

GNSS-Derived Orthometric Heights for Water Level Monitoring and Geoid Accuracy Assessment

GGE4700 – Design Project and Report

Technical Report Presentation

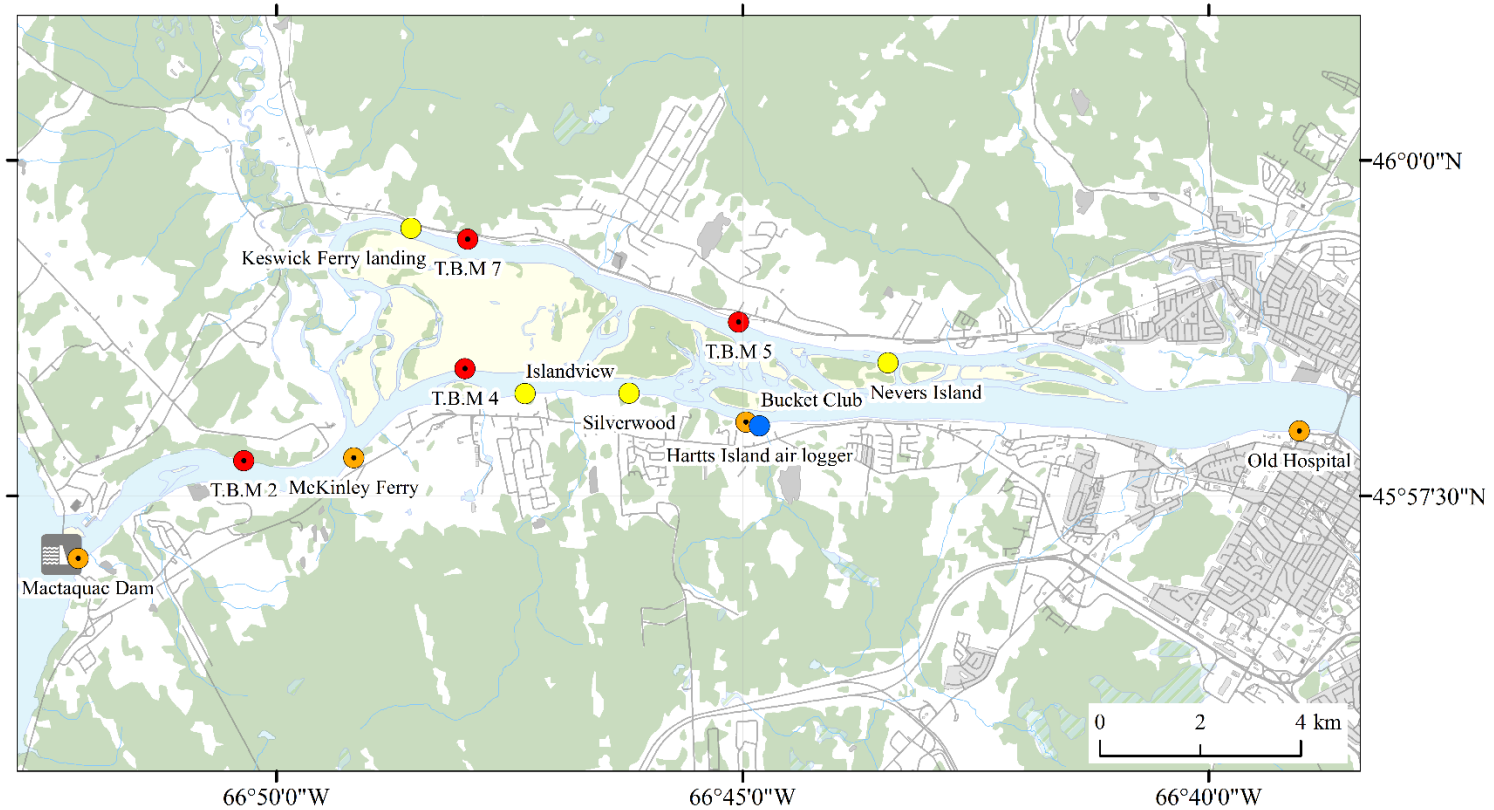
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Supervisor: Dr. Robert Kingdon

- Introduction
- Project Objectives
- Methodology
- Results
- Conclusions

- Mactaquac Aquatic Ecosystem Study (MAES)
 - 3 year project to assess Saint John River
 - Future of Mactaquac Hydroelectric Dam
- 12 river gauge stations
 - Require absolute elevation
- Accuracy assessment of Canadian Geodetic Vertical Datum 2013 (CGVD2013)

