# Acoustic Doppler Current Profile Measurements to Inform the Suitability of the Thames River, Ontario for Asian Carp Spawning

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An acoustic Doppler current profiler was used to collect longitudinal and cross-sectional water velocity, depth, and flow measurements in the Thames River, Ontario in 2021. Longitudinal measurements were collected in the thalweg of the river from Fanshawe Dam and Hunt Dam, located in London, to the mouth of the Thames River at Lake St. Clair in low- (~10 – 38 $m^3/s$) and high-flow (~21 – 496 $m^3/s$) conditions. These data were collected in 31 and 32 longitudinal transects, respectively. Cross-sectional measurements were also collected in low- and high-flow conditions, with a total of 247 cross-section transects taken at 22 cross-section locations in low-flow conditions and 146 cross-section transects taken at 16 cross-section locations in high-flow conditions. These data will be used to inform the suitability of the Thames River as a potential spawning tributary for Asian carps.

## RÉSUMÉ

Illes, C., Smyth, E.R.B., and Drake, D.A.R. 2025. Acoustic Doppler Current Profile Measurements to Inform the Suitability of the Thames River, Ontario for Asian Carp Spawning. Can. Data Rep. Fish. Aquat. Sci. 1442: vii + 18 p. + appendices

Un courantomètre à effet Doppler acoustique a été utilisé pour recueillir des mesures longitudinales et transversales de la vitesse, de la profondeur et du débit de l'eau dans la rivière Thames, en Ontario, en 2021. Des mesures longitudinales ont été effectuées dans le talweg de la rivière depuis le barrage Fanshawe et depuis le barrage Hunt, situés à London, jusqu'à l'embouchure de la rivière Thames au lac Sainte-Claire dans des conditions de faible débit (~10 - 38 $m^3/s$) et de fort débit (~21 - 496 $m^3/s$). Ces données ont été collectées sur 31 et 32 transects longitudinaux, respectivement. Des mesures transversales ont également été prises dans des conditions de faible et de fort débit, avec un total de 247 transects pris à 26 endroits dans des conditions de faible débit et 161 transects pris à 18 endroits dans des conditions de fort débit. Ces données seront utilisées pour déterminer si la rivière Thames est un affluent de fraie potentiel pour les carpes asiatiques.

# INTRODUCTION

Asian carps [Grass Carp (*Ctenopharyngodon idella*), Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), and Black Carp (*Mylopharyngodon piceus*)] pose invasion risk to Canadian waters of the Laurentian Great Lakes basin (Cudmore et al. 2012; Cudmore et al. 2017). Of these species, Grass Carp and Bighead Carp have been captured in Canadian waters (Colm et al. 2019; Aguiar et al. 2021; DFO unpublished data), and Grass Carp reproduction has occurred in the Maumee and Sandusky rivers in Lake Erie, Ohio (Chapman et al. 2021). Grass Carp can travel long distances and have used the Huron-Erie Corridor (HEC) to access Lake Huron (Harris et al. 2021), raising questions about the suitability of tributaries in the HEC for Asian carp spawning.

At the basin-wide scale, researchers have identified tributaries that are potentially suitable for Asian carp spawning by evaluating environmental conditions for spawning, including whether flow conditions will enable egg suspension and hatching (Kočovský et al. 2012). These evaluations have used a variety of approaches: Kolar et al. (2007) used minimum tributary length; Murphy and Jackson (2013) used FluEgg, a particle transport model, to simulate egg survival based on non-linear flow, shear velocity, water depth, and areas of turbulence; and, Mandrak et al. (2020) used bi-weekly water velocity and temperature data.

This data report describes field work to collect detailed hydrology data to inform an assessment of spawning suitability for Asian carps in the Thames River, Ontario. The Thames River is a large, turbid, Lake St. Clair tributary that has been identified as potentially suitable for Asian carp spawning by Mandrak et al. (2020).

# METHODS

Hydrologic data of the Thames River were collected in 2021 during two flow conditions, low and high. The project consisted of longitudinal measurements of the thalweg's water velocity (m/s) and depth (m), and cross-sectional measurements of velocity (m/s), depth (m), and flow ($m^3/s$). Data were collected using an acoustic Doppler current profiler (ADCP), a handheld Global Positioning System (GPS) to collect location data, and data loggers to collect surface water and air temperature data. Details regarding the sampling equipment and methodology are provided below.

## EQUIPMENT

Longitudinal and cross-sectional measurements were made using the Sontek RiverSurveyor M9 ADCP, which was installed on a HydroBoard II and mounted alongside a canoe (operated by two people) with an aluminum pole and fishing rod holders (Figure 1). The M9 was connected to RiverSurveyor Live (RSL; firmware version 4.1) using the Sontek 10 m direct connect cable with an AC power adaptor and USB cable that connected to a lithium battery pack and laptop, respectively. The direct connect option with a non-integrated GPS was selected for georeferencing the data rather than the integrated Sontek differential GPS (DGPS) or real-time kinematic (RTK) GPS for the following reasons: 1) set up, movement, and retrieval of the RTK GPS can be very time consuming and the accuracy of the RTK GPS (<0.02 m) was unnecessary for this project; 2) the direct connect option delivered a constant 18.0 – 18.1 V to the M9 whereas the AA batteries in the DGPS delivered a maximum of 12 V and exponentially decreased voltage while in use - running the DGPS on batteries would require the batteries to be frequently changed, which was not practical for the long periods of data collection; 3) the radio connection between the DGPS and USB radio transmitter plugged into the tablet was unreliable and transmission errors between RSL and the M9 were frequent when a radio

connection was used; and, 4) the GPS error (±3 m) of the handheld GPS provided an acceptable margin of error for the areas of the river being sampled that had an average stream width of 59 m. The non-integrated GPS recorded latitude, longitude, and elevation data at increments typically ranging between 21 to 29 seconds (median = 25 seconds). The handheld GPS was located at the bow seat of the canoe while measurements were made.

In addition, two Honest Observer by Onset (HOBO) Water Temperature Pro version 2 data loggers were deployed during the project to measure surface water temperature and air temperature. The logger measuring water temperature was mounted at the stern of the canoe and the logger measuring air temperature was mounted on the aluminum pole; both loggers were mounted using rope (Figure 1). The temperature loggers were programmed to measure every 10 minutes.

## EQUIPMENT SETUP AND CALIBRATION

Before starting measurements each day, the internal clock of the M9 was synced with the laptop and an internal system test of the M9 was completed. Next, the internal compass of the M9 was calibrated. The calibration was completed on the riverbank where the M9 unit and HydroBoard were rotated in a 720° circle while mimicking wave action for at least one minute. If the compass calibration failed, it was redone further away from obstructions, such as metal or overhanging trees, until a pass result was achieved.

The ADCP's transducer depth (meters; distance from the apex of the M9 to the underside of the HydroBoard) and magnetic declination were recorded each day prior to starting measurements and input into RSL. Magnetic declination was calculated using the National Oceanic and Atmospheric Administration (NOAA) Magnetic Field Calculator (NCEI Geomagnetic Modeling Team and British Geological Survey 2019).

All measurements used bottom-track as the track reference, vertical beam for the depth reference, and sloped bank for edge settings. Salinity was not measured because it was assumed negligible (0 parts per thousand; Sontek 2013).

## LONGITUDINAL DATA COLLECTION

Longitudinal measurements were completed in the thalweg of the river. For each longitudinal transect, sampling time, date, track length (m), depth (m), mean water velocity (m/s; accounts for boat speed), and mean boat speed (m/s) were measured every one second and location was measured at a mean interval of 25 seconds. Starting locations for longitudinal measurements were Fanshawe Dam, located in the north branch of the Thames River, and Hunt Dam, located in the south branch of the Thames River in London (Figure 2). These locations were selected because they are the first impassable barriers on the north and south branches that impede upstream fish movement from Lake St. Clair. The end (downstream) location for the longitudinal measurements was the mouth of the Thames River at Lake St. Clair near Lighthouse Cove. Two sections of the project reach were not measured due to access restrictions (Figure 2). Longitudinal measurements between Fanshawe Dam, Hunt Dam, and Lighthouse Cove were completed in low- and high-flow conditions.

Longitudinal measurements were made by positioning the canoe in the thalweg and paddling parallel to the dominant flow. The HydroBoard was positioned parallel to the canoe on the port or starboard side. Paddling occurred on the side of the canoe opposite the HydroBoard. The frequency of paddling and canoe speed was determined by the flow condition. In high-flow conditions, the person in the stern kept the canoe in the thalweg, but in low-flow conditions, both people were required to paddle to stay in the thalweg. In general, water velocity decreased moving downstream, so more paddling was required as the canoe travelled downstream. The

length of each longitudinal transect varied and was often dictated by river access. The length for each longitudinal transect was calculated using the track data recorded by the M9 while it measured water velocity and depth. The longitudinal track measurements between the external GPS and bottom-track were compared and were within 98 percent accuracy of each other in low- and high-flow conditions.

Longitudinal side channel measurements were made when the river was divided by an island and the side channel had a width 20% or greater of the main channel width. Many side channels were not sampled because they were too shallow and narrow to measure. When a side channel was encountered, the main channel was measured until the side and main channels rejoined, then the equipment was walked or paddled upstream of the split and the side channel was measured.

Areas of turbulence were documented during the low-flow longitudinal measurements because Asian carps may use these areas to initiate spawning. The field team documented all rapids and/or riffles that covered a minimum of 20% of the river width. Areas of turbulence generated by features such as log jams, fallen trees, or other loose debris were not documented because these features may be moved or altered by seasonal fluctuations in river flow. Areas of turbulence were not documented during the high-flow measurements as turbulent and high water levels made previously identified areas of turbulence difficult to locate and challenging to locate rapids and/or riffle habitat throughout the river.

## CROSS-SECTIONAL DATA COLLECTION

Cross-sectional measurements were made strategically throughout the project reach. For each cross-section transect, sampling time, date, track length (m), depth (m), mean water velocity (m/s; accounts for boat speed), mean boat speed (m/s), total flow ($m^3/s$) were measured every one second and location was measured at a mean interval of 25 seconds. Hydraulic features that altered flow characteristics such as side channels, tributaries, and confluences were identified using satellite imagery (108 tributaries, 42 side channels, one confluence, and one area of interest – Springbank Park area) and a subset were chosen for cross-sectional measurements. Tributaries with a mouth width that was 20% or greater of the river width were selected for upstream and downstream cross-sectional measurements; there were eight tributaries that met this criterion. Agricultural drains were not sampled. An additional nine tributaries were selected based on location and proximity to other cross-sectional measurements to ensure that cross sectional measurements were spaced throughout the longitudinal extent of the entire project reach. Eight side channels were identified for cross-section locations based on island size.

