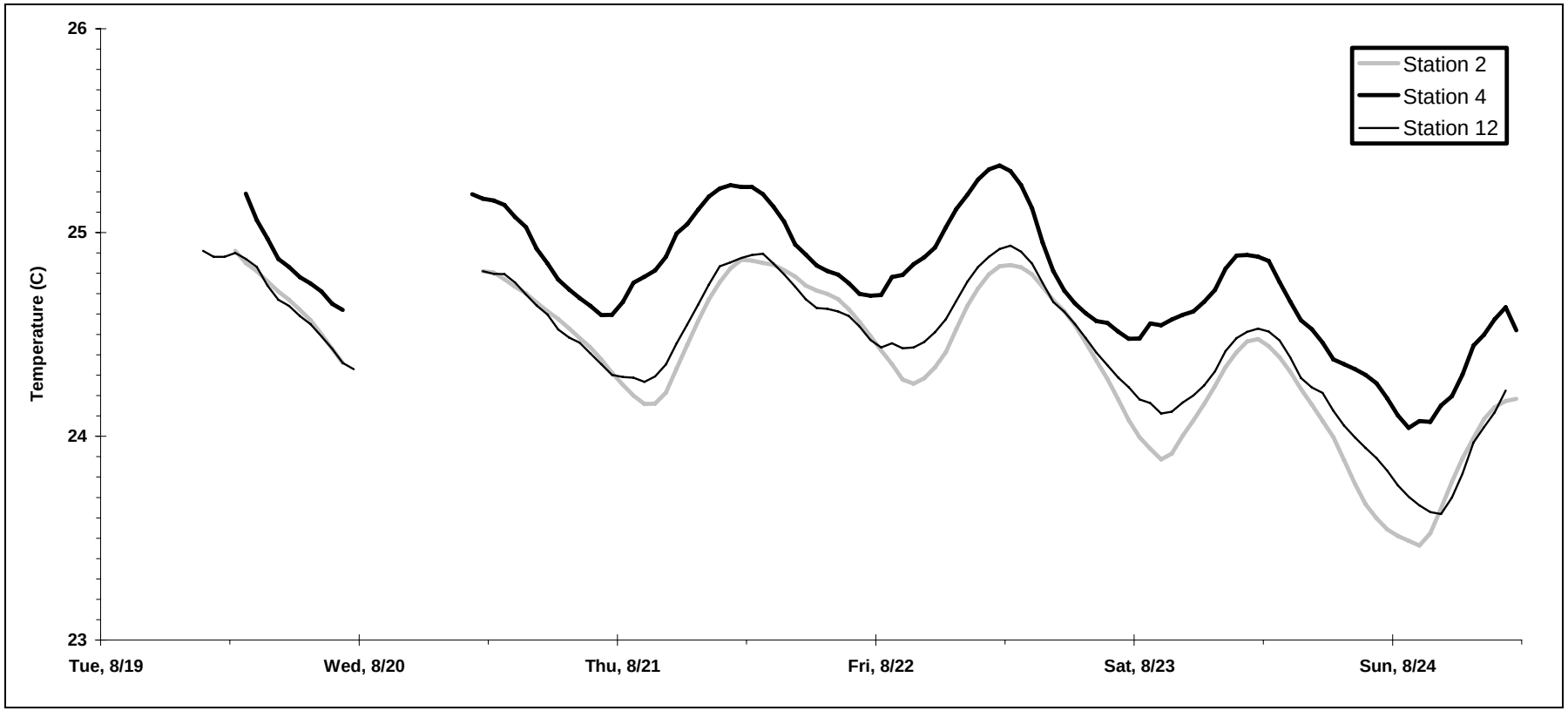
FIGURE 4.3.1-4

HOURLY AVERAGE WATER TEMPERATURES AT THREE MONITORING STATIONS BETWEEN AUGUST 19 AND 24, 2003



Notes: Water temperature fluctuations observed at the three TDG monitoring stations during the August (tourist season) sampling period. The data provide further verification that Station 4 was located in an area dominated by discharge from the RMNPP, as indicated by the similar temperatures at Stations 2 and 12, compared to Station 4

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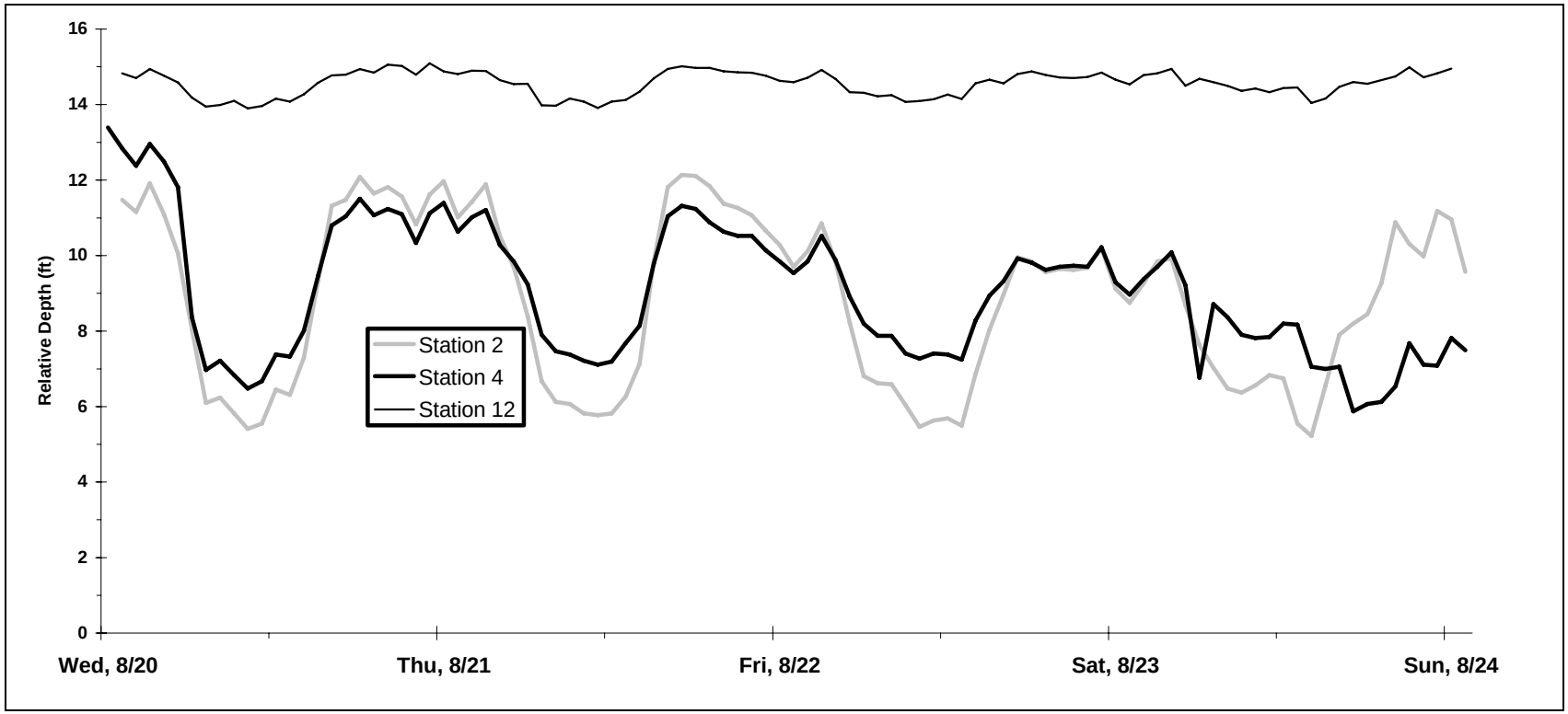
FIGURE 4.3.1-5

CHANGES IN PROBE DEPTH AT THREE MONITORING STATIONS BETWEEN AUGUST 20 AND 24, 2003



Notes: Changes in water depth at the three TDG monitoring stations during the summer (tourist season) sampling period, relative to the water surface. Although similar diel fluctuation patterns occur at all three stations, the minor changes in depth at Station 12 is likely due to the wider river channel at that location compared to the other stations.

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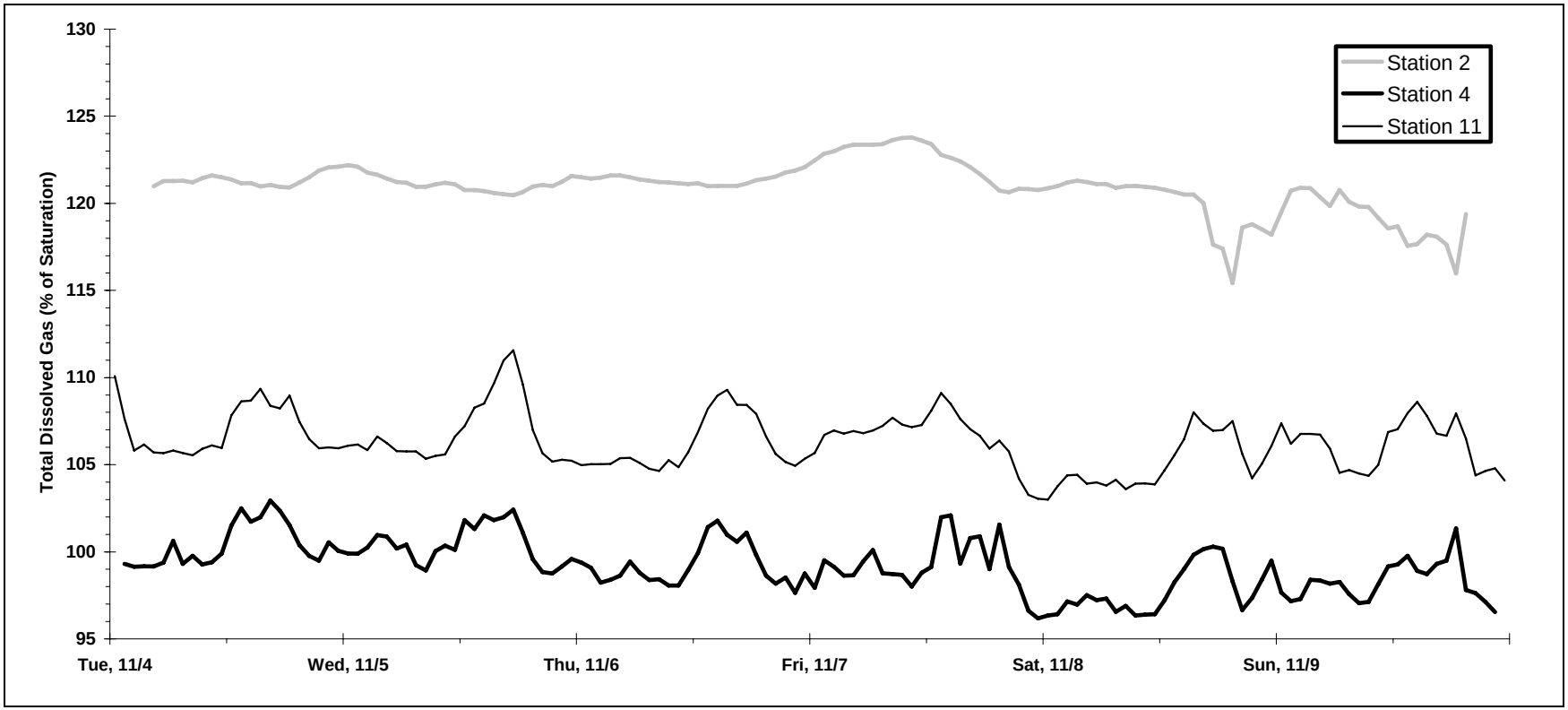
FIGURE 4.3.2-1

HOURLY AVERAGE TOTAL DISSOLVED GAS LEVELS AT THREE STATIONS BETWEEN NOVEMBER 4 AND 10, 2003



Notes: Hourly average TDG levels measured at various locations in the Project area in November (non-tourist season). The data show that the lowest TDG levels occur in the RMNPP discharge plume (Station 4), and the highest levels occur from sources upstream of the Project (Station 2). The TDG levels at Station 11 illustrate the apparent dilution effects of the RMNPP and Sir Adam Beck Plant discharges.