Benchmark and Logger Locations



Group, Site

- | | | | |
|---|---|--|--|
| ● MAES, Harts Island air logger | ● MAES, Nevers Island | ● NATECH, McKinley Ferry | ● NATECH, T.B.M 5 |
| ● MAES, Islandview | ● MAES, Silverwood | ● NATECH, Old Hospital | ● NATECH, T.B.M 7 |
| ● MAES, Keswick Ferry landing | ● NATECH, Bucket Club | ● NATECH, T.B.M 2 | |
| | ● NATECH, Mactaquac Dam | ● NATECH, T.B.M 4 | |

1. Establish vertical control near all 12 river gauge locations along the Saint John River with a vertical accuracy of 3 cm using GNSS.
2. Transfer vertical control to river gauges and supply elevations and standard deviations to MAES
3. Assess the accuracy of the new CGVD2013 using local primary leveling control

- Reconnaissance
- GNSS Network Design and Observation
- Differential Leveling
- Field Data Processing

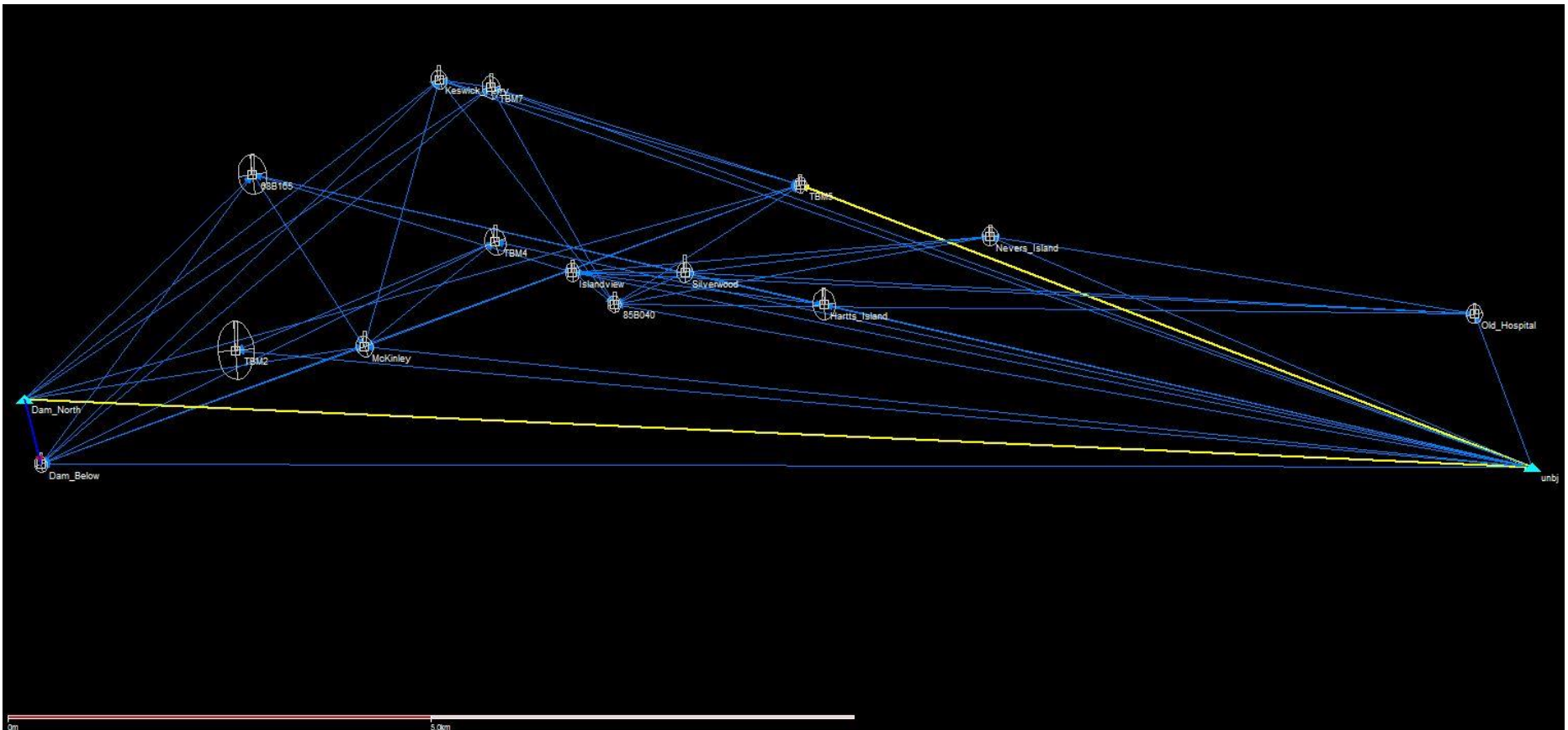
- Located river gauge stations
- Chose suitable GNSS control point
 - Stable and above high waterline
 - Open sky
 - Proximity to river gauge
- Locate vertical control

- 12 gauge stations, 3 control, 1 active control
- 5 GNSS receivers
- 5 planned observation sessions of 4 hours
 - Observed Oct 3rd – 6th
- Addition session on October 10th