In addition, the confluence of the north and south branches of the Thames River and the Springbank Park area were selected as cross-section locations. The confluence of the north and south branches was selected because flow is expected to be greater downstream of the confluence than in either branch. The Springbank Park area was selected as a cross-section location because of two structures in the river, the decommissioned Waterworks dam and Pumphouse dam. The Springbank Park area was not measured during high-flow conditions because the field team thought the structures would not have a substantial influence on flow characteristics.

Each identified hydraulic feature had cross-sectional measurements taken upstream and downstream of the feature. A mid-channel cross-section location was completed if the feature was a side channel, and a mid-channel measurement was also completed for the Springbank Park area. The cross-sectional measurements were made as close to the hydraulic features as

sufficient depths would allow. Cross-sectional measurement distance from a feature ranged between 10 and 300 m.

Multiple cross-section transects were completed from bank to bank at each cross-section location. Prior to starting a cross-section transect, the canoe was positioned perpendicular to the flow of the river with the HydroBoard on the upstream side of the canoe and away from obstructions such as vegetation or woody debris. In addition, the stern of the canoe was positioned against the starting bank and the edge distance from the starting bank was entered into RSL. The canoe remained stationary in a fixed perpendicular position for five seconds before starting the cross-section transect and, if necessary, a paddle was used on the downstream side to steady the canoe. During a cross-section transect, only the person in the stern of the canoe paddled on the downstream side of the canoe to ensure the canoe remained at a consentient speed and was perpendicular to the flow. Once the opposite bank was reached, the transect was stopped. If downstream drift occurred during a cross-section transect, the equipment was walked or paddled upstream to the location across from the transect start location on the opposite bank of the river. At each cross-section location, a minimum of four transects were completed. If four cross-section transects totaled a measurement time of less than 12 minutes, additional transects were completed until a minimum measurement time of 12 minutes was completed, following Mueller et al. (2013). The number of cross-section transects varied between locations due to changes in river width, flow conditions, and wind speed and direction.

River width for each cross-section location was determined using the transect start coordinates on each bank. River width was measured using these coordinates in Garmin BaseCamp. The start edge distance (distance from the river bank to the M9) and the approximate distance from M9 to GPS (1 m) were added to the measurement to calculate river width.

## DATA PROCESSING

Several practical challenges were encountered while collecting longitudinal data. Longitudinal measurements were interrupted for various reasons, such as the HydroBoard getting caught on fishing line or the canoe getting stuck on riffles, especially in low-flow conditions. These data were marked as waypoints and removed during post-processing. Data were reviewed in RSL to identify issues, such as beam separation, and exported from RSL to Microsoft Excel into a comma delineated format (CSV). Data were cleaned by deleting the entire data row(s) for erroneous data that were identified while collecting measurements or in RSL. The mean water velocity (m/s) and boat speed (m/s) values for all longitudinal data were also analyzed in case an interruption was not marked. If the mean water velocity or boat speed abruptly changed to 0 m/s (e.g., changed from 0.722 to 0 m/s) during a longitudinal transect, these data were assumed to be an unmarked interruption and were removed (e.g., the HydroBoard hit a rock causing the M9 to be lifted out of the water). If an interruption or beam separation occurred during a cross-section transect, the transect was redone; therefore, cross-sectional data did not require to be cleaned. Two transects for each cross-section location were used to conduct a moving bed test following the loop method described by Mueller et al. (2013). A moving bed was not identified in the low- or high-flow conditions; however, there is uncertainty about whether a moving bed was present for some of the high-flow cross-sectional measurements. In some cases, a moving bed test was not performed because river flows made returning to the exact starting position of the first cross-section transect extremely challenging during the high-flow conditions. Therefore, flow measurements from some high-flow cross-section transects may be biased.

GPS coordinates for the majority of the longitudinal measurements were unavailable because of the differing data collection intervals. To fill the gaps, direction and speed between two recorded GPS points was assumed to be constant and GPS coordinates were interpolated in ArcMap 10.8.1. For the low-flow measurements, 5,909 GPS measurements were collected and 140,721 data points were interpolated. For the high-flow measurements, 4,185 GPS measurements were collected and GPS coordinates were interpolated for 96,366 data points. No GPS interpolation was conducted on the cross-sectional measurements because so few GPS measurements were available for each transect.

# RESULTS

Summaries of the longitudinal and cross-sectional measurement data are provided below.

## LONGITUDINAL DATA

The low-flow longitudinal data were collected in 31 longitudinal transects over ten days between July 19 and August 12, 2021 (Table 1; Figure 3). The high-flow longitudinal data were collected in 32 longitudinal transects over 12 days between September 16 and October 19, 2021 (Table 2; Figure 3). An example of the longitudinal data collected on September 16, 2021 is in Appendix A. A technical issue with the laptop caused by moisture during longitudinal transect 18 in low-flow conditions resulted in data gaps. This issue occurred near Water Survey of Canada (WSC) gauge 02GE006 (Figure 2). In addition to these data a total of 245 areas of turbulence were documented during the low-flow longitudinal sampling (Figure 4).

## CROSS-SECTIONAL DATA

The low-flow cross-sectional measurements were collected following the longitudinal measurements. There were 247 cross-section transects at 22 cross-section locations over 13 days between August 23 and September 15, 2021 (Table 3; Figure 2). During the low-flow data collection, 74 cross-section transects were completed at three side channel cross-section locations. Following the sampling at the three side channels, further sampling at side channels was abandoned. Many side channels were shallow, had small widths, and had high frequency of riffles that made data collection challenging and resulted in poor data quality. The limited sampling window and challenges with data collection at side-channel locations resulted in efforts being diverted to ensure that cross-section sampling at tributary locations could be completed. The high-flow cross-sectional measurements were collected concurrently with the longitudinal data. There were 146 cross-section transects at 16 cross-section locations over 12 days between September 16 and October 19, 2021 (Table 4). An example of the cross-sectional data from October 5, 2021 is in Appendix B.

Several cross-section locations were not resampled during high-flow conditions due to environmental and/or equipment challenges. Cross-section location 10 was not sampled on September 22, 2021 due to high water velocities that made conditions unsafe for the field team. In addition, cross-section location 11 was not measured due to technical issues with the laptop and location 15 was not measured because the portable lithium battery overheated.

Cross-sectional data may also include data error due to drift. During a cross-section transect, the canoe would drift downstream, especially in high-flow conditions and in narrow sections of the river that had high water velocity. Although the RSL software accounts for drifting [using the distance made good (DMG) feature], flow measurements from some cross-section transects may be biased. The daily flow from the three WSC gauges within the project reach were compared to the mean total flow from the nearest cross-section location (Figure 3; Table 5). The daily flow from WSC gauges 02GE002, 02GE006, and 02GE003 had a mean accuracy

of 95, 97, and 83 percent when compared to the mean total flow from cross-section locations eight, 13, and 16, respectively, in low- and high-flow conditions.

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***Figure 1****. Equipment used for the collection of hydrology data on the Thames River, Ontario, 2021. 1. Nova Craft 4.9 m canoe. 2. Sontek HydroBoard II. 3. Sontek RiverSurveyor M9 with RiverSurveyor firmware version 4.1. 4. Sontek 10 m direct connect cable with AC power adaptor and USB cable. 5. Scotty 289 R-5 rod holder and Scotty 499 portable clamp mount. 6. Panasonic Toughbook 33 with RiverSurveyor Live software version 4.1. 7. Aluminum tube, 2.2 m in length and an outside diameter of 3.18 cm. 8. HOBO Water Temperature Pro version 2 data logger deployed in the air. 9. Goal Zero Yeti 400 Lithium Portable Power Station. 10. Garmin Montana 700 GPS. 11. HOBO Water Temperature Pro version 2 Data Logger deployed in the water.*

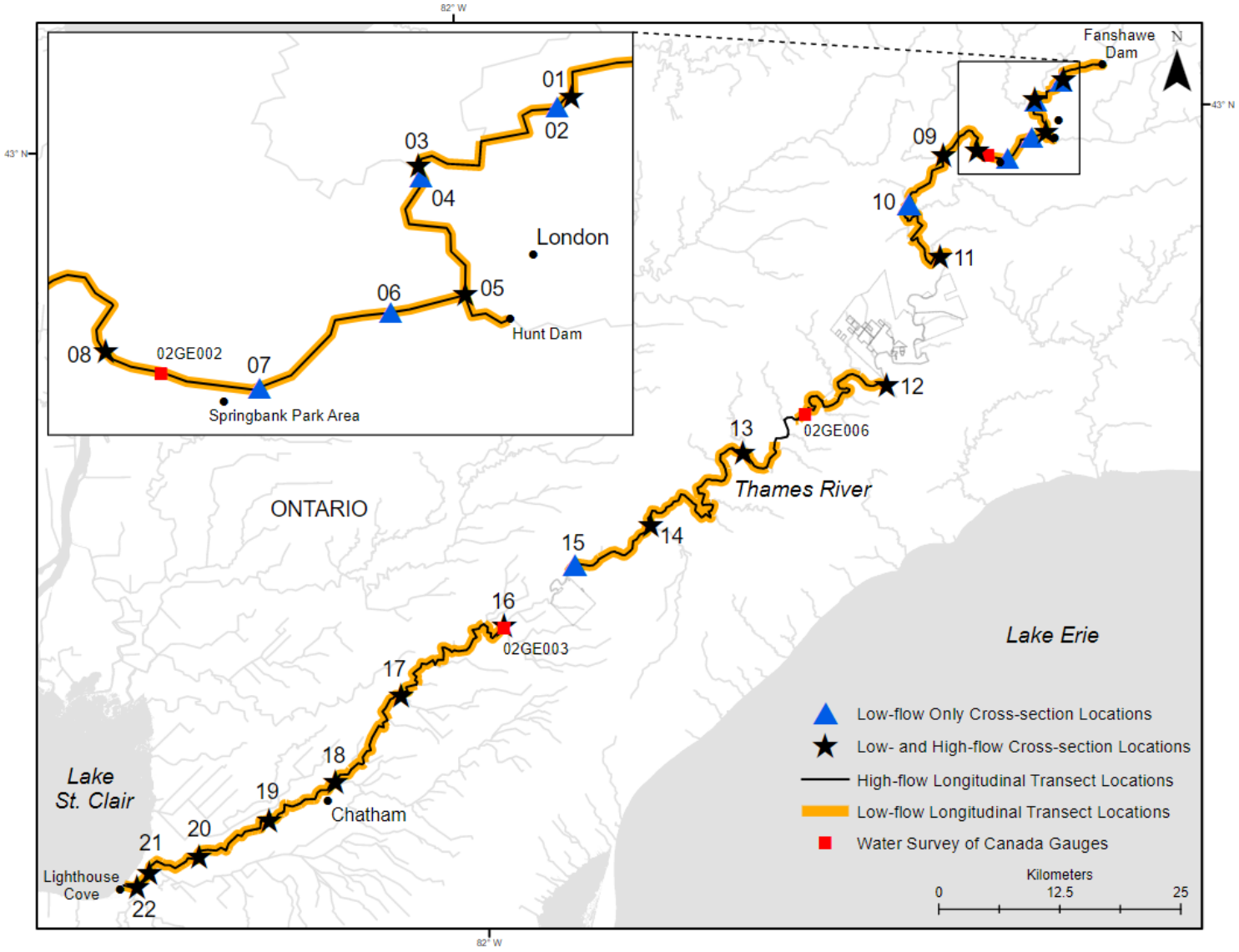


***Figure 2**. Low- and high-flow cross-section locations and longitudinal transects locations completed in the Thames River, Ontario, 2021. Prepared by Fisheries and Oceans Canada in 2022. Projection: Ontario Lambert Conformal Conic, NAD83.*