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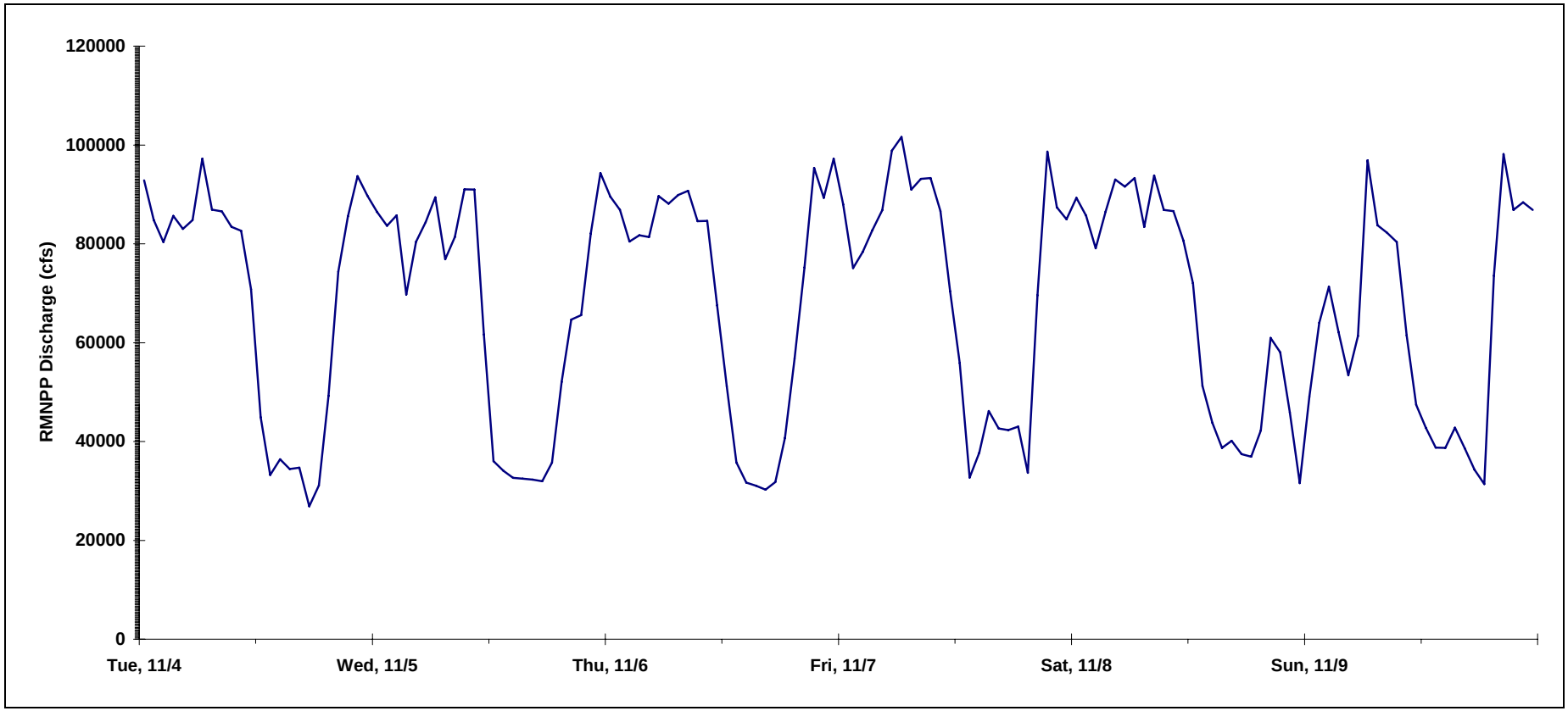
FIGURE 4.3.2-2

RMNPP DISCHARGE DURING THE NON-TOURIST SAMPLING PERIOD, 2003



Notes: Hourly average discharge in thousand cubic feet per second (cfs) from the Robert Moses Niagara Power Plant during the November (non-tourist season) TDG sampling period. The plot shows the relatively uniform discharge pattern during the weekdays compared to the weekend.

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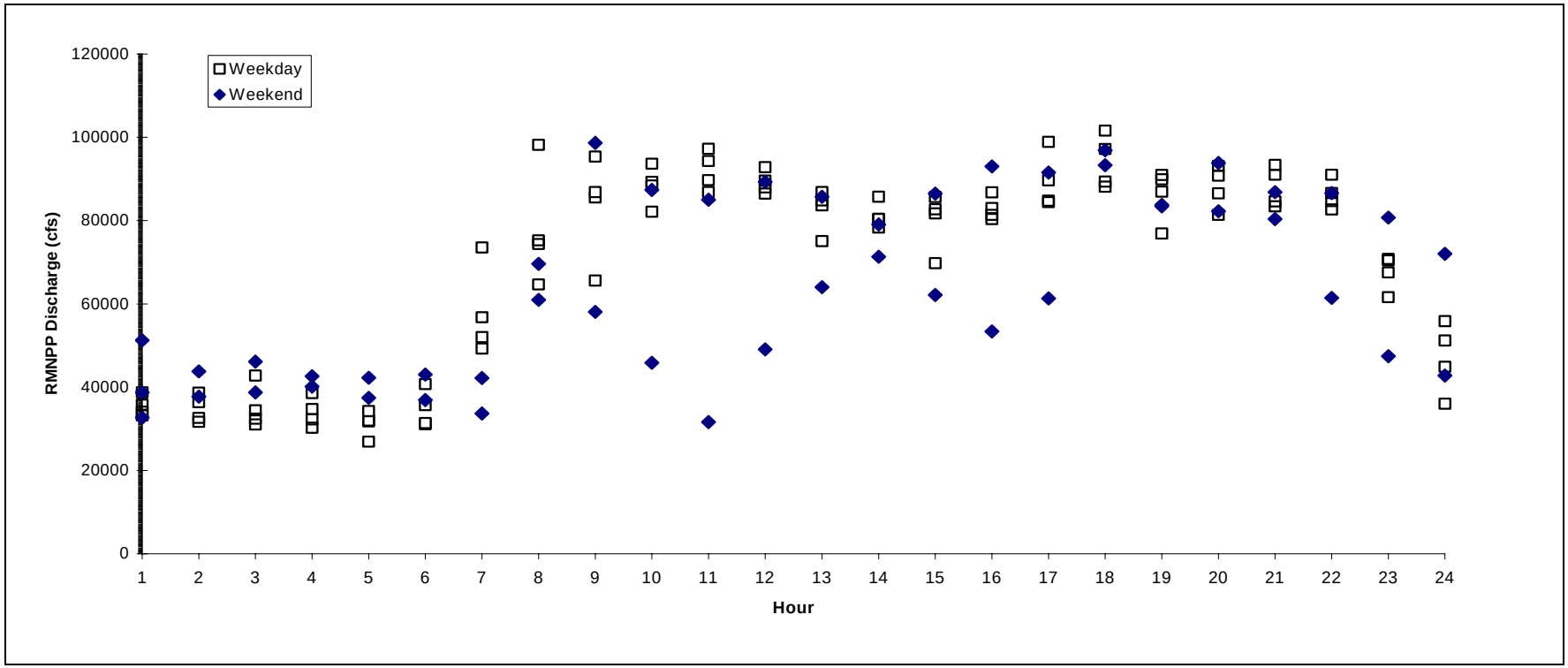
FIGURE 4.3.2-3

WEEKDAY AND WEEKEND HOURLY DISCHARGE FROM THE RMNPP DURING THE NON-TOURIST SAMPLING PERIOD, 2003



Notes: Range of hourly discharge from the RMNPP during the November (non-tourist season) TDG sampling period. The data indicate that discharge is lowest between 0100 and 0700 and highest during the day, although considerable hourly variation occurs, particularly during the day on the weekends than the weekdays. This supports the separation of TDG analyses, to assess the potential effects of project operations, into early morning/early evening and weekday/weekend time periods.

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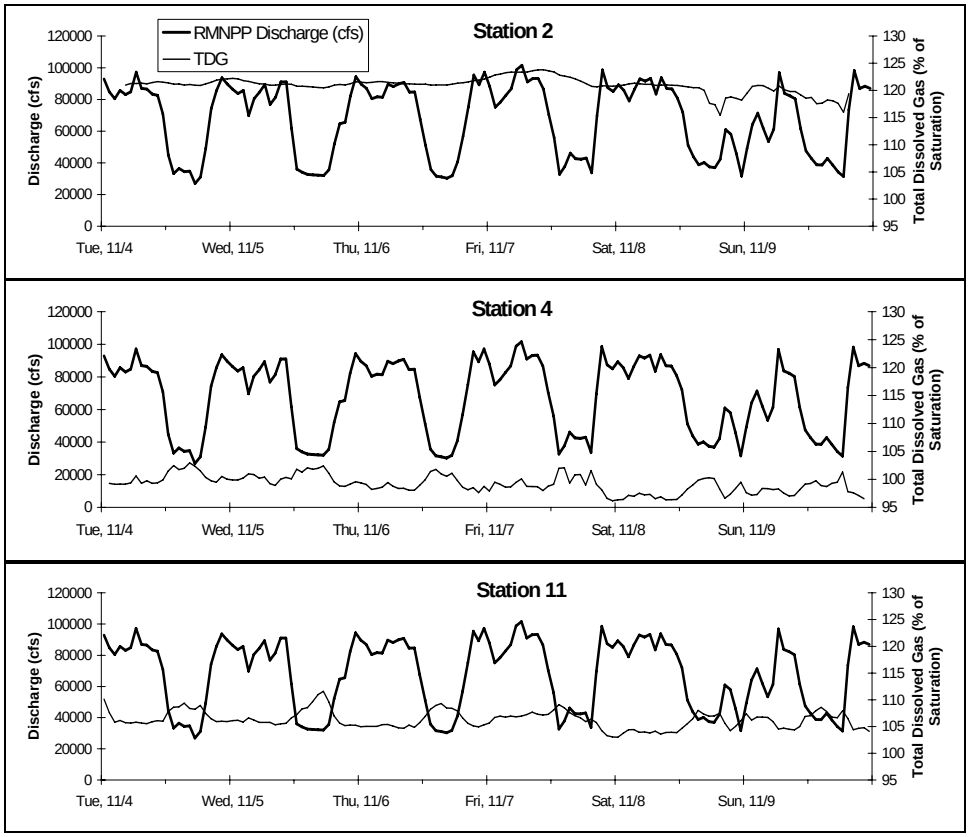
FIGURE 4.3.2-4

HOURLY AVERAGE TOTAL DISSOLVED GAS LEVELS AT THREE MONITORING STATIONS COMPARED TO RMNPP DISCHARGE, NOVEMBER 2003



Notes: TDG levels recorded at three fixed monitoring stations in the lower Niagara River, relative to fluctuations in RMNPP discharge during November. TDG levels at Stations 4 and 11 tend to increase when RMNPP discharge is low, supporting the dilution effects of high discharge levels on downstream TDG levels.