- Leveling between GNSS control points and river gauge or TBMs
- 3rd order standards, most loops less than 200m



- GNSS network processing using Trimble Total Control (TTC)
 - Corrected antenna heights
 - 12 degree mask angle and cycle slip removal
 - UNBJ and POWER 2 fixed control
 - 75 baselines total



6. Adjusted Points in WGS84 (Geogr. Coordinates and Std.Dev.)

Point	Latitude	σ	Longitude	σ	Height	σ
68B165	N 45° 58' 52.85232"	26.3mm	W 66° 50' 11.59458"	19.4mm	2.9328m	37.3mm
85B040	N 45° 58' 03.35561"	11.4mm	W 66° 46' 53.21076"	9.0mm	4.4409m	22.1mm
Dam Below	N 45° 57' 02.10723"	10.6mm	W 66° 52' 07.34776"	8.9mm	-18.1951m	20.6mm
Dam North	N 45° 57' 27.15358"	0.0mm	W 66° 52' 16.10513"	0.0mm	30.2780m	0.0mm
Hartts Island	N 45° 58' 03.11590"	20.3mm	W 66° 44' 58.29747"	14.9mm	-21.3541m	30.2mm
Islandview	N 45° 58' 15.63769"	12.9mm	W 66° 47' 16.11919"	9.5mm	-20.0634m	22.5mm
Keswick Ferry	N 45° 59' 29.21375"	12.7mm	W 66° 48' 29.41188"	10.6mm	-20.9709m	24.6mm
McKinley	N 45° 57' 47.15266"	13.8mm	W 66° 49' 10.15050"	11.3mm	-19.0980m	27.8mm
Nevers Island	N 45° 58' 29.22277"	12.9mm	W 66° 43' 27.19351"	10.6mm	-19.6170m	20.8mm
Old Hospital	N 45° 57' 59.06918"	12.6mm	W 66° 39' 01.76412"	10.7mm	-20.0626m	19.5mm
Silverwood	N 45° 58' 15.60606"	13.8mm	W 66° 46' 14.68246"	11.0mm	-20.9268m	30.1mm
TBM2	N 45° 57' 45.73551"	18.8mm	W 66° 50' 20.78925"	24.2mm	-19.7525m	31.9mm
TBM4	N 45° 58' 27.17808"	18.2mm	W 66° 47' 58.57137"	14.4mm	-18.0629m	30.1mm
TBM5	N 45° 58' 48.91379"	10.6mm	W 66° 45' 11.14132"	8.4mm	-21.7572m	17.8mm
TBM7	N 45° 59' 26.12617"	15.4mm	W 66° 48' 00.81361"	12.1mm	-16.7822m	25.6mm
unbj	N 45° 57' 00.75275"	0.0mm	W 66° 38' 30.13708"	0.0mm	22.7400m	0.0mm

- Calculation of orthometric height using Natural Resources Canada GPS-H tool
- Calculate river gauge elevations using leveling data

Point ID	Logger Elev (m)	St. Dev _{Logger} (cm)	Benchmark Elev (m)	St. Dev _{Benchmark} (cm)
Islandview	2.123	2.6	3.61	2.6
Silverwood	1.578	3.4	2.718	3.4
Nevers Island	0.742	2.5	3.959	2.5
Keswick Ferry	1.101	3.0	2.711	3.0
TBM 2	-	-	6.282	3.3
TBM 4	-	-	5.865	3.4
TBM 5	-	-	5.28	2.5
TBM 7	-	-	5.051	3.0
Mactaquac Dam	2.468	2.6	5.939	2.6
McKinley Ferry	2.374	3.2	4.632	3.2
Old Hospital	0.432	2.5	3.443	2.4
Hartt's Island	-	3.4	5.537	3.4

- CGVD2013 accuracy assessment
 - NRCan GNSS on BM
mean = 15.7 cm, st. dev = 7.3 cm

Point ID	H Published (m)	H Calculated (m)	σ Calculated (cm)	Difference (cm)	Test Statistic (y) (cm)	Test at 95% CL
68B165	26.263	26.229	4.0	3.4	7.8	PASS
85B040	27.57	27.648	2.7	-7.8	5.3	FAIL

1. Control was established using GNSS at each of the 12 river gauge locations
 - 7/12 < 3 cm, remaining 5 < 3.4 cm
2. Table of values supplied to MAES
3. CGVD2013 suitable for vertical control for a practical project of this extent (< 20 km)

- Dr. Robert Kingdon - Supervisor
- Dr. Monica Wachowicz - Instructor
- Nathan Hughes – Fieldwork Assistant
- Dr. Tommi Linnansaari – MAES Team Co-Lead
- Dr. Wendy Monk – MAES Team Co-Lead
- Adam Chateauvert, Meghann Bruce and Ben Wallce - MAES Field Technicians