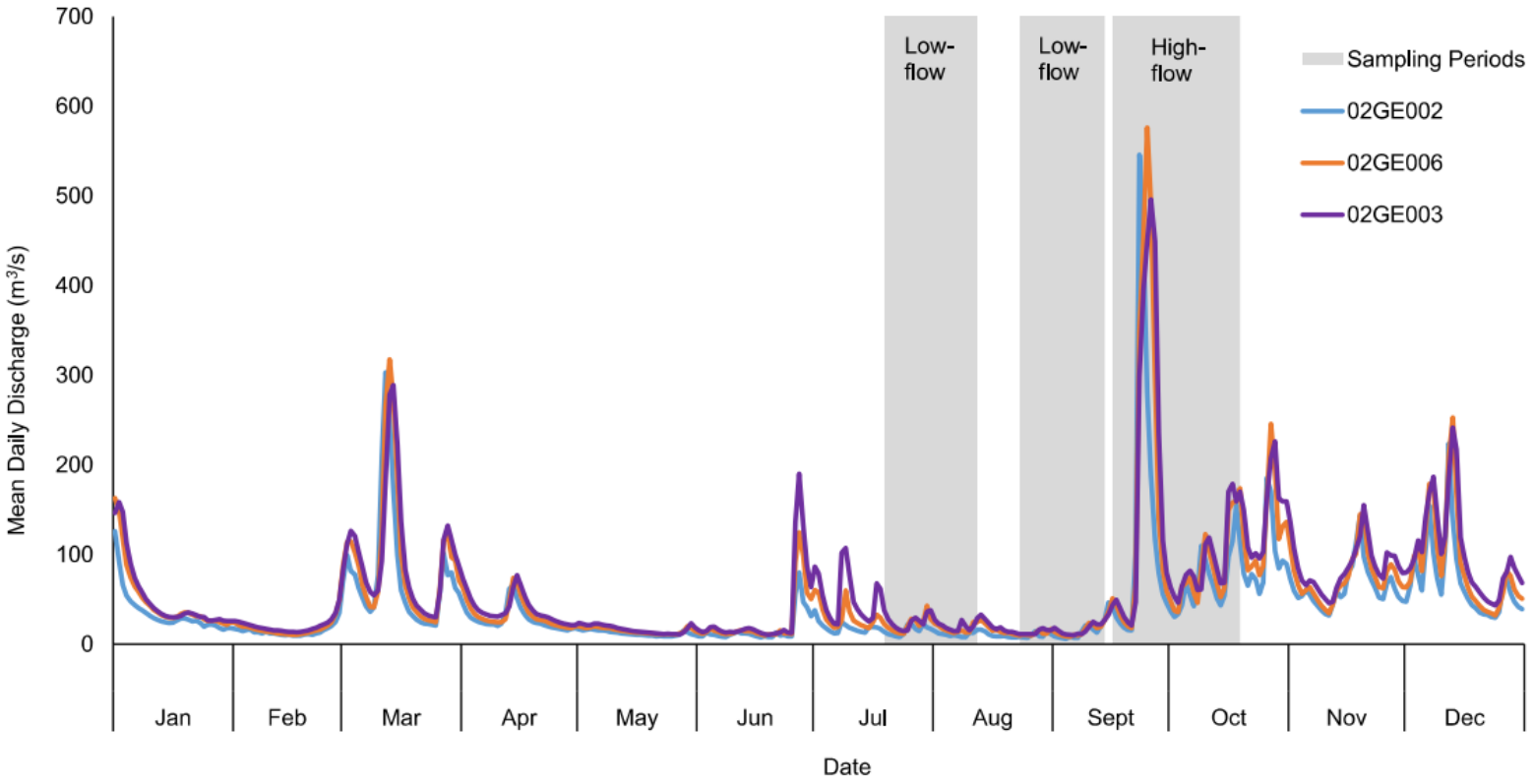


***Figure 3**. The 2021 mean daily flow ($m^3/s$) of the Thames River measured at the Water Survey of Canada gauges 02GE002 (blue), 02GE006 (orange), and 02GE003 (purple) in relation to the low- and high-flow sampling periods shown in grey.*

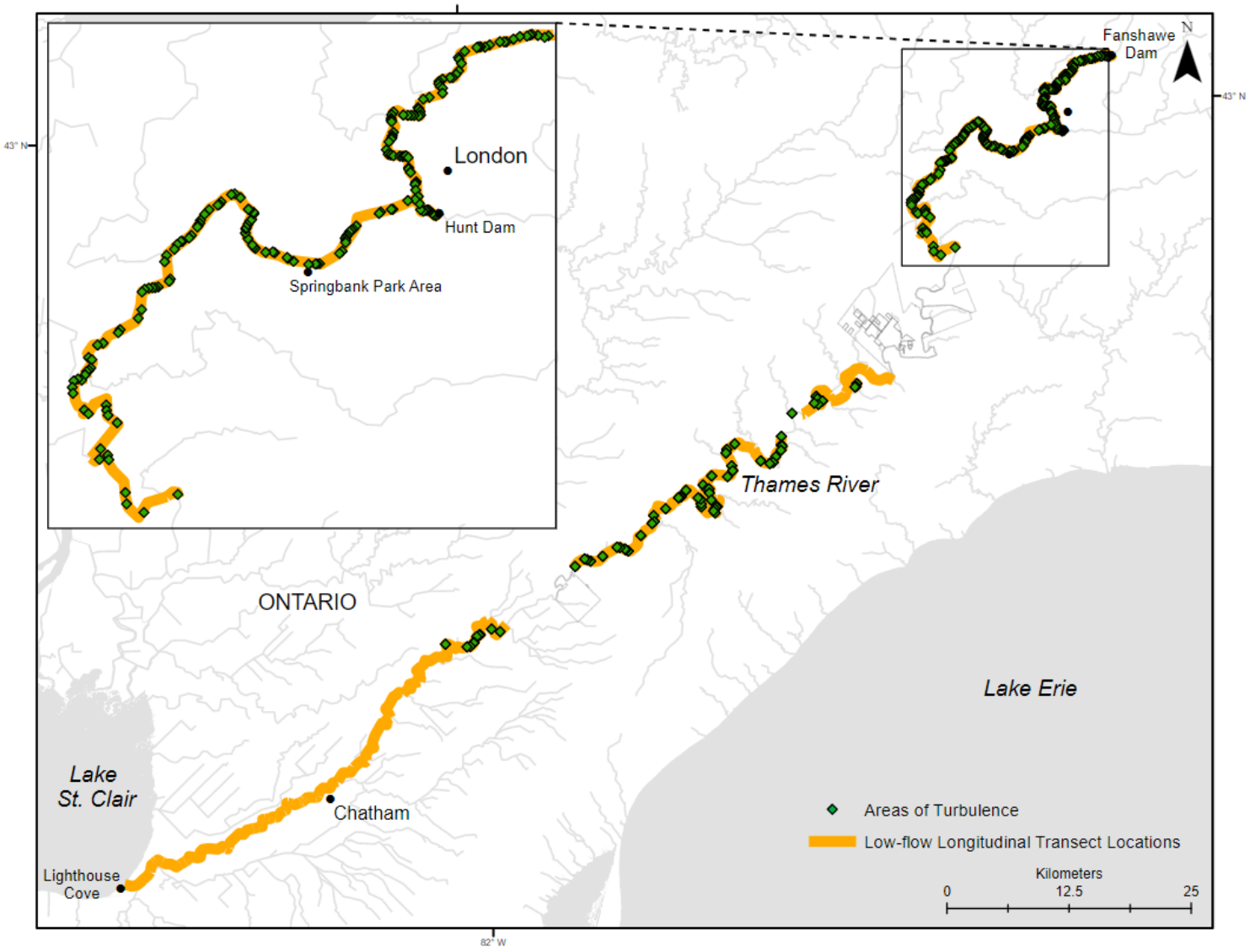


***Figure 4**. Location of the areas of turbulence during the low-flow longitudinal sampling of the Thames River, Ontario, 2021. Prepared by Fisheries and Oceans Canada in 2022. Projection: Ontario Lambert Conformal Conic, NAD83.*