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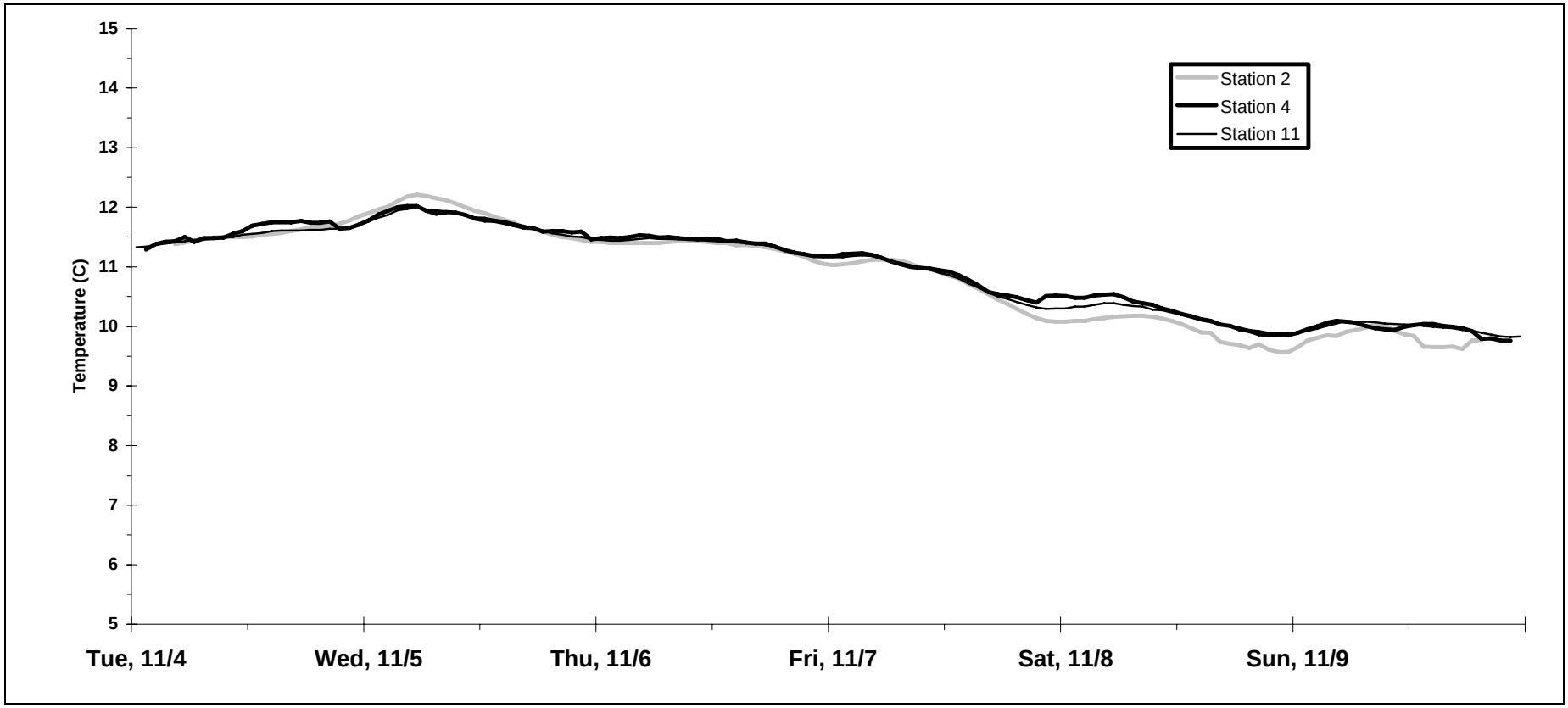
FIGURE 4.3.2-5

HOURLY AVERAGE WATER TEMPERATURES AT THREE MONITORING STATIONS BETWEEN NOVEMBER 4 AND 10, 2003



Notes: Hourly average water temperatures at the three TDG monitoring stations during the November (non-tourist season) sampling period. Compared to the August sampling period, there are limited diel variations or between station differences.

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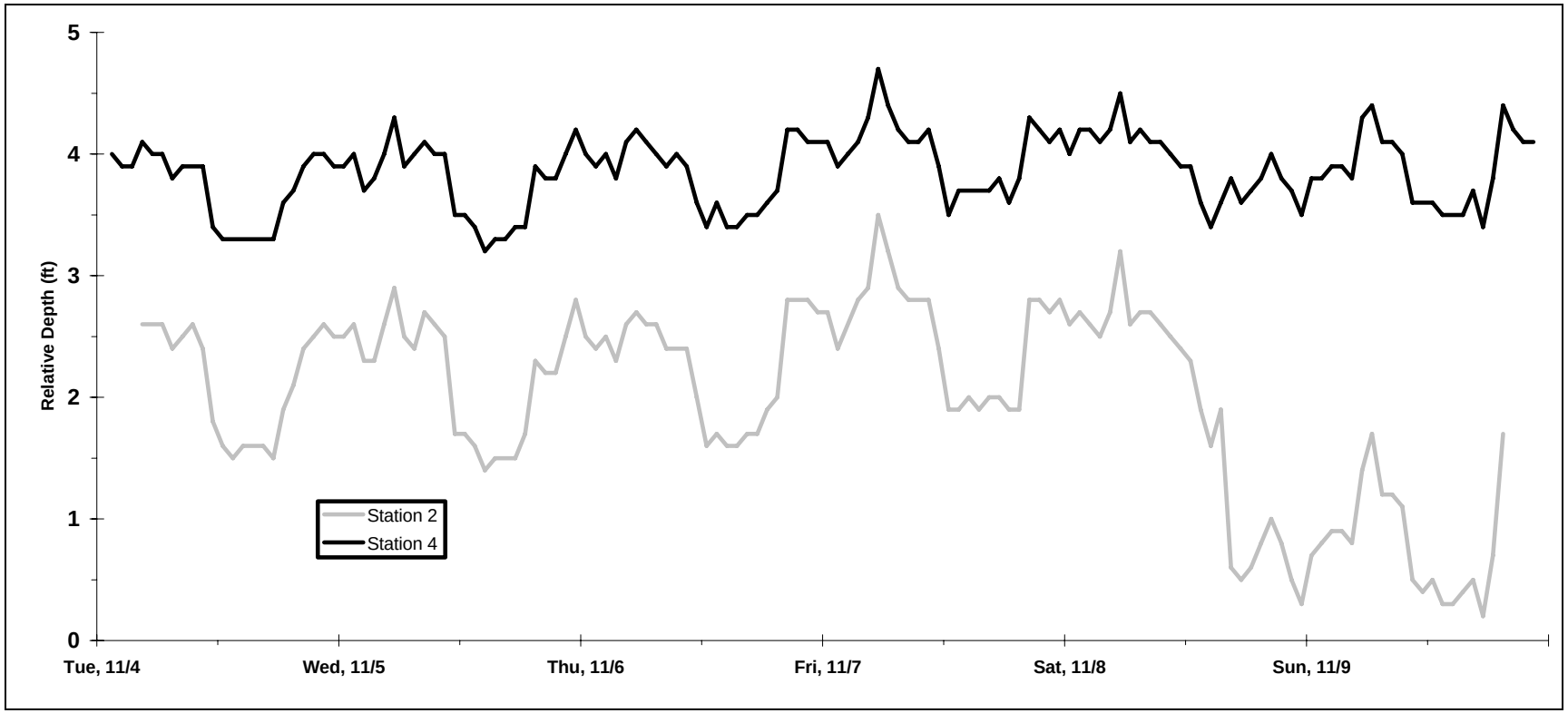
FIGURE 4.3.2-6

CHANGES IN PROBE DEPLOYMENT DEPTH AT TWO MONITORING STATIONS BETWEEN NOVEMBER 4 AND 10, 2003



Notes: Changes in water depth at the three TDG monitoring stations during the fall (non-tourist season) sampling period, relative to the water surface. Similar fluctuations in depth at these two stations occurred throughout the monitoring period. However, the distinct change on November 9, 2003, suggests that the Station 2 probe was moved to a shallower (about 1.5 ft) location. This was noted during the retrieval process, and no apparent differences in the depth measurements of the two probes were observed during the post-retrieval side by side calibration verification.

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5.0 DISCUSSION

Monitoring results showed consistently high levels of TDG (115-129% of saturation) in the Niagara River just upstream of the RMNPP tailrace. The TDG levels in the RMNPP discharge plume were from 97.7% to 103.4% of saturation, while levels downstream from the Project were 105.2% to 113.9%, reflecting the mixing of the sources of water. The significant decrease in TDG saturation levels at all of the monitoring locations downstream of the RMNPP, relative to upstream, demonstrates that Project operations do not produce an increase in TDG saturation levels in the lower Niagara River. Rather, the elevated TDG saturation levels observed in the lower Niagara River are produced primarily by discharge over the Falls. Based on the results of this evaluation it appears that Project operations have a beneficial effect by reducing TDG saturation levels that naturally occur in water discharged at the Falls. The TDG saturation levels upstream of the RMNPP tailrace were consistently greater than 121% of saturation during the August monitoring period (averaging 126.3% of saturation), while TDG saturation levels about a mile or more downstream were consistently below 118% of saturation (averaging 113.6% of saturation). At the same time, TDG levels recorded in the RMNPP discharge plume were consistently below 109% of saturation (averaging 102.9% of saturation). Similar differences between stations were observed in November, although the TDG saturation levels at each continuous monitoring Station were typically at least 3% of saturation lower than in August.

These monitoring results indicate that discharge from the RMNPP reduces TDG saturation levels in the lower Niagara River through the dilution of high TDG concentrations, resulting from discharge at the Falls. The average reduction observed during the tourist season was 12.7% of saturation (8-16% range), and 15.0% of saturation during the non-tourist season (range 9-18%). Similar dilution effects have been observed at some high-head hydroelectric projects in the Columbia River system, that spill water through spillways during high river discharge periods. While spilling water from a great height into a deep plunge pool typically results in an increase in downstream TDG saturation levels, water passing through turbines typically remains at or near the TDG saturation level occurring in the forebay. If there is no mechanism downstream to cause mixing of these two distinct water masses, TDG saturation levels on the spillway side of the river remain elevated for a considerable distance downstream. However, where substantial downstream mixing occurs, reductions in TDG saturation level result from the dilution effect. Significant decreases in TDG were observed between Station 2 (upstream location) and Station 12

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(furthest downstream station). A similar decrease was observed at all of the downstream locations (including various depths), indicating that sufficient mixing occurs downstream of RMNPP to effectively dilute, and significantly reduce downstream TDG saturation levels in the lower Niagara River.

Passing water through turbines does not typically produce increased TDG saturation levels downstream unless air is entrained in the turbine flow. Some hydroelectric projects intentionally inject air into the turbines as a means of reducing cavitation in the unit, and this can result in substantial increases in TDG saturation in the turbine discharge. However, because the RMNPP, LPGP, and the Sir Adam Beck plants do not use air injection to reduce cavitation, increases in TDG saturation levels are not expected. Very low TDG saturation levels were observed in the discharge plumes of both RMNPP and Sir Adam Beck plants during the August and November sampling events, indicating that both facilities contribute to the dilution of naturally occurring high TDG saturation levels in the lower Niagara River. The observations of significantly lower TDG saturation levels at the downstream monitoring sites corroborate this conclusion.

In addition to the significant differences in the TDG measured at the three monitoring stations, peak TDG saturation levels at each Station were similar from day to day, despite obvious differences in RMNPP discharge. Peak daily TDG saturation at the two downstream stations also frequently occurred during periods of the lowest RMNPP discharge, further illustrating the dilution effect of high power plant discharge on lower river TDG saturation levels. However, peak TDG saturation levels upstream of the RMNPP discharge area (Station 2) tended to occur when water depths were high, suggesting the direct influence of discharge over the Falls on the TDG saturation level in the lower Niagara River. This pattern was particularly evident during the summer tourist season when substantial daily fluctuations of discharge occur over the Falls. Substantially lower TDG and water depth fluctuations occurred during the non-tourist season, than during the tourist season, corresponding to the consistent requirements of flow volumes over the Falls and lower water temperatures.

The November water temperatures were similar at all stations, but August water temperatures were consistently slightly higher (0.1-0.7° C ± 0.1° C) at Station 4 than the other stations. Station 4 was intentionally located directly in the RMNPP discharge plume, and the observed water temperatures and

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low TDG saturation levels measured at Station 4 verifies that the probe was located in the RMNPP discharge.

One of the objectives of this investigation was to assess the effects of TDG supersaturation to fish, if TDG levels were significantly higher downstream from the project than upstream. On the contrary, based on the field data collected, TDG levels in the Niagara River are reduced by the RMNPP discharge, and are therefore lower downstream than upstream. Monitoring demonstrated that TDG saturation levels were consistently below the EPA standard of 110% in the RMNPP discharge. As a result, no detrimental biological effects are expected due to TDG levels in the RMNPP discharge plume. Gas bubble disease may occur in fish upstream from the project, due to the naturally occurring high TDG saturation levels, if fish resided in the upper three feet of the river for prolonged periods of time when the TDG levels are in the upper end of the measured range. Exposure of fish in shallow water to TDG at levels in excess of 120% of saturation can produce GBD if the exposure extends over days to weeks. Given the depth of the aquatic habitats in the Niagara Gorge, as well as the rapid currents and steep shorelines there is likely limited opportunity for fish to hold for prolonged periods in shallow water where exposure would be of any biological consequence.

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NIAGARA POWER PROJECT (FERC NO. 2216)
DETERMINE IF PROJECT OPERATION RESULTS IN SUPERSATURATION OF ATMOSPHERIC GASES IN LOWER NIAGARA RIVER

APPENDICES

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NIAGARA POWER PROJECT

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APPENDIX A – TDG LEVELS, LOWER NIAGARA RIVER, MEASURED DURING VARIOUS PERIODS OF DAY, AUGUST 2003

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Table A1. Results of manually monitoring TDG levels at three stations simultaneously in the lower Niagara River, during the morning hours of August 19, 2003.

				Station 2				Station 4				Station 9			
Date	Time	Powerhouse Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp Temp	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/19	6:55		752	3.0	24.4	935	124.3	3.3	24.8	818	108.8	3.1	24.4	865	115.0
8/19	7:00	16080	752	3.6	24.3	944	125.5	3.3	24.9	818	108.8	3.2	24.4	867	115.3
8/19	7:05		752	3.3	24.3	944	125.5	3.3	24.9	818	108.8	3.2	24.4	866	115.2
8/19	7:10		752	3.0	24.3	945	125.7	3.3	24.8	800	106.4	3.1	24.4	863	114.8
8/19	7:15		752	3.0	24.3	947	125.9	3.3	24.9	800	106.4	3.2	24.4	867	115.3
8/19	7:20		752	2.6	24.3	947	125.9	3.3	24.9	803	106.8	3.1	24.4	869	115.6
8/19	7:25		752	2.6	24.3	947	125.9	3.3	24.9	803	106.8	3.1	24.4	870	115.7
8/19	7:30		752	3.0	24.3	947	125.9	3.3	24.9	799	106.3	3.2	24.4	871	115.8
8/19	7:35		752	3.0	24.3	946	125.8	3.3	24.9	792	105.3	3.1	24.3	869	115.6
8/19	7:40		752	2.6	24.3	946	125.8	3.3	24.9	784	104.3	3.1	24.3	866	115.2
8/19	7:45		752	2.6	24.2	946	125.8	3.3	24.9	789	104.9	3.2	24.3	867	115.3
8/19	7:50		752	2.6	24.2	945	125.7	3.3	24.9	773	102.8	3.1	24.3	868	115.4
8/19	7:55		752	3.0	24.2	946	125.8	3.3	24.9	775	103.1	2.9	24.3	866	115.2
8/19	8:00	28760	752	3.0	24.2	942	125.3	3.3	24.9	777	103.3	3.0	24.3	864	114.9
8/19	8:05		752	3.3	24.2	942	125.3	3.3	24.9	780	103.7	2.9	24.3	865	115.0
8/19	8:10		752	3.3	24.2	944	125.5	3.3	24.9	782	104.0	2.9	24.3	868	115.4
8/19	8:15		752	3.3	24.2	945	125.7	3.3	24.9	768	102.1	3.2	24.3	869	115.6
8/19	8:20		752	3.0	24.2	947	125.9	3.3	25.0	763	101.5	2.1	24.3	872	116.0
8/19	8:25		752					3.3	24.9	759	100.9	2.4	24.3	869	115.6
8/19	8:30		752									2.2	24.3	867	115.3

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Table A2. Results of manually monitoring TDG levels at three stations simultaneously in the lower Niagara River, during the early evening hours of August 19, 2003.

				Station 2				Station 4				Station 9			
Date	Time	Powerhouse Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/19	16:10	75740	752												
8/19	16:15		752												
8/19	16:20		752												
8/19	16:25		752												
8/19	16:30		752									5.1	24.9	862	114.6
8/19	16:35		752									5.0	24.9	868	115.4
8/19	16:40		752									4.9	24.9	870	115.7
8/19	16:45		752									5.2	24.9	871	115.8
8/19	16:50		752									4.8	24.9	873	116.1
8/19	16:55		752									5.1	24.9	874	116.2
8/19	17:00	72610	752									4.8	24.9	875	116.4
8/19	17:05		752									5.0	24.9	875	116.4
8/19	17:10		752									5.0	24.9	875	116.4
8/19	17:15		752									5.1	24.9	874	116.2
8/19	17:20		752									4.5	24.9	870	115.7
8/19	17:25		752									5.1	24.9	866	115.2
8/19	17:30		752									4.9	24.9	863	114.8
8/19	17:35		752									5.1	24.9	862	114.6
8/19	17:40		752									5.1	24.9	861	114.5
8/19	17:45		752									4.6	24.9	861	114.5
8/19	17:50		752									5.0	24.9	861	114.5
8/19	17:55		752									4.4	24.9	861	114.5
8/19	18:00	62350	752	3.3	24.9	962	127.9					5.1	24.9	862	114.6
8/19	18:05		752	3.3	24.9	962	127.9					5.1	24.9	863	114.8
8/19	18:10		752	3.3	24.9	961	127.8					3.4	24.9	862	114.6
8/19	18:15		752	3.3	24.9	961	127.8					4.4	24.9	863	114.8
8/19	18:20		752	3.3	24.9	960	127.7					4.7	24.9	863	114.8
8/19	18:25		752									5.1	24.9	863	114.8
8/19	18:30		752					0.7	25.6	762.7	101.5	4.5	24.9	864	114.9
8/19	18:35		752					0.7	25.8	761.7	101.3	4.2	24.9	864	114.9
8/19	18:40		752					0.7	25.8	761.7	101.3	5.2	24.9	865	115.0
8/19	18:45		752					0.7	25.9	762.6	101.5	4.3	24.9	864	114.9

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Table A2 (Con't). **Results of manually monitoring TDG levels at three stations simultaneously in the lower Niagara River, during the early evening hours of August 19, 2003.**

		Powerhouse	Bar.	Station 2				Station 4				Station 9			
Date	Time	Discharge (cfs)	Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/19	18:50		752					0.7	25.9	762.6	101.5	4.2	24.9	864	114.9
8/19	18:55		752					0.7	25.8	762.6	101.5	5.2	24.9	863	114.8
8/19	19:00	58660	752					0.7	25.8	762.5	101.5	4.1	24.9	861	114.6
8/19	19:05		752					0.7	25.8	762.5	101.5	4.0	24.9	861	114.6
8/19	19:10		752					0.7	25.7	762.5	101.5	5.2	24.9	862	114.8
8/19	19:15		752					0.7	25.7	762.5	101.5				
8/19	19:20		752					0.7	25.6	762.5	101.5				
8/19	19:25		752					0.7	25.6	762.5	101.5				
8/19	19:30		752					0.7	25.5	762.5	101.5				
8/19	19:35		752					0.7	25.4	762.5	101.5				
8/19	19:40		752					0.7	25.3	761.5	101.3				

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Table A3. Results of continuous TDG monitoring, at three stations in the lower Niagara River (1950 hr 8/19 to 0650 hr 8/20, 2003.)

		Powerhouse	Bar.	Station 2				Station 4				Station 12			
Date	Time	Discharge (cfs)	Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/19	19:15	58660	750	10.5	24.9		127.3								
8/19	19:20		750	10.5	24.9		127.5								
8/19	19:25		750	10.5	24.9		127.7								
8/19	19:30		750	10.5	24.9		127.5								
8/19	19:35		750	10.8	24.9		127.8								
8/19	19:40		750	10.5	24.9		127.7					6.9	24.9	854	114.0
8/19	19:45		750	10.2	24.9		127.4					7.1	24.9	858	114.5
8/19	19:50		750	10.2	24.9		127.5					7.0	24.9	858	114.5
8/19	19:55		750	9.8	24.9		127.8					6.9	24.9	858	114.5
8/19	20:00	61610	750	10.2	24.9		127.8					7.0	24.9	861	114.9
8/19	20:05		750	9.8	24.9		127.9	17.4	25.2	786.7	104.9	7.0	24.9	864	115.2
8/19	20:10		750	10.5	24.9		127.9	18.0	25.3	776.7	103.6	7.0	24.9	865	115.3
8/19	20:15		750	10.8	24.9		128.1	18.4	25.3	776.8	103.6	7.0	24.9	866	115.4
8/19	20:20		750	10.8	24.9		128.1	17.7	25.3	774.8	103.3	7.2	24.9	868	115.7
8/19	20:25		750	10.8	24.9		127.9	18.4	25.2	772.8	103.1	7.4	24.9	865	115.3
8/19	20:30		750	11.2	24.9		127.8	19.0	25.2	774.8	103.3	7.4	24.9	863	115.0
8/19	20:35		750	11.5	24.9		128.2	18.7	25.2	775.9	103.5	7.4	24.9	864	115.2
8/19	20:40		750	11.5	24.9		127.8	19.0	25.2	769.9	102.7	7.5	24.9	863	115.0
8/19	20:45		750	11.8	24.9		127.8	19.0	25.2	768.9	102.5	7.6	24.9	861	114.8
8/19	20:50		750	12.1	24.9		127.8	19.0	25.2	768.9	102.5	7.6	24.9	859	114.5
8/19	20:55		750	11.2	24.9		127.7	18.0	25.2	769.0	102.5	7.3	24.9	857	114.2
8/19	21:00	74650	750	10.8	24.9		127.7	18.4	25.2	769.0	102.5	7.1	24.9	856	114.1
8/19	21:05		750	11.2	24.9		127.8	18.4	25.2	767.0	102.3	7.1	24.9	857	114.2
8/19	21:10		750	11.2	24.9		128.1	17.7	25.2	767.0	102.3	7.0	24.9	861	114.8
8/19	21:15		750	10.8	24.8		127.8	17.7	25.2	767.1	102.3	7.0	24.9	861	114.8
8/19	21:20		750	10.5	24.8		127.7	17.4	25.2	767.1	102.3	6.6	24.9	859	114.5
8/19	21:25		750	10.2	24.8		127.9	17.7	25.1	767.1	102.3	6.7	24.9	859	114.5
8/19	21:30		750	10.5	24.8		127.9	17.4	25.1	767.1	102.3	6.8	24.9	862	114.9
8/19	21:35		750	10.2	24.8		128.1	17.4	25.1	769.1	102.5	6.9	24.9	863	115.0
8/19	21:40		750	10.2	24.8		127.9	17.7	25.1	771.2	102.8	6.8	24.9	863	115.0
8/19	21:45		750	9.8	24.8		128.1	17.4	25.1	771.2	102.8	6.9	24.9	863	115.0
8/19	21:50		750	9.8	24.8		128.1	17.1	25.1	772.2	102.9	7.0	24.8	864	115.2

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Table A3 (Con't). Results of continuous TDG monitoring, at three stations in the lower Niagara River (1950 hr 8/19 to 0650 hr 8/20, 2003.)

		Powerhouse	Bar.	Station 2				Station 4				Station 12			
Date	Time	Discharge (cfs)	Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/19	21:55		750	9.8	24.8		128.1	17.7	25.1	772.2	102.9	6.9	24.8	865	115.3
8/19	22:00	75060	750	10.2	24.8		128.2	18.0	25.1	773.2	103.1	7.2	24.8	869	115.8
8/19	22:05		750	10.8	24.8		128.3	18.4	25.1	770.2	102.7	7.3	24.8	872	116.2
8/19	22:10		750	11.2	24.8		128.3	18.4	25.1	770.2	102.7	7.2	24.8	874	116.5
8/19	22:15		750	10.5	24.8		128.2	18.0	25.1	774.2	103.2	7.2	24.8	870	116.0
8/19	22:20		750	10.2	24.8		127.7	17.4	25.1	770.2	102.7	7.1	24.8	861	114.8
8/19	22:25		750	9.5	24.8		127.9	17.1	25.0	768.1	102.4	7.0	24.8	860	114.6
8/19	22:30		750	8.9	24.8		127.9	17.1	25.0	767.1	102.3	7.0	24.8	860	114.6
8/19	22:35		750	8.9	24.8		127.9	16.7	25.0	768.1	102.4	6.6	24.8	861	114.8
8/19	22:40		750	8.2	24.8		128.1	16.1	25.0	768.1	102.4	6.3	24.8	864	115.2
8/19	22:45		750	7.5	24.8		128.1	15.7	25.0	771.0	102.8	6.0	24.8	867	115.6
8/19	22:50		750	7.2	24.8		128.1	15.4	25.0	781.0	104.1	6.0	24.8	869	115.8
8/19	22:55		750	6.9	24.8		127.9	15.1	25.0	789.9	105.3	5.7	24.8	870	116.0
8/19	23:00	60050	750	6.2	24.8		127.9	15.1	25.0	787.9	105.0	5.9	24.7	872	116.2
8/19	23:05		750	6.6	24.8		127.8	16.1	25.0	778.9	103.9	6.2	24.7	872	116.2
8/19	23:10		750	7.5	24.8		127.7	16.4	24.9	775.0	103.3	6.5	24.7	872	116.2
8/19	23:15		750	7.5	24.8		127.5	16.4	24.9	783.9	104.5	6.8	24.7	873	116.4
8/19	23:20		750	7.9	24.7		127.7	16.7	24.9	774.0	103.2	7.1	24.7	873	116.4
8/19	23:25		750	8.2	24.7		127.7	16.4	24.9	770.0	102.7	7.0	24.7	864	115.2
8/19	23:30		750	7.5	24.7		127.7	16.1	24.9	771.0	102.8	6.9	24.7	858	114.4
8/19	23:35		750	7.2	24.7		127.7	16.1	24.9	777.0	103.6	7.0	24.7	853	113.7
8/19	23:40		750	7.2	24.7		127.7	16.1	24.9	787.9	105.0	7.0	24.7	849	113.2
8/19	23:45		750	7.2	24.7		127.7	16.1	24.9	779.9	104.0	6.8	24.7	848	113.0
8/19	23:50		750	7.2	24.7		127.7	15.7	24.9	775.0	103.3	6.5	24.7	849	113.2
8/19	23:55		750	6.6	24.7		127.7	15.1	24.9	773.0	103.1	6.1	24.7	851	113.4
8/20	0:00	48100	750	6.2	24.7		127.5	15.1	24.9	774.0	103.2	5.9	24.7	853	113.7
8/20	0:05		750	6.2	24.7		127.5	15.1	24.9	780.9	104.1	5.8	24.7	853	113.7
8/20	0:10		750	6.6	24.7		127.5	15.4	24.9	781.9	104.2	6.2	24.7	853	113.7
8/20	0:15		750	6.9	24.7		127.4	15.4	24.9	773.0	103.1	6.2	24.7	856	114.1
8/20	0:20		750	6.6	24.7		127.4	15.1	24.8	770.0	102.7	6.1	24.7	858	114.4
8/20	0:25		750	6.2	24.7		127.4	15.1	24.9	771.0	102.8	6.2	24.7	857	114.2
8/20	0:30		750	6.2	24.7		127.4	15.1	24.8	782.9	104.4	6.5	24.7	854	113.8
8/20	0:35		750	6.2	24.7		127.4	15.4	24.9	781.9	104.2	6.7	24.7	850	113.3