***Table 1**. Summary of the longitudinal transects sampled during the low-flow conditions between July 19 and August 12, 2021 in the Thames River, Ontario.*

| Longitudinal Transect ID | Date | Start Latitude (°) | Start Longitude (°) | Longitudinal Transect Length (km) |
|---|---|---|---|---|
| 01 | 19-07-21 | 43.04165 | -81.18357 | 2.77 |
| 02 | 19-07-21 | 43.03998 | -81.21211 | 0.76 |
| 03 | 19-07-21 | 43.03834 | -81.22368 | 1.98 |
| 04 | 19-07-21 | 43.02763 | -81.23488 | 4.78 |
| 05 | 19-07-21 | 43.01281 | -81.26893 | 4.64 |
| 06 | 20-07-21 | 42.97558 | -81.24669 | 3.48 |
| 07 | 20-07-21 | 42.97751 | -81.27637 | 4.60 |
| 08 | 20-07-21 | 42.95857 | -81.3173 | 1.02 |
| 09 | 20-07-21 | 42.96074 | -81.32592 | 8.67 |
| 10 | 21-07-21 | 42.96517 | -81.38919 | 1.98 |
| 11 | 21-07-21 | 42.95287 | -81.39376 | 3.61 |
| 12 | 21-07-21 | 42.93783 | -81.41174 | 1.51 |
| 13 | 21-07-21 | 42.9338 | -81.42303 | 1.60 |
| 14 | 21-07-21 | 42.92855 | -81.43282 | 5.56 |
| 15 | 22-07-21 | 42.90858 | -81.42479 | 0.6 |
| 16 | 22-07-21 | 42.90519 | -81.42417 | 2.14 |
| 17 | 22-07-21 | 42.89198 | -81.42845 | 7.23 |
| 18 | 03-08-21 | 42.75495 | -81.47256 | 19.79 |
| 19 | 04-08-21 | 42.70619 | -81.61685 | 3.26 |
| 20 | 04-08-21 | 42.68332 | -81.62804 | 4.54 |
| 21 | 04-08-21 | 42.70195 | -81.66907 | 13.87 |
| 22 | 05-08-21 | 42.64192 | -81.70713 | 10.50 |
| 23 | 05-08-21 | 42.63315 | -81.778 | 11.67 |
| 24 | 10-08-21 | 42.54441 | -81.96834 | 12.34 |
| 25 | 10-08-21 | 42.51799 | -82.04387 | 8.42 |
| 26 | 10-08-21 | 42.48886 | -82.09434 | 13.10 |
| 27 | 11-08-21 | 42.41372 | -82.17469 | 8.39 |
| 28 | 11-08-21 | 42.38836 | -82.24981 | 8.35 |
| 29 | 12-08-21 | 42.35587 | -82.31901 | 6.09 |
| 30 | 12-08-21 | 42.34243 | -82.37375 | 6.57 |
| 31 | 12-08-21 | 42.32248 | -82.43085 | 2.20 |
| | | **Total** | | **186.02** |

**Table 2**. Summary of the longitudinal transects sampled during the high-flow conditions between September 16 and October 19, 2021 in the Thames River, Ontario.

| Longitudinal Transect ID | Date | Start Latitude (°) | Start Longitude (°) | Longitudinal Transect Length (km) |
|---|---|---|---|---|
| 01 | 16-09-21 | 43.04171 | -81.18332 | 5.18 |
| 02 | 16-09-21 | 43.02912 | -81.23355 | 5.16 |
| 03 | 16-09-21 | 43.01068 | -81.26773 | 2.06 |
| 04 | 20-09-21 | 42.99815 | -81.26381 | 2.25 |
| 05 | 21-09-21 | 42.97528 | -81.24659 | 5.98 |
| 06 | 21-09-21 | 42.96317 | -81.29748 | 2.78 |
| 07 | 21-09-21 | 42.96066 | -81.32585 | 2.06 |
| 08 | 21-09-21 | 42.96901 | -81.34641 | 6.81 |
| 09 | 22-09-21 | 42.96263 | -81.3908 | 0.28 |
| 10 | 22-09-21 | 42.95724 | -81.38775 | 10.64 |
| 11 | 23-09-21 | 42.90954 | -81.42339 | 8.04 |
| 12 | 05-10-21 | 42.75496 | -81.47243 | 0.36 |
| 13 | 05-10-21 | 42.75335 | -81.47511 | 16.86 |
| 14 | 06-10-21 | 42.73169 | -81.57723 | 13.03 |
| 15 | 06-10-21 | 42.6985 | -81.66051 | 14.59 |
| 16 | 07-10-21 | 42.64202 | -81.7071 | 10.52 |
| 17 | 07-10-21 | 42.63319 | -81.77843 | 7.80 |
| 18 | 07-10-21 | 42.60261 | -81.84572 | 0.51 |
| 19 | 07-10-21 | 42.59973 | -81.85072 | 0.16 |
| 20 | 07-10-21 | 42.59886 | -81.85307 | 2.50 |
| 21 | 12-10-21 | 42.54696 | -81.9657 | 0.34 |
| 22 | 13-10-21 | 42.54491 | -81.96822 | 18.49 |
| 23 | 13-10-21 | 42.49469 | -82.07931 | 2.80 |
| 24 | 13-10-21 | 42.48468 | -82.10085 | 10.72 |
| 25 | 13-10-21 | 42.42453 | -82.15348 | 2.38 |
| 26 | 14-10-21 | 42.4136 | -82.17465 | 1.48 |
| 27 | 14-10-21 | 42.40656 | -82.18591 | 9.44 |
| 28 | 14-10-21 | 42.37461 | -82.27086 | 5.32 |
| 29 | 19-10-21 | 42.35558 | -82.31943 | 4.44 |
| 30 | 19-10-21 | 42.34332 | -82.35781 | 6.99 |
| 31 | 19-10-21 | 42.329 | -82.42194 | 1.95 |
| 32 | 19-10-21 | 42.31727 | -82.43961 | 1.28 |
| | | **Total** | | **183.20** |

***Table 3**. Summary of the cross-section transects sampled during the low-flow conditions between August 23 and September 15, 2021 in the Thames River, Ontario. NA reflect cross-section locations that were not sampled due to spatial overlap.*

| Cross-section Location ID | Description | Date (dd-mm-yy) | Locality | Start Latitude (°) | Start Longitude (°) | River/Channel Width (m) | Number of Cross-Section Transects |
|---|---|---|---|---|---|---|---|
| 01 | Tributary | 23-08-21 | Upstream | 43.03013 | -81.23138 | 19 | 8 |
| 01 | Tributary | 23-08-21 | Downstream | 43.02935 | -81.23360 | 27 | 6 |
| 02 | Side channel | 23-08-21 | Upstream | 43.02775 | -81.23479 | 25 | 6 |
| 02 | Side channel | 23-08-21 | Right channel | 43.02764 | -81.23576 | 8 | 8 |
| 02 | Side channel | 23-08-21 | Left channel | 43.02706 | -81.23540 | 40 | 5 |
| 02 | Side channel | 23-08-21 | Downstream | 43.02726 | -81.23921 | 22 | 6 |
| 03 | Tributary | 24-08-21 | Upstream | 43.01361 | -81.26905 | 20 | 6 |
| 03 | Tributary | 24-08-21 | Downstream | 43.01055 | -81.26812 | 34 | 6 |
| 04 | Side channel | 24-08-21 | Upstream | 43.01361 | -81.26905 | NA | NA |
| 04 | Side channel | 24-08-21 | Right channel | 43.01194 | -81.26873 | 14 | 8 |
| 04 | Side channel | 24-08-21 | Left channel | 43.01191 | -81.26802 | 10 | 8 |
| 04 | Side channel | 24-08-21 | Downstream | 43.01055 | -81.26812 | NA | NA |
| 05 | Confluence | 25-09-21 | Upstream - North branch | 42.98204 | -81.25689 | 28 | 6 |
| 05 | Confluence | 25-09-21 | Upstream - South branch | 42.97993 | -81.25636 | 25 | 6 |
| 05 | Confluence | 25-09-21 | Downstream | 42.98113 | -81.26015 | 78 | 8 |
| 06 | Side channel | 26-08-21 | Upstream | 42.97746 | -81.27552 | 62 | 4 |
| 06 | Side channel | 26-08-21 | Right channel | 42.97753 | -81.27836 | 18 | 7 |
| 06 | Side channel | 26-08-21 | Left channel | 42.97651 | -81.27881 | 37 | 6 |
| 06 | Side channel | 26-08-21 | Downstream | 42.97634 | -81.28147 | 62 | 4 |
| 07 | Springbank Park area | 30-08-21 | Upstream | 42.95886 | -81.30758 | 56 | 4 |
| 07 | Springbank Park area | 30-08-21 | Midsection | 42.96008 | -81.32241 | 60 | 4 |
| 07 | Springbank Park area | 30-08-21 | Downstream | 42.96187 | -81.32927 | 55 | 4 |
| 08 | Tributary | 31-08-21 | Upstream | 42.96805 | -81.34523 | 41 | 6 |
| 08 | Tributary | 31-08-21 | Downstream | 42.97197 | -81.34819 | 61 | 4 |
| 09 | Tributary | 31-08-21 | Upstream | 42.96567 | -81.38815 | 63 | 4 |
| 09 | Tributary | 31-08-21 | Downstream | 42.96306 | -81.39040 | 43 | 5 |
| 10 | Tributary | 01-09-21 | Upstream | 42.92117 | -81.43427 | 29 | 5 |
| 10 | Tributary | 01-09-21 | Downstream | 42.91817 | -81.43543 | 27 | 5 |
| 11 | Tributary | 01-09-21 | Upstream | 42.87043 | -81.39969 | 61 | 4 |
| 11 | Tributary | 01-09-21 | Downstream | 42.87269 | -81.39511 | 54 | 4 |
| 12 | Tributary | 02-09-21 | Upstream | 42.75375 | -81.47297 | 27 | 5 |

| Cross-section Location ID | Description | Date (dd-mm-yy) | Locality | Start Latitude (°) | Start Longitude (°) | River/Channel Width (m) | Number of Cross-Section Transects |
|---|---|---|---|---|---|---|---|
| 12 | Tributary | 02-09-21 | Downstream | 42.75326 | -81.47565 | 27 | 5 |
| 13 | Tributary | 02-09-21 | Upstream | 42.69788 | -81.65870 | 41 | 4 |
| 13 | Tributary | 02-09-21 | Downstream | 42.69857 | -81.65968 | 41 | 4 |
| 14 | Tributary | 08-09-21 | Upstream | 42.63557 | -81.77710 | 50 | 4 |
| 14 | Tributary | 08-09-21 | Downstream | 42.6331 | -81.77778 | 36 | 4 |
| 15 | Tributary | 09-09-21 | Upstream | 42.6002 | -81.87487 | 48 | 4 |
| 15 | Tributary | 09-09-21 | Downstream | 42.59917 | -81.87585 | 50 | 4 |
| 16 | Tributary | 09-09-21 | Upstream | 42.5465 | -81.96597 | 34 | 4 |
| 16 | Tributary | 09-09-21 | Downstream | 42.54239 | -81.97128 | 31 | 4 |
| 17 | Tributary | 13-09-21 | Upstream | 42.48493 | -82.09889 | 58 | 4 |
| 17 | Tributary | 13-09-21 | Downstream | 42.48483 | -82.10172 | 33 | 4 |
| 18 | Tributary | 14-09-21 | Upstream | 42.408 | -82.18431 | 60 | 4 |
| 18 | Tributary | 14-09-21 | Downstream | 42.40663 | -82.18651 | 45 | 4 |
| 19 | Tributary | 14-09-21 | Upstream | 42.37556 | -82.26846 | 85 | 4 |
| 19 | Tributary | 14-09-21 | Downstream | 42.37348 | -82.27260 | 80 | 4 |
| 20 | Tributary | 14-09-21 | Upstream | 42.34451 | -82.35764 | 95 | 4 |
| 20 | Tributary | 14-09-21 | Downstream | 42.34214 | -82.35887 | 111 | 4 |
| 21 | Tributary | 15-09-21 | Upstream | 42.33067 | -82.42162 | 135 | 4 |
| 21 | Tributary | 15-09-21 | Downstream | 42.32837 | -82.42334 | 155 | 4 |
| 22 | Tributary | 15-09-21 | Upstream | 42.31908 | -82.43514 | 123 | 4 |
| 22 | Tributary | 15-09-21 | Downstream | 42.31699 | -82.43984 | 127 | 4 |
| | | | | | **Total** | | **247** |