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Table A3 (Con't). Results of continuous TDG monitoring, at three stations in the lower Niagara River (1950 hr 8/19 to 0650 hr 8/20, 2003.)

		Powerhouse	Bar.	Station 2				Station 4				Station 12			
Date	Time	Discharge (cfs)	Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/20	0:40		750	6.2	24.7		127.4	15.4	24.9	781.9	104.2	6.8	24.7	848	113.0
8/20	0:45		750	6.6	24.7		127.4	15.7	24.9	778.9	103.9	6.8	24.7	848	113.0
8/20	0:50		750	6.6	24.7		127.3	15.7	24.9	782.9	104.4	6.7	24.6	849	113.2
8/20	0:55		750	6.6	24.7		127.4	15.4	24.8	783.9	104.5	6.5	24.6	849	113.2
8/20	1:00	45960	750	6.2	24.7		127.3	15.4	24.8	788.9	105.2	6.5	24.6	851	113.4
8/20	1:05		750	6.6	24.7		127.4	15.4	24.8	792.9	105.7	6.5	24.6	852	113.6
8/20	1:10		750	6.9	24.7		127.4	15.4	24.8	785.9	104.8	6.4	24.6	853	113.7
8/20	1:15		750	6.6	24.7		127.3	15.4	24.8	775.0	103.3	6.3	24.6	854	113.8
8/20	1:20		750	6.2	24.7		127.1	15.4	24.8	776.0	103.5	6.2	24.6	855	114.0
8/20	1:25		750	6.6	24.7		127.1	15.4	24.8	785.9	104.8	6.2	24.6	856	114.1
8/20	1:30		750	6.2	24.7		127.0	15.1	24.8	791.9	105.6	6.3	24.6	855	114.0
8/20	1:35		750	6.2	24.7		127.0	15.1	24.8	794.9	106.0	6.4	24.6	854	113.8
8/20	1:40		750	6.2	24.6		126.9	15.4	24.8	793.9	105.8	6.4	24.6	854	113.8
8/20	1:45		750	6.6	24.6		126.9	15.7	24.8	789.9	105.3	6.4	24.6	852	113.6
8/20	1:50		750	6.9	24.6		126.9	15.4	24.8	792.9	105.7	6.4	24.6	851	113.4
8/20	1:55		750	6.6	24.6		126.7	15.4	24.8	785.9	104.8	6.5	24.6	851	113.4
8/20	2:00	41990	750	6.6	24.6		126.6	15.7	24.8	788.9	105.2	6.6	24.6	850	113.3
8/20	2:05		750	6.9	24.6		126.6	16.1	24.8	779.0	103.9	6.7	24.6	850	113.3
8/20	2:10		750	6.9	24.6		126.5	15.7	24.8	771.0	102.8	6.6	24.6	848	113.0
8/20	2:15		750	6.6	24.6		126.3	15.4	24.8	770.0	102.7	6.6	24.6	847	112.9
8/20	2:20		750	6.2	24.6		126.2	15.4	24.8	770.1	102.7	6.5	24.6	847	112.9
8/20	2:25		750	6.6	24.6		126.2	15.4	24.8	775.1	103.3	6.4	24.6	845	112.6
8/20	2:30		750	6.2	24.6		126.1	15.1	24.8	784.1	104.5	6.2	24.6	844	112.5
8/20	2:35		750	6.2	24.6		125.9	15.1	24.8	790.1	105.3	6.2	24.6	844	112.5
8/20	2:40		750	6.2	24.6		125.8	15.1	24.8	792.1	105.6	6.3	24.6	845	112.6
8/20	2:45		750	6.2	24.6		125.7	15.1	24.8	793.1	105.7	6.2	24.6	846	112.8
8/20	2:50		750	6.2	24.6		125.5	15.1	24.8	794.1	105.8	6.3	24.6	847	112.9
8/20	2:55		750	5.9	24.6		125.4	14.8	24.8	791.1	105.4	6.1	24.6	849	113.2
8/20	3:00	42350	750	5.9	24.6		125.3	14.8	24.8	791.2	105.4	6.2	24.6	850	113.3
8/20	3:05		750	6.2	24.6		125.1	15.1	24.7	792.1	105.6	6.3	24.6	851	113.4
8/20	3:10		750	6.2	24.6		125.1	15.4	24.7	791.1	105.4	6.5	24.5	851	113.4
8/20	3:15		750	6.6	24.6		125.1	15.7	24.7	780.1	104.0	6.7	24.5	855	114.0
8/20	3:20		750	6.9	24.6		125.1	15.7	24.7	785.1	104.6	6.8	24.6	861	114.8

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Table A3 (Con't). Results of continuous TDG monitoring, at three stations in the lower Niagara River (1950 hr 8/19 to 0650 hr 8/20, 2003.)

		Powerhouse	Bar.	Station 2				Station 4				Station 12			
Date	Time	Discharge (cfs)	Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/20	3:25		750	6.9	24.5		125.1	15.7	24.7	790.1	105.3	6.7	24.5	863	115.0
8/20	3:30		750	7.2	24.5		125.1	16.1	24.7	789.0	105.2	6.8	24.5	863	115.0
8/20	3:35		750	7.2	24.5		125.1	16.1	24.7	781.1	104.1	6.7	24.5	861	114.8
8/20	3:40		750	6.9	24.5		125.1	15.7	24.7	776.0	103.5	6.6	24.5	855	114.0
8/20	3:45		750	6.9	24.5		125.3	15.7	24.7	777.0	103.6	6.5	24.5	852	113.6
8/20	3:50		750	6.9	24.5		125.1	15.7	24.7	770.0	102.7	6.5	24.5	849	113.2
8/20	3:55		750	6.9	24.5		125.3	15.4	24.7	772.0	102.9	6.4	24.5	845	112.6
8/20	4:00	39140	750	6.2	24.5		125.1	15.1	24.7	780.9	104.1	6.2	24.5	843	112.4
8/20	4:05		750	5.9	24.5		125.1	15.1	24.7	791.9	105.6	6.1	24.5	843	112.4
8/20	4:10		750	5.9	24.5		125.1	15.1	24.7	793.8	105.8	6.1	24.5	841	112.1
8/20	4:15		750	5.9	24.5		125.0	14.8	24.7	791.8	105.6	6.0	24.5	841	112.1
8/20	4:20		750	5.9	24.5		125.1	15.1	24.7	793.8	105.8	6.2	24.5	843	112.4
8/20	4:25		750	6.2	24.5		125.0	15.4	24.7	792.8	105.7	6.3	24.5	845	112.6
8/20	4:30		750	6.2	24.5		125.0	15.4	24.7	791.8	105.6	6.4	24.5	848	113.0
8/20	4:35		750	6.6	24.5		125.0	15.4	24.7	790.7	105.4	6.4	24.5	850	113.3
8/20	4:40		750	6.6	24.5		125.0	15.4	24.7	791.7	105.6	6.5	24.4	851	113.4
8/20	4:45		750	6.6	24.5		125.0	15.4	24.7	789.7	105.3	6.6	24.4	850	113.3
8/20	4:50		750	6.6	24.4		125.0	15.7	24.7	780.7	104.1	6.9	24.4	850	113.3
8/20	4:55		750	6.9	24.4		125.0	16.1	24.7	776.7	103.6	6.9	24.4	849	113.2
8/20	5:00	35000	750	7.2	24.4		125.0	16.4	24.7	770.7	102.8	7.0	24.4	849	113.2
8/20	5:05		750	7.5	24.4		125.0	16.4	24.6	773.7	103.2	6.9	24.4	848	113.0
8/20	5:10		750	7.5	24.4		125.0	16.1	24.6	771.8	102.9	6.7	24.4	848	113.0
8/20	5:15		750	7.2	24.4		125.1	16.1	24.6	771.8	102.9	6.6	24.4	846	112.8
8/20	5:20		750	7.2	24.4		125.1	15.7	24.6	767.8	102.4	6.4	24.4	843	112.4
8/20	5:25		750	6.9	24.4		125.1	15.7	24.6	771.8	102.9	6.5	24.4	840	112.0
8/20	5:30		750	7.2	24.4		125.1	15.7	24.6	780.8	104.1	6.4	24.4	839	111.8
8/20	5:35		750	6.9	24.4		125.0	15.4	24.6	784.8	104.6	6.1	24.4	838	111.7
8/20	5:40		750	6.2	24.4		125.0	15.1	24.6	782.8	104.4	6.0	24.4	838	111.7
8/20	5:45		750	6.2	24.4		125.0	15.1	24.6	784.9	104.6	6.1	24.4	837	111.6
8/20	5:50		750	6.2	24.4		125.0	15.1	24.6	782.9	104.4	6.1	24.4	836	111.4
8/20	5:55		750	6.2	24.4		125.0	15.1	24.6	787.9	105.0	6.1	24.4	838	111.7
8/20	6:00	40720	750	5.9	24.4		124.9	15.1	24.6	789.9	105.3	6.3	24.4	842	112.2
8/20	6:05		750	6.2	24.4		124.9	15.1	24.6	776.0	103.5	6.3	24.4	843	112.4

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Table A3 (Con't). Results of continuous TDG monitoring, at three stations in the lower Niagara River (1950 hr 8/19 to 0650 hr 8/20, 2003.)

		Powerhouse	Bar.	Station 2				Station 4				Station 12			
Date	Time	Discharge (cfs)	Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/20	6:10		750	6.2	24.3		124.9	15.1	24.6	769.0	102.5	6.4	24.4	845	112.6
8/20	6:15		750	6.2	24.3		124.9	15.4	24.6	768.0	102.4	6.4	24.4	847	112.9
8/20	6:20		750	6.6	24.3		124.9	15.4	24.6	778.0	103.7	6.6	24.4	848	113.0
8/20	6:25		750	6.6	24.3		124.9	15.4	24.6	783.9	104.5	6.7	24.4	849	113.2
8/20	6:30		750	6.6	24.3		124.9	15.7	24.6	785.9	104.8	Probe Retrieved			
8/20	6:35		750	6.9	24.3		124.9	Probe Retrieved							
8/20	6:40		750	7.2	24.3		125.0								
8/20	6:45		750	7.2	24.3		125.0								
8/20	6:50	40720	750	Probe Retrieved											

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Table A4. Results of manually monitoring TDG levels at three stations simultaneously in the lower Niagara River, during the morning hours of August 20, 2003.

				Station 2				Station 4				Station 12			
Date	Time	Powerhouse Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/20	6:45		750									3.4	24.3	848	113.0
8/20	6:50		750									2.2	24.3	850	113.3
8/20	6:55		750									3.4	24.3	848	113.0
8/20	7:00	42860	750									3.5	24.3	847	112.9
8/20	7:05		750	3.0	24.3		125.0					1.6	24.3	841	112.1
8/20	7:10		750	3.3	24.3		125.3					1.5	24.3	840	112.0
8/20	7:15		750	2.6	24.3		125.4	0.7	24.6	773.1	103.1	3.4	24.3	842	112.2
8/20	7:20		750	2.6	24.3		125.7	0.7	24.6	770.1	102.7	1.6	24.3	838	111.7
8/20	7:25		750	3.3	24.3		125.8	1.0	24.6	769.1	102.5	1.7	24.3	834	111.2
8/20	7:30		750	3.3	24.3		125.8	1.0	24.7	772.2	102.9				
8/20	7:35		750	3.6	24.3		125.8	1.0	24.7	772.2	102.9				
8/20	7:40		750	2.6	24.3		125.9	1.3	24.7	774.2	103.2				
8/20	7:45		750	0.3	24.2		125.9	1.0	24.7	770.2	102.7				
8/20	7:50		750	0.0				1.0	24.7	769.3	102.5				
8/20	7:55		750	0.3	24.2		125.5	0.7	24.7	772.3	102.9				
8/20	8:00	62060	750	3.3	24.2		126.1	1.0	24.7	771.3	102.8				
8/20	8:05		750												
8/20	8:10		750												
8/20	8:15		750												

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Table A5. Results of manually monitoring TDG levels at three stations simultaneously in the lower Niagara River, during the early evening hours of August 20, 2003.

				Station 2				Station 4				Station 12			
Date	Time	Powerhouse Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	TGP (mmHg)	%TDG
8/20	16:35		749									2.8	24.7	841	112.4
8/20	16:40		749									4.1	24.8	845	112.9
8/20	16:45		749									1.1	24.8	841	112.4
8/20	17:00	89260	749												
8/20	17:05		749					13.4	25.2	778.4	104.0				
8/20	17:10		748					13.4	25.2	775.4	103.6				
8/20	17:15		748					13.4	25.2	773.4	103.3				
8/20	17:20		748					13.8	25.2	772.3	103.2				
8/20	17:25		748					13.4	25.2	771.3	103.1				
8/20	17:30		748					13.8	25.2	771.3	103.1				
8/20	17:35		748					13.4	25.2	771.3	103.1				
8/20	17:40		748					13.4	25.2	770.3	102.9				
8/20	17:45		748					13.1	25.2	770.2	102.9				
8/20	17:50		748					13.1	25.2	770.2	102.9				
8/20	17:55		748					13.1	25.2	769.2	102.8				
8/20	18:00	86020	748					13.1	25.2	770.2	102.9				
8/20	18:05		748					13.1	25.2	769.2	102.8				
8/20	18:10		748					12.8	25.2	769.2	102.8				
8/20	18:15		748					12.8	25.2	770.2	102.9				
8/20	18:20		748					13.1	25.2	770.2	102.9				
8/20	18:25		748					13.1	25.2	770.2	102.9				
8/20	18:30		748	11.5	24.8		126.5	12.8	25.2	768.2	102.7				
8/20	18:35		748	11.5	24.8		127.0	12.8	25.2	768.2	102.7				
8/20	18:40		748	11.5	24.8		127.0	12.8	25.2	768.2	102.7				
8/20	18:45		748	11.5	24.8		127.1	12.8	25.2	768.2	102.7				
8/20	18:50		748	11.5	24.8		127.3	12.8	25.2	768.2	102.7				
8/20	18:55		748	11.5	24.8		127.1	12.8	25.2	769.2	102.8				
8/20	19:00		748	11.5	24.8		127.3	12.5	25.2	769.2	102.8				

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APPENDIX B – HOURLY AVERAGE TDG LEVELS, LOWER NIAGARA RIVER, AUGUST AND NOVEMBER 2003

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
8/20	18:00	86020	748					13.4	25.2	774	103.4				
8/20	19:00	82420	748	11.5	24.8	957	127.9	12.8	25.2	774	103.4	14.8	24.8	846	113.1
8/20	20:00	79420	748	11.2	24.8	958	128.0	12.4	25.2	774	103.4	14.7	24.8	852	113.9
8/20	21:00	90000	748	11.9	24.8	958	128.0	13.0	25.1	773	103.3	14.9	24.8	849	113.5
8/20	22:00	77570	748	11.1	24.7	957	127.9	12.5	25.1	772	103.2	14.8	24.8	852	113.9
8/20	23:00	70030	748	10.1	24.7	960	128.3	11.8	25.0	768	102.6	14.6	24.7	847	113.2
8/21	0:00	60670	748	8.0	24.7	958	128.0	8.4	24.9	769	102.8	14.2	24.6	838	112.0
8/21	1:00	43200	748	6.1	24.6	954	127.5	7.0	24.8	769	102.8	13.9	24.6	862	115.2
8/21	2:00	39400	748	6.2	24.6	948	126.7	7.2	24.8	775	103.6	14.0	24.5	848	113.3
8/21	3:00	37300	747	5.8	24.5	940	125.8	6.8	24.7	781	104.5	14.1	24.5	862	115.4
8/21	4:00	34990	747	5.4	24.5	933	124.9	6.5	24.7	791	105.9	13.9	24.5	873	116.9
8/21	5:00	30560	747	5.5	24.4	932	124.8	6.7	24.6	781	104.5	14.0	24.4	867	116.1
8/21	6:00	40840	747	6.5	24.4	933	124.9	7.4	24.6	796	106.6	14.2	24.4	839	112.3
8/21	7:00	41210	747	6.3	24.3	934	125.0	7.3	24.6	780	104.4	14.1	24.3	843	112.8
8/21	8:00	58800	746	7.3	24.3	937	125.6	8.0	24.7	772	103.5	14.3	24.3	841	112.7
8/21	9:00	68690	746	9.3	24.2	942	126.2	9.5	24.8	762	102.1	14.6	24.3	830	111.2
8/21	10:00	78400	746	11.3	24.2	939	125.8	10.8	24.8	757	101.4	14.8	24.3	836	112.0
8/21	11:00	81580	745	11.5	24.2	948	127.2	11.0	24.8	755	101.3	14.8	24.3	836	112.1
8/21	12:00	91810	745	12.1	24.2	955	128.1	11.5	24.9	754	101.1	14.9	24.4	844	113.2
8/21	13:00	92370	744	11.6	24.3	956	128.4	11.1	25.0	756	101.5	14.9	24.5	845	113.5
8/21	14:00	93530	744	11.8	24.4	956	128.4	11.2	25.0	769	103.3	15.1	24.5	847	113.8
8/21	15:00	93370	743	11.6	24.6	956	128.6	11.1	25.1	774	104.1	15.0	24.6	851	114.5
8/21	16:00	88980	743	10.8	24.7	957	128.7	10.3	25.2	777	104.5	14.8	24.7	851	114.5
8/21	17:00	91820	743	11.6	24.8	955	128.5	11.1	25.2	776	104.4	15.1	24.8	848	114.1
8/21	18:00	90330	742	12.0	24.8	952	128.3	11.4	25.2	777	104.7	14.9	24.9	849	114.4
8/21	19:00	82420	741	11.0	24.9	950	128.2	10.6	25.2	778	105.0	14.8	24.9	847	114.3
8/21	20:00	89100	742	11.4	24.9	949	127.9	11.0	25.2	771	103.9	14.9	24.9	846	114.0
8/21	21:00	98780	742	11.9	24.9	949	127.9	11.2	25.2	771	103.9	14.9	24.9	849	114.4
8/21	22:00	76080	742	10.5	24.8	950	128.0	10.3	25.1	775	104.5	14.6	24.8	851	114.7
8/21	23:00	69600	742	9.7	24.8	952	128.3	9.8	25.1	776	104.6	14.5	24.8	848	114.3
8/22	0:00	63240	742	8.4	24.8	950	128.0	9.2	24.9	777	104.7	14.6	24.7	836	112.7
8/22	1:00	44770	742	6.7	24.7	945	127.4	7.9	24.9	776	104.6	14.0	24.7	839	113.1

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
8/22	2:00	40150	741	6.1	24.7	943	127.2	7.5	24.8	778	105.0	14.0	24.6	840	113.3
8/22	3:00	42780	742	6.1	24.7	936	126.2	7.4	24.8	789	106.4	14.2	24.6	845	113.9
8/22	4:00	40990	742	5.8	24.7	932	125.7	7.2	24.8	788	106.2	14.1	24.6	840	113.3
8/22	5:00	41260	743	5.8	24.6	931	125.4	7.1	24.8	798	107.4	13.9	24.6	842	113.4
8/22	6:00	40330	743	5.8	24.6	930	125.2	7.2	24.7	778	104.8	14.1	24.5	843	113.5
8/22	7:00	38970	743	6.3	24.5	930	125.2	7.7	24.7	774	104.2	14.1	24.5	838	112.8
8/22	8:00	53940	744	7.1	24.4	934	125.5	8.1	24.7	777	104.4	14.3	24.4	841	113.0
8/22	9:00	78240	744	9.8	24.4	936	125.8	9.8	24.8	779	104.7	14.7	24.5	833	112.0
8/22	10:00	93250	744	11.8	24.3	938	126.1	11.0	24.8	757	101.8	14.9	24.4	840	112.9
8/22	11:00	94750	744	12.1	24.3	949	127.6	11.3	24.8	756	101.6	15.0	24.4	843	113.3
8/22	12:00	94640	744	12.1	24.3	957	128.6	11.2	24.9	764	102.7	15.0	24.5	850	114.3
8/22	13:00	93450	744	11.8	24.3	959	128.9	10.9	24.9	769	103.4	15.0	24.5	855	114.9
8/22	14:00	85640	744	11.4	24.4	959	128.9	10.6	25.0	768	103.2	14.9	24.6	856	115.1
8/22	15:00	86530	744	11.3	24.5	961	129.2	10.5	25.1	766	103.0	14.9	24.7	860	115.6
8/22	16:00	82980	744	11.1	24.6	961	129.2	10.5	25.2	764	102.7	14.8	24.8	861	115.7
8/22	17:00	73670	744	10.7	24.7	961	129.2	10.1	25.3	765	102.8	14.8	24.8	864	116.1
8/22	18:00	68080	744	10.3	24.8	961	129.2	9.8	25.3	773	103.9	14.6	24.9	868	116.7
8/22	19:00	64010	744	9.7	24.8	961	129.2	9.5	25.3	783	105.2	14.6	24.9	873	117.3
8/22	20:00	70580	745	10.1	24.8	957	128.5	9.8	25.3	778	104.4	14.7	24.9	870	116.8
8/22	21:00	69360	745	10.9	24.8	957	128.5	10.5	25.2	775	104.0	14.9	24.9	858	115.2
8/22	22:00	57090	745	9.8	24.8	960	128.9	9.9	25.1	768	103.1	14.7	24.8	875	117.5
8/22	23:00	43690	745	8.2	24.7	959	128.7	8.9	25.0	771	103.5	14.3	24.8	873	117.2
8/23	0:00	36280	745	6.8	24.7	955	128.2	8.2	24.8	766	102.8	14.3	24.7	859	115.3
8/23	1:00	46160	745	6.6	24.6	953	127.9	7.9	24.7	775	104.0	14.2	24.6	846	113.6
8/23	2:00	47400	745	6.6	24.5	947	127.1	7.9	24.7	773	103.8	14.2	24.6	842	113.0
8/23	3:00	36980	746	6.0	24.5	937	125.6	7.4	24.6	781	104.7	14.1	24.5	839	112.5
8/23	4:00	28210	746	5.5	24.4	928	124.4	7.3	24.6	762	102.2	14.1	24.4	845	113.3
8/23	5:00	26010	747	5.6	24.3	922	123.5	7.4	24.6	767	102.7	14.1	24.3	840	112.5
8/23	6:00	29490	748	5.7	24.2	917	122.7	7.4	24.5	790	105.7	14.3	24.3	847	113.3
8/23	7:00	30130	748	5.5	24.1	914	122.3	7.2	24.5	782	104.6	14.1	24.2	845	113.0
8/23	8:00	41920	749	6.9	24.0	920	122.9	8.3	24.5	768	102.6	14.6	24.2	824	110.0
8/23	9:00	46840	749	8.0	23.9	928	123.9	8.9	24.6	772	103.1	14.7	24.2	826	110.3