***Table 4**. Summary of the cross-section transects sampled during high-flow conditions between September 16 and October 19, 2021, in the Thames River, Ontario. NA reflect cross-section locations that were not sampled due to equipment failures. Cross-sections where sampling was incomplete are marked with an asterisk.*

| Cross-section Location ID | Description | Date (dd-mm-yy) | Locality | Start Latitude (°) | Start Longitude (°) | River/Channel Width (m) | Number of Cross-Section Transects |
|---|---|---|---|---|---|---|---|
| 01 | Tributary | 16-09-21 | Upstream | 43.03023 | -81.23136 | 25 | 6 |
| 01 | Tributary | 16-09-21 | Downstream | 43.02937 | -81.23364 | 37 | 6 |
| 03 | Tributary | 16-09-21 | Upstream | 43.01331 | -81.26873 | 28 | 6 |
| 03 | Tributary | 16-09-21 | Downstream | 43.01056 | -81.26807 | 31 | 5 |
| 05 | Confluence | 20-09-21 | Upstream - North branch | 42.98201 | -81.25719 | 62 | 4 |
| 05 | Confluence | 20-09-21 | Upstream - South branch | 42.9809 | -81.25716 | 44 | 5 |
| 05 | Confluence | 20-09-21 | Downstream | 42.98115 | -81.26013 | 77 | 4 |
| 08 | Tributary | 21-09-21 | Upstream | 42.968 | -81.34519 | 46 | 5 |
| 08 | Tributary | 21-09-21 | Downstream | 42.96869 | -81.34573 | 53 | 5 |
| 09 | Tributary | 22-09-21 | Upstream | 42.96576 | -81.38805 | 60 | 4 |
| 09 | Tributary | 22-09-21 | Downstream | 42.96314 | -81.39037 | 49 | 4 |
| 11 | Tributary | 23-09-21 | Upstream | 42.87137 | -81.39810 | 78 | 2* |
| 11 | Tributary | 23-09-21 | Downstream | NA | NA | NA | NA |
| 12 | Tributary | 05-10-21 | Upstream | 42.75457 | -81.47288 | 40 | 6 |
| 12 | Tributary | 05-10-21 | Downstream | 42.75321 | -81.47417 | 47 | 6 |
| 13 | Tributary | 06-10-21 | Upstream | 42.69803 | -81.65760 | 47 | 4 |
| 13 | Tributary | 06-10-21 | Downstream | 42.69846 | -81.66060 | 47 | 5 |
| 14 | Tributary | 07-10-21 | Upstream | 42.63498 | -81.77733 | 58 | 5 |
| 14 | Tributary | 07-10-21 | Downstream | 42.63364 | -81.77710 | 35 | 4 |
| 16 | Tributary | 12-10-21 | Upstream | 42.54676 | -81.96611 | 41 | 6 |
| 16 | Tributary | 12-10-21 | Downstream | 42.54414 | -81.96834 | 45 | 6 |
| 17 | Tributary | 13-10-21 | Upstream | 42.48554 | -82.09882 | 57 | 4 |
| 17 | Tributary | 13-10-21 | Downstream | 42.48468 | -82.10085 | 46 | 4 |
| 18 | Tributary | 14-10-21 | Upstream | 42.40836 | -82.18494 | 63 | 4 |
| 18 | Tributary | 14-10-21 | Downstream | 42.40652 | -82.18675 | 53 | 4 |
| 19 | Tributary | 14-10-21 | Upstream | 42.37531 | -82.26919 | 84 | 4 |
| 19 | Tributary | 14-10-21 | Downstream | 42.37401 | -82.27131 | 88 | 4 |
| 20 | Tributary | 19-10-21 | Upstream | 42.34386 | -82.35850 | 97 | 4 |
| 20 | Tributary | 19-10-21 | Downstream | 42.34271 | -82.35843 | 118 | 4 |

| Cross-section Location ID | Description | Date (dd-mm-yy) | Locality | Start Latitude (°) | Start Longitude (°) | River/Channel Width (m) | Number of Cross-Section Transects |
|---|---|---|---|---|---|---|---|
| 21 | Tributary | 19-10-21 | Upstream | 42.33073 | -82.42158 | 149 | 4 |
| 21 | Tributary | 19-10-21 | Downstream | 42.32893 | -82.42262 | 159 | 4 |
| 22 | Tributary | 19-10-21 | Upstream | 42.3179 | -82.43718 | 126 | 4 |
| 22 | Tributary | 19-10-21 | Downstream | 42.31662 | -82.44076 | 135 | 4 |
| | | | | | **Total** | | **146** |

***Table 5**. Summary of the daily flows from the Water Survey of Canada gauges within the project reach and total flows from the nearest cross-section location in the Thames River, Ontario, 2021.*

| Date (dd-mm-yy) | Flow Condition | Cross-section Location ID | Total Number of Transects | Mean Transect Total Flow ($m^3/s$) | Nearest WSC Gauge | WSC Gauge Daily Flow ($m^3/s$) | Cross-section Location Distance from Gauge (rkm) | Cross-section Location Locality from Gauge |
|---|---|---|---|---|---|---|---|---|
| 31-08-21 | Low | 8 | 10 | 11.2 | 02GE002 | 11.2 | 1.4 | Downstream |
| 21-09-21 | High | 8 | 10 | 14.2 | 02GE002 | 15.7 | 1.4 | Downstream |
| 02-09-21 | Low | 13 | 8 | 10.6 | 02GE006 | 11 | 12.7 | Downstream |
| 06-10-21 | High | 13 | 9 | 75 | 02GE006 | 73.4 | 12.6 | Downstream |
| 09-09-21 | Low | 16 | 8 | 10.5 | 02GE003 | 14.2 | 0.2 | Upstream |
| 12-10-21 | High | 16 | 12 | 91.8 | 02GE003 | 100 | 0.3 | Upstream |

## APPENDIX A

Example of the data collected using the acoustic Doppler current profiler (RiverSurveyor M9) in a longitudinal transect on September 16, 2021 in the Thames River, Ontario (full dataset available in digital format). Step refers to the sampling phase (i.e., start edge, in transect, end edge) and sample refers to the measurement identification number. Mean water column velocity accounts for boat speed. Interpolated latitude and longitude distances are presented in italicized font.

| Step | Sample | Time | Track (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|
| In Transect | 48 | 3:01:41 PM | 28.49 | 2.03 | 0.48 | 1.215 | 43.00992 | -81.2674 |
| In Transect | 49 | 3:01:42 PM | 29.94 | 2.02 | 0.491 | 1.451 | *43.00991* | *-81.26740* |
| In Transect | 50 | 3:01:43 PM | 31.26 | 2.15 | 0.518 | 1.311 | *43.00990* | *-81.26740* |
| In Transect | 51 | 3:01:44 PM | 32.55 | 2.2 | 0.439 | 1.3 | *43.00988* | *-81.26739* |
| In Transect | 52 | 3:01:45 PM | 33.86 | 2.17 | 0.437 | 1.304 | *43.00987* | *-81.26739* |
| In Transect | 53 | 3:01:46 PM | 35.26 | 2.13 | 0.561 | 1.401 | *43.00985* | *-81.26739* |
| In Transect | 54 | 3:01:47 PM | 36.56 | 2.1 | 0.526 | 1.299 | *43.00984* | *-81.26739* |
| In Transect | 55 | 3:01:48 PM | 37.87 | 2.09 | 0.544 | 1.309 | *43.00983* | *-81.26739* |
| In Transect | 56 | 3:01:49 PM | 39.16 | 2.05 | 0.454 | 1.29 | *43.00981* | *-81.26738* |
| In Transect | 57 | 3:01:50 PM | 40.43 | 1.98 | 0.439 | 1.274 | *43.00980* | *-81.26738* |
| In Transect | 58 | 3:01:51 PM | 41.77 | 1.87 | 0.388 | 1.334 | *43.00979* | *-81.26738* |
| In Transect | 59 | 3:01:52 PM | 43.23 | 1.73 | 0.47 | 1.464 | *43.00977* | *-81.26738* |
| In Transect | 60 | 3:01:53 PM | 44.72 | 1.61 | 0.673 | 1.492 | *43.00976* | *-81.26738* |
| In Transect | 61 | 3:01:54 PM | 46.25 | 1.59 | 0.561 | 1.525 | *43.00974* | *-81.26737* |
| In Transect | 62 | 3:01:55 PM | 47.74 | 1.47 | 0.61 | 1.495 | *43.00973* | *-81.26737* |
| In Transect | 63 | 3:01:56 PM | 49.29 | 1.39 | 0.632 | 1.551 | *43.00972* | *-81.26737* |
| In Transect | 64 | 3:01:57 PM | 50.91 | 1.32 | 0.567 | 1.618 | *43.00970* | *-81.26737* |
| In Transect | 65 | 3:01:58 PM | 52.45 | 1.31 | 0.581 | 1.538 | *43.00969* | *-81.26736* |
| In Transect | 66 | 3:01:59 PM | 54.1 | 1.32 | 0.623 | 1.651 | 43.00968 | -81.26736 |
| In Transect | 67 | 3:02:00 PM | 55.72 | 1.36 | 0.603 | 1.627 | *43.00966* | *-81.26736* |
| In Transect | 68 | 3:02:01 PM | 57.39 | 1.39 | 0.635 | 1.662 | *43.00965* | *-81.26736* |
| In Transect | 69 | 3:02:02 PM | 58.97 | 1.35 | 0.687 | 1.588 | *43.00964* | *-81.26736* |
| In Transect | 70 | 3:02:03 PM | 60.56 | 1.37 | 0.61 | 1.582 | *43.00963* | *-81.26736* |
| In Transect | 71 | 3:02:04 PM | 62.15 | 1.38 | 0.645 | 1.589 | *43.00961* | *-81.26735* |
| In Transect | 72 | 3:02:05 PM | 63.67 | 1.33 | 0.618 | 1.526 | *43.00960* | *-81.26735* |
| In Transect | 73 | 3:02:06 PM | 65.25 | 1.37 | 0.71 | 1.581 | *43.00959* | *-81.26735* |