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
8/23	10:00	46920	749	9.0	23.9	939	125.4	9.3	24.5	749	100.0	14.6	24.1	846	113.0
8/23	11:00	57750	749	9.9	23.9	954	127.4	9.9	24.6	759	101.4	14.8	24.1	853	113.9
8/23	12:00	57940	749	9.8	24.0	963	128.6	9.8	24.6	758	101.2	14.9	24.2	861	115.0
8/23	13:00	53700	749	9.6	24.1	967	129.1	9.6	24.6	757	101.1	14.8	24.2	873	116.6
8/23	14:00	53040	749	9.6	24.2	967	129.1	9.7	24.7	764	102.0	14.7	24.3	867	115.8
8/23	15:00	53610	748	9.6	24.2	966	129.1	9.7	24.7	768	102.6	14.7	24.3	872	116.5
8/23	16:00	56260	748	9.7	24.3	966	129.1	9.7	24.8	766	102.4	14.7	24.4	876	117.1
8/23	17:00	58430	748	10.2	24.4	964	128.8	10.2	24.9	774	103.4	14.8	24.5	869	116.1
8/23	18:00	47500	748	9.1	24.5	965	129.0	9.3	24.9	782	104.5	14.7	24.5	875	116.9
8/23	19:00	46510	749	8.7	24.5	964	128.7	9.0	24.9	785	104.8	14.5	24.5	884	118.1
8/23	20:00	51150	749	9.3	24.4	964	128.7	9.4	24.9	789	105.4	14.8	24.5	883	117.9
8/23	21:00	56520	749	9.8	24.4	962	128.5	9.7	24.8	780	104.2	14.8	24.5	867	115.8
8/23	22:00	50970	750	9.9	24.3	964	128.6	10.1	24.7	772	103.0	14.9	24.4	876	116.9
8/23	23:00	44930	750	8.7	24.2	964	128.6	9.2	24.6	780	104.1	14.5	24.3	870	116.1
8/24	0:00	45050	750	7.6	24.2	961	128.2	6.8	24.5	779	103.9	14.7	24.2	847	113.0
8/24	1:00	37450	750	7.0	24.1	958	127.8	8.7	24.5	779	103.9	14.6	24.2	845	112.7
8/24	2:00	31870	750	6.5	24.0	950	126.7	8.4	24.4	764	101.9	14.5	24.1	842	112.3
8/24	3:00	32590	750	6.4	23.9	942	125.7	7.9	24.4	781	104.2	14.4	24.1	848	113.1
8/24	4:00	38570	750	6.6	23.8	937	125.0	7.8	24.3	775	103.4	14.4	24.0	847	113.0
8/24	5:00	44700	750	6.8	23.7	936	124.9	7.8	24.3	787	105.0	14.3	23.9	838	111.8
8/24	6:00	39770	751	6.8	23.6	934	124.4	8.2	24.3	759	101.1	14.4	23.9	833	111.0
8/24	7:00	27680	751	5.5	23.5	928	123.6	8.2	24.2	780	103.9	14.5	23.8	840	111.9
8/24	8:00	26160	751	5.2	23.5	923	123.0	7.1	24.1	759	101.1	14.0	23.8	863	115.0
8/24	9:00	26580	751	6.6	23.5	927	123.5	7.0	24.0	790	105.3	14.2	23.7	841	112.0
8/24	10:00	28380	750	7.9	23.5	941	125.5	7.1	24.1	783	104.4	14.5	23.7	867	115.6
8/24	11:00	31600	750	8.2	23.5	957	127.6	5.9	24.1	779	103.9	14.6	23.6	869	115.9
8/24	12:00	35040	749	8.4	23.6	965	128.8	6.1	24.2	774	103.3	14.5	23.6	875	116.8
8/24	13:00	52900	749	9.3	23.8	969	129.4	6.1	24.2	786	104.9	14.7	23.7	872	116.4
8/24	14:00	73550	748	10.9	23.9	965	129.0	6.5	24.3	773	103.3	14.7	23.8	858	114.7
8/24	15:00	64570	748	10.3	24.0	965	129.0	7.7	24.4	760	101.6	15.0	24.0	865	115.6
8/24	16:00	58200	747	10.0	24.1	964	129.0	7.1	24.5	760	101.7	14.7	24.0	866	115.9
8/24	17:00	81530	747	11.2	24.1	960	128.5	7.1	24.6	765	102.4	14.8	24.1	857	114.7

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
8/24	18:00	78210	747	11.0	24.2	961	128.6	7.8	24.6	766	102.5	15.0	24.2	857	114.7
8/24	19:00	57070	747	9.6	24.2	961	128.6	7.5	24.5	761	101.9				
					Min		122.3		Min		100.0		Min		110.0
					Max		129.4		Max		107.4		Max		118.1
					Mean		127.2		Mean		103.5		Mean		114.2
					Median		128.0		Median		103.5		Median		114.0

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
11/4	12:00	92850	751									3.6	11.3	827	110.1
11/4	13:00	84830	750					4	11.3	745	99.3	3.6	11.3	808	107.6
11/4	14:00	80380	750					3.9	11.4	743	99.1	3.6	11.4	793	105.8
11/4	15:00	85670	749					3.9	11.4	743	99.2	3.6	11.4	795	106.2
11/4	16:00	83020	749	2.6	11.4	906	121.0	4.1	11.4	743	99.2	3.6	11.4	792	105.7
11/4	17:00	84810	749	2.6	11.4	908	121.3	4	11.5	744	99.4	3.6	11.4	791	105.7
11/4	18:00	97210	749	2.6	11.4	908	121.3	4	11.4	753	100.6	3.6	11.5	792	105.8
11/4	19:00	86940	748	2.4	11.5	908	121.3	3.8	11.5	743	99.3	3.6	11.5	791	105.7
11/4	20:00	86560	748	2.5	11.5	907	121.2	3.9	11.5	746	99.8	3.6	11.5	789	105.5
11/4	21:00	83420	747	2.6	11.5	908	121.5	3.9	11.5	742	99.3	3.6	11.5	792	105.9
11/4	22:00	82660	747	2.4	11.5	909	121.6	3.9	11.6	743	99.4	3.6	11.5	793	106.1
11/4	23:00	70810	747	1.8	11.5	908	121.5	3.4	11.6	746	99.9	3.6	11.5	792	106.0
11/4	0:00	44890	747	1.6	11.5	906	121.4	3.3	11.7	758	101.5	3.6	11.6	805	107.8
11/5	1:00	33220	747	1.5	11.5	905	121.2	3.3	11.7	765	102.5	3.6	11.6	811	108.6
11/5	2:00	36420	747	1.6	11.6	905	121.2	3.3	11.8	760	101.7	3.6	11.6	811	108.7
11/5	3:00	34440	747	1.6	11.6	903	121.0	3.3	11.8	761	102.0	3.6	11.6	816	109.4
11/5	4:00	34720	746	1.6	11.6	904	121.1	3.3	11.8	768	102.9	3.6	11.6	809	108.4
11/5	5:00	26920	747	1.5	11.6	903	120.9	3.3	11.8	764	102.4	3.6	11.6	808	108.2
11/5	6:00	31110	747	1.9	11.7	903	120.9	3.6	11.7	758	101.5	3.6	11.6	814	109.0
11/5	7:00	49270	747	2.1	11.7	905	121.2	3.7	11.7	750	100.4	3.6	11.6	802	107.5
11/5	8:00	74350	747	2.4	11.7	908	121.5	3.9	11.8	745	99.8	3.6	11.6	796	106.5
11/5	9:00	85550	747	2.5	11.7	910	121.9	4	11.6	743	99.5	3.6	11.6	792	106.0
11/5	10:00	93670	747	2.6	11.8	912	122.1	4	11.7	751	100.5	3.6	11.7	792	106.0
11/5	11:00	89720	747	2.5	11.9	912	122.1	3.9	11.7	747	100.1	3.6	11.7	791	105.9
11/5	12:00	86460	747	2.5	11.9	912	122.2	3.9	11.8	746	99.9	3.6	11.8	792	106.1
11/5	13:00	83670	747	2.6	12.0	912	122.1	4	11.9	746	99.9	3.6	11.8	793	106.2
11/5	14:00	85740	747	2.3	12.0	910	121.8	3.7	11.9	749	100.2	3.6	11.9	791	105.8
11/5	15:00	69770	748	2.3	12.1	910	121.6	3.8	12.0	755	101.0	3.6	12.0	798	106.6
11/5	16:00	80400	749	2.6	12.2	910	121.4	4	12.0	756	100.9	3.6	12.0	796	106.2
11/5	17:00	84400	750	2.9	12.2	909	121.2	4.3	12.0	752	100.2	3.6	12.0	793	105.8
11/5	18:00	89390	751	2.5	12.2	910	121.2	3.9	11.9	754	100.4	3.6	12.0	794	105.8
11/5	19:00	76880	752	2.4	12.2	910	121.0	4	11.9	746	99.2	3.6	12.0	795	105.8

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
11/5	20:00	81350	753	2.7	12.1	911	121.0	4.1	11.9	745	98.9	3.6	11.9	793	105.4
11/5	21:00	91020	754	2.6	12.1	912	121.1	4	11.9	754	100.0	3.6	11.9	795	105.5
11/5	22:00	91000	754	2.5	12.0	914	121.2	4	11.9	757	100.4	3.6	11.9	796	105.6
11/5	23:00	61640	754	1.7	11.9	913	121.1	3.5	11.8	755	100.1	3.6	11.8	804	106.6
11/5	0:00	36050	754	1.7	11.9	911	120.8	3.5	11.8	768	101.8	3.6	11.8	809	107.2
11/6	1:00	34100	754	1.6	11.8	911	120.8	3.4	11.8	764	101.3	3.6	11.8	817	108.3
11/6	2:00	32650	755	1.4	11.8	911	120.7	3.2	11.7	770	102.1	3.6	11.8	819	108.5
11/6	3:00	32480	755	1.5	11.7	910	120.6	3.3	11.7	769	101.8	3.6	11.7	828	109.7
11/6	4:00	32270	755	1.5	11.7	910	120.5	3.3	11.7	770	102.0	3.6	11.7	838	111.0
11/6	5:00	31970	755	1.5	11.6	909	120.5	3.4	11.7	773	102.4	3.6	11.7	842	111.6
11/6	6:00	35700	755	1.7	11.6	911	120.7	3.4	11.6	763	101.1	3.6	11.6	827	109.6
11/6	7:00	52050	754	2.3	11.5	912	121.0	3.9	11.6	751	99.6	3.6	11.6	807	107.0
11/6	8:00	64690	755	2.2	11.5	914	121.1	3.8	11.6	746	98.8	3.6	11.5	798	105.7
11/6	9:00	65600	756	2.2	11.5	914	121.0	3.8	11.6	746	98.8	3.6	11.5	795	105.2
11/6	10:00	82130	755	2.5	11.5	916	121.2	4	11.6	749	99.2	3.6	11.5	795	105.3
11/6	11:00	94320	755	2.8	11.4	917	121.6	4.2	11.5	752	99.6	3.6	11.5	794	105.2
11/6	12:00	89590	755	2.5	11.4	917	121.5	4	11.5	750	99.4	3.6	11.5	792	105.0
11/6	13:00	86860	754	2.4	11.4	916	121.4	3.9	11.5	747	99.1	3.6	11.4	792	105.0
11/6	14:00	80460	754	2.5	11.4	916	121.5	4	11.5	741	98.2	3.6	11.4	792	105.0
11/6	15:00	81720	754	2.3	11.4	916	121.6	3.8	11.5	742	98.4	3.6	11.5	792	105.1
11/6	16:00	81360	754	2.6	11.4	916	121.6	4.1	11.5	743	98.6	3.6	11.5	794	105.4
11/6	17:00	89650	754	2.7	11.4	915	121.5	4.2	11.5	749	99.4	3.6	11.5	794	105.4
11/6	18:00	88160	754	2.6	11.4	915	121.4	4.1	11.5	745	98.8	3.6	11.5	792	105.1
11/6	19:00	89900	753	2.6	11.4	914	121.3	4	11.5	741	98.4	3.6	11.5	789	104.8
11/6	20:00	90750	753	2.4	11.4	913	121.2	3.9	11.5	741	98.4	3.6	11.5	788	104.7
11/6	21:00	84620	753	2.4	11.4	913	121.2	4	11.5	739	98.1	3.6	11.5	793	105.3
11/6	22:00	84660	754	2.4	11.4	913	121.2	3.9	11.5	739	98.1	3.6	11.5	790	104.9
11/6	23:00	67530	754	2	11.4	913	121.1	3.6	11.5	746	99.0	3.6	11.4	797	105.7
11/6	0:00	51220	754	1.6	11.4	913	121.2	3.4	11.5	753	99.9	3.6	11.4	805	106.9
11/7	1:00	35780	753	1.7	11.4	911	121.0	3.6	11.4	764	101.4	3.6	11.4	815	108.2
11/7	2:00	31680	753	1.6	11.4	911	121.0	3.4	11.4	767	101.8	3.6	11.4	821	109.0
11/7	3:00	31050	753	1.6	11.4	912	121.0	3.4	11.4	761	101.0	3.6	11.4	823	109.3

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
11/7	4:00	30300	753	1.7	11.4	912	121.0	3.5	11.4	758	100.6	3.6	11.4	817	108.4
11/7	5:00	31820	753	1.7	11.3	912	121.1	3.5	11.4	761	101.1	3.6	11.4	816	108.4
11/7	6:00	40720	753	1.9	11.3	913	121.3	3.6	11.3	751	99.8	3.6	11.3	812	107.9
11/7	7:00	56820	753	2	11.3	915	121.4	3.7	11.3	743	98.6	3.6	11.3	803	106.6
11/7	8:00	75230	754	2.8	11.2	916	121.5	4.2	11.2	740	98.2	3.6	11.2	796	105.6
11/7	9:00	95360	754	2.8	11.2	919	121.8	4.2	11.2	743	98.5	3.6	11.2	793	105.2
11/7	10:00	89310	754	2.8	11.1	919	121.9	4.1	11.2	736	97.7	3.6	11.2	791	104.9
11/7	11:00	97220	754	2.7	11.1	920	122.1	4.1	11.2	744	98.8	3.6	11.2	794	105.3
11/7	12:00	87980	753	2.7	11.0	923	122.5	4.1	11.2	738	97.9	3.6	11.2	796	105.7
11/7	13:00	75100	753	2.4	11.0	925	122.9	3.9	11.2	749	99.5	3.6	11.2	803	106.7
11/7	14:00	78340	753	2.6	11.1	926	123.0	4	11.2	746	99.1	3.6	11.2	805	107.0
11/7	15:00	82740	753	2.8	11.1	927	123.2	4.1	11.2	743	98.6	3.6	11.2	804	106.8
11/7	16:00	86800	753	2.9	11.1	929	123.4	4.3	11.2	743	98.6	3.6	11.2	805	106.9
11/7	17:00	98870	753	3.5	11.1	929	123.4	4.7	11.2	749	99.5	3.6	11.1	805	106.8
11/7	18:00	101590	754	3.2	11.1	930	123.4	4.4	11.1	755	100.1	3.6	11.1	806	107.0
11/7	19:00	90970	754	2.9	11.1	931	123.4	4.2	11.0	745	98.8	3.6	11.1	809	107.2
11/7	20:00	93140	755	2.8	11.1	933	123.6	4.1	11.0	745	98.7	3.6	11.0	813	107.7
11/7	21:00	93340	755	2.8	11.0	935	123.7	4.1	11.0	745	98.7	3.6	11.0	810	107.3
11/7	22:00	86580	756	2.8	11.0	936	123.8	4.2	11.0	741	98.0	3.6	11.0	810	107.2
11/7	23:00	70460	756	2.4	10.9	935	123.6	3.9	10.9	747	98.8	3.6	10.9	811	107.3
11/7	0:00	55870	757	1.9	10.9	934	123.4	3.5	10.9	751	99.1	3.6	10.9	819	108.1
11/8	1:00	32690	758	1.9	10.8	931	122.8	3.7	10.9	773	102.0	3.6	10.8	827	109.1
11/8	2:00	37730	758	2	10.7	930	122.6	3.7	10.8	774	102.1	3.6	10.7	823	108.5
11/8	3:00	46180	759	1.9	10.6	929	122.4	3.7	10.7	753	99.3	3.6	10.7	817	107.6
11/8	4:00	42620	759	2	10.5	927	122.1	3.7	10.6	765	100.8	3.6	10.6	813	107.0
11/8	5:00	42300	760	2	10.5	924	121.7	3.8	10.5	766	100.9	3.6	10.5	810	106.7
11/8	6:00	43010	760	1.9	10.4	922	121.2	3.6	10.5	753	99.0	3.6	10.5	806	105.9
11/8	7:00	33660	761	1.9	10.3	919	120.7	3.8	10.5	773	101.6	3.6	10.4	810	106.4
11/8	8:00	69600	762	2.8	10.2	919	120.6	4.3	10.4	755	99.1	3.6	10.4	806	105.8
11/8	9:00	98650	762	2.8	10.1	921	120.8	4.2	10.4	748	98.1	3.6	10.3	795	104.2
11/8	10:00	87390	763	2.7	10.1	922	120.8	4.1	10.5	737	96.6	3.6	10.3	788	103.3
11/8	11:00	84990	764	2.8	10.1	922	120.8	4.2	10.5	734	96.2	3.6	10.3	787	103.1

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
11/8	12:00	89320	763	2.6	10.1	923	120.9	4	10.5	735	96.3	3.6	10.3	786	103.0
11/8	13:00	85700	763	2.7	10.1	924	121.0	4.2	10.5	736	96.4	3.6	10.3	792	103.8
11/8	14:00	79090	763	2.6	10.1	925	121.2	4.2	10.5	742	97.2	3.6	10.3	797	104.4
11/8	15:00	86510	764	2.5	10.1	926	121.3	4.1	10.5	740	97.0	3.6	10.4	797	104.4
11/8	16:00	92990	764	2.7	10.1	926	121.2	4.2	10.5	745	97.5	3.6	10.4	794	103.9
11/8	17:00	91560	764	3.2	10.2	925	121.1	4.5	10.5	743	97.2	3.6	10.4	795	104.0
11/8	18:00	93300	764	2.6	10.2	925	121.1	4.1	10.5	744	97.3	3.6	10.4	793	103.8
11/8	19:00	83420	764	2.7	10.2	924	120.9	4.2	10.4	738	96.6	3.6	10.3	796	104.1
11/8	20:00	93820	764	2.7	10.2	925	121.0	4.1	10.4	741	96.9	3.6	10.3	792	103.6
11/8	21:00	86860	765	2.6	10.2	925	121.0	4.1	10.4	736	96.3	3.6	10.3	794	103.9
11/8	22:00	86610	765	2.5	10.1	925	121.0	4	10.3	737	96.4	3.6	10.3	795	103.9
11/8	23:00	80710	765	2.4	10.1	925	120.9	3.9	10.3	738	96.4	3.6	10.2	795	103.9
11/8	0:00	72020	766	2.3	10.0	925	120.8	3.9	10.2	744	97.2	3.6	10.2	801	104.7
11/9	1:00	51250	766	1.9	10.0	924	120.7	3.6	10.2	752	98.2	3.6	10.2	808	105.5
11/9	2:00	43810	766	1.6	9.9	923	120.5	3.4	10.1	758	99.0	3.6	10.1	815	106.5
11/9	3:00	38750	766	1.9	9.9	923	120.5	3.6	10.1	765	99.8	3.6	10.1	827	108.0
11/9	4:00	40160	766	0.6	9.7	919	120.0	3.8	10.0	767	100.2	3.6	10.0	823	107.4
11/9	5:00	37460	766	0.5	9.7	903	117.6	3.6	10.0	768	100.3	3.6	10.0	819	106.9
11/9	6:00	36920	766	0.6	9.7	900	117.4	3.7	10.0	768	100.2	3.6	10.0	820	107.0
11/9	7:00	42240	766	0.8	9.6	885	115.4	3.8	9.9	753	98.3	3.6	9.9	824	107.5
11/9	8:00	60960	767	1	9.7	908	118.6	4	9.9	741	96.7	3.6	9.9	810	105.6
11/9	9:00	58090	767	0.8	9.6	911	118.8	3.8	9.9	746	97.4	3.6	9.9	799	104.2
11/9	10:00	45840	767	0.5	9.6	909	118.5	3.7	9.9	755	98.4	3.6	9.9	806	105.0
11/9	11:00	31610	767	0.3	9.6	907	118.2	3.5	9.9	763	99.5	3.6	9.9	813	106.1
11/9	12:00	49070	767	0.7	9.7	916	119.5	3.8	9.9	749	97.7	3.6	9.9	823	107.4
11/9	13:00	64050	766	0.8	9.8	924	120.7	3.8	10.0	744	97.2	3.6	9.9	813	106.2
11/9	14:00	71340	765	0.9	9.8	925	120.9	3.9	10.0	745	97.3	3.6	10.0	817	106.8
11/9	15:00	62140	765	0.9	9.9	924	120.9	3.9	10.1	753	98.4	3.6	10.0	817	106.8
11/9	16:00	53400	764	0.8	9.8	920	120.4	3.8	10.1	752	98.3	3.6	10.1	816	106.7
11/9	17:00	61350	764	1.4	9.9	916	119.9	4.3	10.1	750	98.2	3.6	10.1	809	105.9
11/9	18:00	96920	764	1.7	9.9	921	120.8	4.4	10.1	751	98.3	3.6	10.1	799	104.5
11/9	19:00	83770	764	1.2	10.0	917	120.1	4.1	10.0	745	97.6	3.6	10.1	799	104.7

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Table B.1 Hourly average TDG levels recorded during continuous monitoring at three stations in the lower Niagara River, August and November, 2003.

				Station 2				Station 4				Station 12			
Date	Hour Ending	RMNPP Discharge (cfs)	Bar. Pres. (mmHg)	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG	Depth (ft)	Temp (Deg C)	Tot. Gas Pres. (mmHg)	%TDG
11/9	20:00	82230	763	1.2	10.0	915	119.8	4.1	10.0	741	97.0	3.6	10.1	798	104.5
11/9	21:00	80360	763	1.1	10.0	914	119.8	4	10.0	741	97.1	3.6	10.1	796	104.4
11/9	22:00	61450	763	0.5	9.9	909	119.2	3.6	9.9	749	98.1	3.6	10.0	801	105.0
11/9	23:00	47460	762	0.4	9.9	904	118.6	3.6	10.0	756	99.2	3.6	10.0	815	106.9
11/9	0:00	42800	762	0.5	9.8	904	118.7	3.6	10.0	756	99.3	3.6	10.0	816	107.0
11/10	1:00	38770	762	0.3	9.7	898	117.6	3.5	10.0	760	99.8	3.6	10.0	822	108.0
11/10	2:00	38710	761	0.3	9.7	896	117.7	3.5	10.0	753	98.9	3.6	10.0	827	108.6
11/10	3:00	42790	761	0.4	9.7	900	118.2	3.5	10.0	752	98.7	3.6	10.0	821	107.8
11/10	4:00	38590	761	0.5	9.7	897	118.1	3.7	10.0	756	99.3	3.6	10.0	813	106.8
11/10	5:00	34270	761	0.2	9.6	895	117.6	3.4	10.0	757	99.5	3.6	9.9	812	106.7
11/10	6:00	31400	761	0.7	9.8	883	116.0	3.8	9.9	771	101.3	3.6	9.9	822	107.9
11/10	7:00	73550	761	1.7	9.8	909	119.4	4.4	9.8	745	97.8	3.6	9.9	811	106.5
11/10	8:00	98200	761					4.2	9.8	743	97.6	3.6	9.9	794	104.4
11/10	9:00	86860	761					4.1	9.8	739	97.1	3.6	9.8	796	104.7
11/10	10:00	88400	761					4.1	9.8	734	96.5	3.6	9.8	797	104.8
11/10	11:00	86860	760									3.6	9.8	791	104.1
					Min		115.4		Min		96.2		Min		103.0
					Max		123.8		Max		102.9		Max		111.6
					Mean		121.0		Mean		99.2		Mean		106.3
					Median		121.1		Median		99.2		Median		106.1

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