| Step | Sample | Time | Track (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|
| In Transect | 74 | 3:02:07 PM | 66.91 | 1.39 | 0.642 | 1.658 | *43.00958* | *-81.26735* |
| In Transect | 75 | 3:02:08 PM | 68.49 | 1.43 | 0.581 | 1.577 | *43.00956* | *-81.26735* |
| In Transect | 76 | 3:02:09 PM | 70.08 | 1.41 | 0.56 | 1.597 | *43.00955* | *-81.26734* |
| In Transect | 77 | 3:02:10 PM | 71.57 | 1.25 | 0.607 | 1.49 | *43.00954* | *-81.26734* |
| In Transect | 78 | 3:02:11 PM | 73.14 | 1.08 | 0.664 | 1.562 | *43.00952* | *-81.26734* |
| In Transect | 79 | 3:02:12 PM | 74.71 | 0.88 | 0.727 | 1.571 | *43.00951* | *-81.26734* |
| In Transect | 80 | 3:02:13 PM | 76.28 | 0.71 | 0.723 | 1.575 | *43.00950* | *-81.26734* |
| In Transect | 81 | 3:02:14 PM | 78.03 | 0.63 | 0.913 | 1.747 | *43.00949* | *-81.26734* |
| In Transect | 82 | 3:02:15 PM | 79.84 | 0.69 | 0.661 | 1.814 | 43.00947 | -81.26733 |
| In Transect | 83 | 3:02:16 PM | 81.61 | 0.67 | 0.685 | 1.762 | *43.00946* | *-81.26733* |
| In Transect | 84 | 3:02:17 PM | 83.41 | 0.79 | 0.595 | 1.804 | *43.00945* | *-81.26733* |
| In Transect | 85 | 3:02:18 PM | 85.15 | 0.84 | 0.584 | 1.742 | *43.00944* | *-81.26733* |
| In Transect | 86 | 3:02:19 PM | 86.93 | 0.92 | 0.586 | 1.78 | *43.00943* | *-81.26733* |
| In Transect | 87 | 3:02:20 PM | 88.6 | 0.97 | 0.496 | 1.665 | *43.00942* | *-81.26733* |
| In Transect | 88 | 3:02:21 PM | 90.33 | 1.09 | 0.439 | 1.737 | *43.00940* | *-81.26732* |
| In Transect | 89 | 3:02:22 PM | 92.01 | 1.2 | 0.447 | 1.673 | *43.00939* | *-81.26732* |
| In Transect | 90 | 3:02:23 PM | 93.64 | 1.35 | 0.413 | 1.632 | *43.00938* | *-81.26732* |
| In Transect | 91 | 3:02:24 PM | 95.22 | 1.4 | 0.365 | 1.582 | *43.00937* | *-81.26732* |
| In Transect | 92 | 3:02:25 PM | 96.88 | 1.44 | 0.48 | 1.659 | *43.00936* | *-81.26732* |
| In Transect | 93 | 3:02:26 PM | 98.46 | 1.51 | 0.447 | 1.585 | *43.00935* | *-81.26732* |
| In Transect | 94 | 3:02:27 PM | 100.01 | 1.56 | 0.374 | 1.544 | *43.00933* | *-81.26732* |
| In Transect | 95 | 3:02:28 PM | 101.54 | 1.61 | 0.377 | 1.533 | *43.00932* | *-81.26731* |
| In Transect | 96 | 3:02:29 PM | 102.99 | 1.64 | 0.286 | 1.445 | *43.00931* | *-81.26731* |
| In Transect | 97 | 3:02:30 PM | 104.55 | 1.76 | 0.317 | 1.563 | *43.00930* | *-81.26731* |
| In Transect | 98 | 3:02:31 PM | 105.92 | 1.82 | 0.309 | 1.374 | *43.00929* | *-81.26731* |
| In Transect | 99 | 3:02:32 PM | 107.31 | 1.87 | 0.232 | 1.387 | 43.00928 | -81.26731 |
| In Transect | 100 | 3:02:33 PM | 108.78 | 1.89 | 0.525 | 1.47 | *43.00926* | *-81.26731* |
| In Transect | 101 | 3:02:34 PM | 110.28 | 1.93 | 0.619 | 1.497 | *43.00925* | *-81.26731* |
| In Transect | 102 | 3:02:35 PM | 111.63 | 1.91 | 0.456 | 1.349 | *43.00923* | *-81.26731* |
| In Transect | 103 | 3:02:36 PM | 112.98 | 1.89 | 0.44 | 1.353 | *43.00922* | *-81.26731* |
| In Transect | 104 | 3:02:37 PM | 114.51 | 1.82 | 0.586 | 1.535 | *43.00920* | *-81.26731* |
| In Transect | 105 | 3:02:38 PM | 115.98 | 1.67 | 0.404 | 1.469 | *43.00919* | *-81.26731* |

| Step | Sample | Time | Track (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|
| In Transect | 106 | 3:02:39 PM | 117.49 | 1.49 | 0.642 | 1.502 | *43.00918* | *-81.26731* |
| In Transect | 107 | 3:02:40 PM | 119.02 | 1.4 | 0.637 | 1.534 | *43.00916* | *-81.26731* |
| In Transect | 108 | 3:02:41 PM | 120.44 | 1.4 | 0.549 | 1.421 | *43.00915* | *-81.26731* |
| In Transect | 109 | 3:02:42 PM | 121.88 | 1.36 | 0.549 | 1.444 | *43.00913* | *-81.26731* |
| In Transect | 110 | 3:02:43 PM | 123.42 | 1.29 | 0.627 | 1.539 | *43.00912* | *-81.26731* |
| In Transect | 111 | 3:02:44 PM | 124.99 | 1.21 | 0.751 | 1.572 | *43.00910* | *-81.26731* |
| In Transect | 112 | 3:02:45 PM | 126.46 | 1.18 | 0.599 | 1.462 | *43.00909* | *-81.26731* |
| In Transect | 113 | 3:02:46 PM | 127.89 | 1.29 | 0.599 | 1.429 | *43.00908* | *-81.26731* |
| In Transect | 114 | 3:02:47 PM | 129.31 | 1.38 | 0.532 | 1.42 | *43.00906* | *-81.26731* |
| In Transect | 115 | 3:02:48 PM | 130.71 | 1.49 | 0.555 | 1.407 | *43.00905* | *-81.26731* |
| In Transect | 116 | 3:02:49 PM | 132.1 | 1.57 | 0.659 | 1.392 | *43.00903* | *-81.26731* |
| In Transect | 117 | 3:02:50 PM | 133.44 | 1.6 | 0.547 | 1.339 | *43.00902* | *-81.26731* |
| In Transect | 118 | 3:02:51 PM | 134.89 | 1.58 | 0.628 | 1.449 | 43.009 | -81.2673 |
| In Transect | 119 | 3:02:52 PM | 136.34 | 1.72 | 0.565 | 1.45 | *43.00899* | *-81.26731* |
| In Transect | 120 | 3:02:53 PM | 137.72 | 1.71 | 0.633 | 1.375 | *43.00897* | *-81.26731* |
| In Transect | 121 | 3:02:54 PM | 139.05 | 1.72 | 0.52 | 1.336 | *43.00896* | *-81.26732* |
| In Transect | 122 | 3:02:55 PM | 140.49 | 1.66 | 0.591 | 1.434 | *43.00894* | *-81.26732* |
| In Transect | 123 | 3:02:56 PM | 141.91 | 1.86 | 0.608 | 1.422 | *43.00893* | *-81.26732* |
| In Transect | 124 | 3:02:57 PM | 143.29 | 1.85 | 0.639 | 1.378 | *43.00891* | *-81.26733* |
| In Transect | 125 | 3:02:58 PM | 144.67 | 1.94 | 0.589 | 1.382 | *43.00890* | *-81.26733* |
| In Transect | 126 | 3:02:59 PM | 146.08 | 1.98 | 0.596 | 1.406 | *43.00888* | *-81.26734* |
| In Transect | 127 | 3:03:00 PM | 147.52 | 1.84 | 0.561 | 1.444 | *43.00887* | *-81.26734* |
| In Transect | 128 | 3:03:01 PM | 148.89 | 1.78 | 0.511 | 1.366 | *43.00885* | *-81.26734* |
| In Transect | 129 | 3:03:02 PM | 150.31 | 1.83 | 0.654 | 1.425 | *43.00884* | *-81.26735* |
| In Transect | 130 | 3:03:03 PM | 151.78 | 1.85 | 0.597 | 1.465 | *43.00882* | *-81.26735* |
| In Transect | 131 | 3:03:04 PM | 153.24 | 1.84 | 0.604 | 1.465 | *43.00881* | *-81.26735* |
| In Transect | 132 | 3:03:05 PM | 154.57 | 1.88 | 0.576 | 1.334 | *43.00879* | *-81.26736* |
| In Transect | 133 | 3:03:06 PM | 155.91 | 1.96 | 0.549 | 1.332 | *43.00878* | *-81.26736* |
| In Transect | 134 | 3:03:07 PM | 157.33 | 2.09 | 0.482 | 1.427 | *43.00877* | *-81.26736* |
| In Transect | 135 | 3:03:08 PM | 158.74 | 2.15 | 0.521 | 1.407 | 43.00875 | -81.26736 |
| In Transect | 136 | 3:03:09 PM | 160.11 | 2.22 | 0.484 | 1.366 | *43.00874* | *-81.26737* |
| In Transect | 137 | 3:03:10 PM | 161.53 | 2.24 | 0.533 | 1.428 | *43.00872* | *-81.26738* |

| Step | Sample | Time | Track (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|
| In Transect | 138 | 3:03:11 PM | 162.88 | 2.29 | 0.444 | 1.349 | *43.00871* | *-81.26739* |
| In Transect | 139 | 3:03:12 PM | 164.23 | 2.28 | 0.337 | 1.348 | *43.00870* | *-81.26739* |
| In Transect | 140 | 3:03:13 PM | 165.72 | 2.24 | 0.442 | 1.493 | *43.00868* | *-81.26740* |
| In Transect | 141 | 3:03:14 PM | 167.21 | 2.15 | 0.522 | 1.491 | *43.00867* | *-81.26741* |
| In Transect | 142 | 3:03:15 PM | 168.61 | 2.04 | 0.492 | 1.393 | *43.00866* | *-81.26741* |
| In Transect | 143 | 3:03:16 PM | 170.09 | 2.02 | 0.625 | 1.482 | *43.00864* | *-81.26742* |
| In Transect | 144 | 3:03:17 PM | 171.54 | 2.08 | 0.431 | 1.446 | *43.00863* | *-81.26743* |
| In Transect | 145 | 3:03:18 PM | 173.07 | 2.13 | 0.525 | 1.536 | *43.00861* | *-81.26743* |
| In Transect | 146 | 3:03:19 PM | 174.55 | 2.15 | 0.514 | 1.48 | *43.00860* | *-81.26744* |
| In Transect | 147 | 3:03:20 PM | 176.16 | 2.18 | 0.472 | 1.608 | *43.00859* | *-81.26744* |
| In Transect | 148 | 3:03:21 PM | 177.76 | 2.23 | 0.487 | 1.596 | *43.00857* | *-81.26745* |
| In Transect | 149 | 3:03:22 PM | 179.36 | 2.27 | 0.599 | 1.601 | *43.00856* | *-81.26746* |
| In Transect | 150 | 3:03:23 PM | 180.9 | 2.3 | 0.544 | 1.544 | *43.00855* | *-81.26746* |

## APPENDIX B

Example of the data collected using the acoustic Doppler current profiler (RiverSurveyor M9) in a cross-section transect on October 5, 2021 in the Thames River, Ontario (full dataset available in digital format). DMG = distance made good. Step refers to the sampling phase (i.e., start edge, in transect, end edge) and sample refers to the measurement identification number. Mean water column velocity accounts for boat speed. Total Q refers to the cumulative flow measurement for the cross-section transect. Missing latitude and longitudinal data is marked with an "-" as GPS data were not extrapolated for cross-section transects.

| Step | Sample | Time | Track (m) | DMG (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Total Q ($m^3/s$) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|---|---|
| Start Edge | 1 | 10:53:31 AM | 0.02 | 0.02 | 1.32 | 0.059 | 0.021 | 0 | - | - |
| Start Edge | 2 | 10:53:32 AM | 0.11 | 0.1 | 1.36 | 0.061 | 0.088 | 0 | - | - |
| Start Edge | 3 | 10:53:33 AM | 0.2 | 0.17 | 1.38 | 0.091 | 0.096 | 0 | - | - |
| Start Edge | 4 | 10:53:34 AM | 0.25 | 0.2 | 1.41 | 0.088 | 0.045 | 0 | - | - |
| Start Edge | 5 | 10:53:35 AM | 0.27 | 0.21 | 1.47 | 0.121 | 0.023 | 0 | - | - |
| Start Edge | 6 | 10:53:36 AM | 0.33 | 0.27 | 1.46 | 0.118 | 0.061 | 0 | - | - |
| Start Edge | 7 | 10:53:37 AM | 0.43 | 0.34 | 1.51 | 0.172 | 0.092 | 0 | - | - |
| Start Edge | 8 | 10:53:38 AM | 0.52 | 0.39 | 1.53 | 0.173 | 0.098 | 0 | - | - |
| Start Edge | 9 | 10:53:39 AM | 0.62 | 0.46 | 1.59 | 0.152 | 0.098 | 0 | - | - |
| Start Edge | 10 | 10:53:40 AM | 0.69 | 0.53 | 1.61 | 0.076 | 0.074 | 0 | 42.75417 | -81.47273 |
| Start Edge | 11 | 10:53:41 AM | 0.77 | 0.61 | 1.7 | 0.105 | 0.076 | 0 | - | - |
| Start Edge | 12 | 10:53:42 AM | 0.88 | 0.71 | 1.81 | 0.127 | 0.105 | 0 | - | - |
| In Transect | 13 | 10:53:43 AM | 0.1 | 0.1 | 1.94 | 0.149 | 0.101 | 0.134 | - | - |
| In Transect | 14 | 10:53:44 AM | 0.25 | 0.24 | 2.08 | 0.096 | 0.149 | 0.185 | - | - |
| In Transect | 15 | 10:53:45 AM | 0.47 | 0.46 | 2.17 | 0.098 | 0.218 | 0.221 | - | - |
| In Transect | 16 | 10:53:46 AM | 0.77 | 0.75 | 2.25 | 0.085 | 0.298 | 0.253 | - | - |
| In Transect | 17 | 10:53:47 AM | 1.15 | 1.13 | 2.43 | 0.09 | 0.389 | 0.34 | - | - |
| In Transect | 18 | 10:53:48 AM | 1.57 | 1.54 | 2.59 | 0.187 | 0.413 | 0.541 | - | - |
| In Transect | 19 | 10:53:49 AM | 1.95 | 1.93 | 2.75 | 0.311 | 0.383 | 0.866 | - | - |
| In Transect | 20 | 10:53:50 AM | 2.38 | 2.36 | 2.84 | 0.217 | 0.432 | 1.111 | - | - |
| In Transect | 21 | 10:53:51 AM | 2.85 | 2.82 | 2.87 | 0.238 | 0.463 | 1.309 | - | - |
| In Transect | 22 | 10:53:52 AM | 3.31 | 3.27 | 2.93 | 0.449 | 0.461 | 1.847 | - | - |
| In Transect | 23 | 10:53:53 AM | 3.78 | 3.74 | 2.97 | 0.439 | 0.472 | 2.434 | - | - |
| In Transect | 24 | 10:53:54 AM | 4.26 | 4.22 | 2.86 | 0.55 | 0.483 | 3.155 | - | - |
| In Transect | 25 | 10:53:55 AM | 4.78 | 4.74 | 2.84 | 0.533 | 0.515 | 3.866 | - | - |

| Step | Sample | Time | Track (m) | DMG (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Total Q ($m^3/s$) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|---|---|
| In Transect | 26 | 10:53:56 AM | 5.29 | 5.24 | 3 | 0.57 | 0.508 | 4.594 | - | - |
| In Transect | 27 | 10:53:57 AM | 5.8 | 5.75 | 2.91 | 0.61 | 0.518 | 5.393 | - | - |
| In Transect | 28 | 10:53:58 AM | 6.29 | 6.24 | 2.95 | 0.626 | 0.486 | 6.207 | - | - |
| In Transect | 29 | 10:53:59 AM | 6.81 | 6.76 | 3.09 | 0.654 | 0.523 | 7.099 | - | - |
| In Transect | 30 | 10:54:00 AM | 7.34 | 7.28 | 3.11 | 0.634 | 0.527 | 7.955 | - | - |
| In Transect | 31 | 10:54:01 AM | 7.95 | 7.88 | 3.12 | 0.717 | 0.615 | 9.086 | - | - |
| In Transect | 32 | 10:54:02 AM | 8.54 | 8.46 | 3.17 | 0.719 | 0.589 | 10.155 | - | - |
| In Transect | 33 | 10:54:03 AM | 9.18 | 9.07 | 3.14 | 0.788 | 0.635 | 11.365 | - | - |
| In Transect | 34 | 10:54:04 AM | 9.91 | 9.76 | 3.18 | 0.798 | 0.728 | 12.673 | - | - |
| In Transect | 35 | 10:54:05 AM | 10.63 | 10.44 | 3.19 | 0.849 | 0.728 | 13.935 | - | - |
| In Transect | 36 | 10:54:06 AM | 11.36 | 11.09 | 3.19 | 0.832 | 0.726 | 14.956 | - | - |
| In Transect | 37 | 10:54:07 AM | 12.07 | 11.75 | 3.27 | 0.831 | 0.715 | 15.992 | - | - |
| In Transect | 38 | 10:54:08 AM | 12.83 | 12.48 | 3.2 | 0.816 | 0.751 | 17.153 | - | - |
| In Transect | 39 | 10:54:09 AM | 13.65 | 13.26 | 3.2 | 0.942 | 0.829 | 18.408 | - | - |
| In Transect | 40 | 10:54:10 AM | 14.41 | 13.99 | 3.23 | 0.888 | 0.753 | 19.626 | - | - |
| In Transect | 41 | 10:54:11 AM | 15.17 | 14.71 | 3.27 | 0.918 | 0.761 | 20.835 | - | - |
| In Transect | 42 | 10:54:12 AM | 16 | 15.51 | 3.29 | 0.876 | 0.829 | 22.103 | - | - |
| In Transect | 43 | 10:54:13 AM | 16.84 | 16.31 | 3.32 | 0.845 | 0.84 | 23.349 | 42.75409 | -81.47273 |
| In Transect | 44 | 10:54:14 AM | 17.75 | 17.2 | 3.35 | 0.894 | 0.917 | 24.8 | - | - |
| In Transect | 45 | 10:54:15 AM | 18.63 | 18.04 | 3.42 | 0.799 | 0.88 | 26.077 | - | - |
| In Transect | 46 | 10:54:16 AM | 19.53 | 18.9 | 3.45 | 0.715 | 0.898 | 27.108 | - | - |
| In Transect | 47 | 10:54:17 AM | 20.43 | 19.77 | 3.51 | 0.765 | 0.903 | 28.484 | - | - |
| In Transect | 48 | 10:54:18 AM | 21.36 | 20.65 | 3.57 | 0.773 | 0.921 | 29.787 | - | - |
| In Transect | 49 | 10:54:19 AM | 22.28 | 21.54 | 3.56 | 0.818 | 0.92 | 31.263 | - | - |
| In Transect | 50 | 10:54:20 AM | 23.19 | 22.41 | 3.6 | 0.772 | 0.919 | 32.574 | - | - |
| In Transect | 51 | 10:54:21 AM | 24.12 | 23.29 | 3.56 | 0.741 | 0.922 | 33.824 | - | - |
| In Transect | 52 | 10:54:22 AM | 25.08 | 24.22 | 3.6 | 0.862 | 0.966 | 35.213 | - | - |
| In Transect | 53 | 10:54:23 AM | 26.06 | 25.14 | 3.67 | 0.834 | 0.975 | 36.603 | - | - |
| In Transect | 54 | 10:54:24 AM | 27.02 | 26.07 | 3.67 | 0.889 | 0.967 | 38.072 | - | - |
| In Transect | 55 | 10:54:25 AM | 28.05 | 27.02 | 3.67 | 0.876 | 1.022 | 39.21 | - | - |
| In Transect | 56 | 10:54:26 AM | 29.04 | 27.96 | 3.73 | 0.777 | 0.993 | 40.104 | - | - |
| In Transect | 57 | 10:54:27 AM | 30.03 | 28.89 | 3.73 | 0.826 | 0.986 | 41.018 | - | - |

| Step | Sample | Time | Track (m) | DMG (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Total Q ($m^3/s$) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|---|---|
| In Transect | 58 | 10:54:28 AM | 31.03 | 29.85 | 3.76 | 0.807 | 1.003 | 42.066 | - | - |
| In Transect | 59 | 10:54:29 AM | 32.01 | 30.8 | 3.78 | 0.826 | 0.985 | 43 | - | - |
| In Transect | 60 | 10:54:30 AM | 32.99 | 31.73 | 3.79 | 0.827 | 0.98 | 43.826 | - | - |
| In Transect | 61 | 10:54:31 AM | 34 | 32.67 | 3.79 | 0.843 | 1.007 | 44.571 | - | - |
| In Transect | 62 | 10:54:32 AM | 34.92 | 33.55 | 3.78 | 0.78 | 0.92 | 45.414 | - | - |
| In Transect | 63 | 10:54:33 AM | 35.87 | 34.46 | 3.77 | 0.792 | 0.945 | 46.506 | - | - |
| In Transect | 64 | 10:54:34 AM | 36.83 | 35.37 | 3.76 | 0.9 | 0.959 | 47.591 | - | - |
| In Transect | 65 | 10:54:35 AM | 37.75 | 36.26 | 3.73 | 0.916 | 0.93 | 48.719 | - | - |
| In Transect | 66 | 10:54:36 AM | 38.66 | 37.13 | 3.71 | 0.873 | 0.905 | 49.713 | - | - |
| In Transect | 67 | 10:54:37 AM | 39.59 | 38.03 | 3.69 | 0.871 | 0.933 | 50.84 | - | - |
| In Transect | 68 | 10:54:38 AM | 40.5 | 38.89 | 3.71 | 0.835 | 0.904 | 51.861 | - | - |
| In Transect | 69 | 10:54:39 AM | 41.34 | 39.7 | 3.64 | 0.779 | 0.839 | 52.734 | - | - |
| In Transect | 70 | 10:54:40 AM | 42.19 | 40.51 | 3.69 | 0.809 | 0.849 | 53.608 | - | - |
| In Transect | 71 | 10:54:41 AM | 42.98 | 41.27 | 3.66 | 0.838 | 0.79 | 54.403 | - | - |
| In Transect | 72 | 10:54:42 AM | 43.8 | 42.06 | 3.63 | 0.841 | 0.826 | 55.118 | - | - |
| In Transect | 73 | 10:54:43 AM | 44.61 | 42.84 | 3.6 | 0.845 | 0.812 | 55.797 | - | - |
| In Transect | 74 | 10:54:44 AM | 45.38 | 43.59 | 3.49 | 0.828 | 0.77 | 56.39 | - | - |
| In Transect | 75 | 10:54:45 AM | 46.12 | 44.29 | 3.46 | 0.777 | 0.734 | 56.859 | - | - |
| In Transect | 76 | 10:54:46 AM | 46.82 | 44.97 | 3.46 | 0.806 | 0.698 | 57.4 | 42.75409 | -81.47276 |
| In Transect | 77 | 10:54:47 AM | 47.43 | 45.57 | 3.43 | 0.85 | 0.615 | 57.865 | - | - |
| In Transect | 78 | 10:54:48 AM | 48.08 | 46.19 | 3.44 | 0.822 | 0.65 | 58.265 | - | - |
| In Transect | 79 | 10:54:49 AM | 48.71 | 46.79 | 3.43 | 0.699 | 0.625 | 58.652 | - | - |
| In Transect | 80 | 10:54:50 AM | 49.29 | 47.35 | 3.38 | 0.632 | 0.585 | 59.047 | - | - |
| In Transect | 81 | 10:54:51 AM | 49.75 | 47.78 | 3.31 | 0.549 | 0.463 | 59.322 | - | - |
| In Transect | 82 | 10:54:52 AM | 50.2 | 48.19 | 3.37 | 0.628 | 0.442 | 59.662 | - | - |
| In Transect | 83 | 10:54:53 AM | 50.62 | 48.58 | 3.28 | 0.573 | 0.422 | 59.91 | - | - |
| In Transect | 84 | 10:54:54 AM | 51.03 | 48.96 | 3.24 | 0.58 | 0.414 | 60.146 | - | - |
| In Transect | 85 | 10:54:55 AM | 51.46 | 49.35 | 3.29 | 0.651 | 0.43 | 60.371 | - | - |
| In Transect | 86 | 10:54:56 AM | 51.9 | 49.75 | 3.32 | 0.645 | 0.433 | 60.606 | - | - |
| In Transect | 87 | 10:54:57 AM | 52.34 | 50.15 | 3.33 | 0.609 | 0.441 | 60.858 | - | - |
| In Transect | 88 | 10:54:58 AM | 52.74 | 50.51 | 3.34 | 0.489 | 0.399 | 61.093 | - | - |
| In Transect | 89 | 10:54:59 AM | 53.09 | 50.81 | 3.35 | 0.503 | 0.351 | 61.227 | - | - |

| Step | Sample | Time | Track (m) | DMG (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Total Q ($m^3/s$) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|---|---|
| In Transect | 90 | 10:55:00 AM | 53.31 | 51 | 3.37 | 0.431 | 0.219 | 61.236 | - | - |
| In Transect | 91 | 10:55:01 AM | 53.52 | 51.17 | 3.37 | 0.489 | 0.21 | 61.201 | - | - |
| In Transect | 92 | 10:55:02 AM | 53.75 | 51.39 | 3.38 | 0.473 | 0.236 | 61.26 | - | - |
| In Transect | 93 | 10:55:03 AM | 54 | 51.63 | 3.38 | 0.535 | 0.252 | 61.365 | - | - |
| In Transect | 94 | 10:55:04 AM | 54.22 | 51.83 | 3.38 | 0.472 | 0.213 | 61.486 | - | - |
| In Transect | 95 | 10:55:05 AM | 54.45 | 52.03 | 3.31 | 0.575 | 0.236 | 61.549 | - | - |
| In Transect | 96 | 10:55:06 AM | 54.7 | 52.24 | 3.29 | 0.538 | 0.253 | 61.582 | - | - |
| In Transect | 97 | 10:55:07 AM | 54.95 | 52.41 | 3.3 | 0.465 | 0.244 | 61.54 | - | - |
| In Transect | 98 | 10:55:08 AM | 55.2 | 52.55 | 3.38 | 0.537 | 0.255 | 61.417 | - | - |
| In Transect | 99 | 10:55:09 AM | 55.46 | 52.69 | 3.4 | 0.535 | 0.255 | 61.256 | - | - |
| In Transect | 100 | 10:55:10 AM | 55.69 | 52.9 | 3.42 | 0.539 | 0.234 | 61.318 | - | - |
| In Transect | 101 | 10:55:11 AM | 55.96 | 53.15 | 3.44 | 0.487 | 0.266 | 61.517 | - | - |
| In Transect | 102 | 10:55:12 AM | 56.22 | 53.41 | 3.4 | 0.548 | 0.266 | 61.741 | - | - |
| In Transect | 103 | 10:55:13 AM | 56.47 | 53.64 | 3.34 | 0.542 | 0.243 | 62.097 | - | - |
| In Transect | 104 | 10:55:14 AM | 56.66 | 53.8 | 3.28 | 0.454 | 0.195 | 62.373 | - | - |
| In Transect | 105 | 10:55:15 AM | 56.89 | 53.96 | 3.18 | 0.417 | 0.223 | 62.668 | - | - |
| In Transect | 106 | 10:55:16 AM | 57.07 | 54.12 | 3.11 | 0.43 | 0.188 | 62.907 | 42.75406 | -81.47276 |
| In Transect | 107 | 10:55:17 AM | 57.36 | 54.31 | 2.98 | 0.412 | 0.283 | 63.248 | - | - |
| In Transect | 108 | 10:55:18 AM | 57.64 | 54.53 | 2.85 | 0.334 | 0.28 | 63.494 | - | - |
| In Transect | 109 | 10:55:19 AM | 58.01 | 54.78 | 2.7 | 0.344 | 0.376 | 63.76 | - | - |
| In Transect | 110 | 10:55:20 AM | 58.38 | 55.06 | 2.44 | 0.421 | 0.371 | 64.063 | - | - |
| In Transect | 111 | 10:55:21 AM | 58.77 | 55.38 | 2.14 | 0.337 | 0.382 | 64.329 | - | - |
| In Transect | 112 | 10:55:22 AM | 59.21 | 55.72 | 1.82 | 0.235 | 0.439 | 64.513 | - | - |
| In Transect | 113 | 10:55:23 AM | 59.7 | 56.13 | 1.5 | 0.341 | 0.489 | 64.7 | - | - |
| In Transect | 114 | 10:55:24 AM | 59.96 | 56.38 | 1.15 | 0.308 | 0.261 | 64.767 | - | - |
| In Transect | 115 | 10:55:25 AM | 60.29 | 56.57 | 0.95 | 0.451 | 0.339 | 64.782 | - | - |
| In Transect | 116 | 10:55:26 AM | 60.47 | 56.74 | 0.85 | 0.212 | 0.172 | 64.801 | - | - |
| End Edge | 117 | 10:55:27 AM | 60.52 | 56.74 | 0.77 | 0.161 | 0.049 | 64.943 | - | - |
| End Edge | 118 | 10:55:28 AM | 60.69 | 56.75 | 0.74 | 0.287 | 0.17 | 65.039 | - | - |
| End Edge | 119 | 10:55:29 AM | 60.86 | 56.77 | 0.74 | 0.345 | 0.17 | 65.075 | - | - |
| End Edge | 120 | 10:55:30 AM | 60.95 | 56.77 | 0.79 | 0.284 | 0.096 | 65.071 | - | - |
| End Edge | 121 | 10:55:31 AM | 61.07 | 56.8 | 0.83 | 0.309 | 0.115 | 65.099 | - | - |

| Step | Sample | Time | Track (m) | DMG (m) | Water Depth (m) | Mean Water Column Velocity (m/s) | Boat Speed (m/s) | Total Q ($m^3/s$) | Latitude (°) | Longitude (°) |
|---|---|---|---|---|---|---|---|---|---|---|
| End Edge | 122 | 10:55:32 AM | 61.21 | 56.76 | 0.94 | 0.347 | 0.14 | 65.138 | - | - |
| End Edge | 123 | 10:55:33 AM | 61.27 | 56.76 | 0.93 | 0.354 | 0.059 | 65.129 | - | - |
| End Edge | 124 | 10:55:34 AM | 61.3 | 56.77 | 0.93 | 0.464 | 0.035 | 65.139 | - | - |