

OKANAGAN BASIN WATER BOARD
OBWB 18-025

BATHYMETRY SURVEY (CROSS SECTIONS) OF OKANAGAN RIVER

MARCH 31, 2019





BATHYMETRY SURVEY (CROSS SECTIONS) OF OKANAGAN RIVER

OKANAGAN BASIN WATER BOARD

REPORT OF FINDINGS (V0)

PROJECT NO.: 181-16858-00
CLIENT REF:OBWB 18-025
DATE: SEPTEMBER 16, 2019

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September 16, 2019

Okanagan Basin Water Board
1450 KLO Road
Kelowna, BC V1W 3Z4

Attention: James Littley, Operations & Grants Manager

Dear Madam/Sir:

Subject: Bathymetry Survey (Cross Sections) of Okanagan River
Client ref.: 2018-RFP-23

WSP Canada Inc is pleased to provide you with our findings for the above mentioned survey services.

The following documentation has been included with the submission:

- 181-16858-00-Coordinates (NAD83 UTM11)-R2.csv
- 181-16858-00 Lat Long UTM Coordinates-R1.csv
- 181-16858-00-HEC-RAS-R1.xls
- 181-16858-00-OkanaganRiver-R2.pdf

I trust that the results are to your satisfaction in terms of the contract.

If you should require any further clarification, please do not hesitate to contact me directly. The opportunity to provide you with survey services is greatly appreciated.

Yours sincerely,

Geoffrey Hobbs, BCIS

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September 16, 2019

Date

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TABLE OF CONTENTS

1	EXECUTIVE SUMMARY.....	1
2	HISTORIC DATA TRANSFORMATION	2
2.1	Primary control.....	2
2.2	Data Transformation	3
2.2.1	Okanagan Lake to Skaha Lake	3
2.2.2	Skaha Lake to Vaseux lake	4
2.2.3	Vaseux lake to Osoyoos lake	4
3	FIELD SURVEY ACTIVITES	9
3.1	Okanagan Lake to Skaha Lake.....	9
3.2	Skaha Lake to Vaseux lake.....	9
3.3	Vaseux lake to Osoyoos lake	10
4	COMMENTARY ON RESULTS.....	11
4.1	Okanagan Lake to Skaha Lake.....	11
4.2	Skaha Lake to Vaseux lake.....	11
4.3	Vaseux lake to Osoyoos lake	11
4.3.1	Cross Sections 25+265 to 24+219 – Improved Channel	11
4.3.2	Cross Sections XS-MT01 to 18+336 – Unimproved Channel	12
4.3.3	Cross Sections 18+251 to 0+799	12
	BIBLIOGRAPHY	13

TABLES

TABLE 1 - UTM11 NAD27 PUBLISHED COORDINATES FROM 1980 SURVEY	2
TABLE 2 - UTM11 NAD83(CSRS) CGVD2013 PUBLISHED COORDINATES OF DRAO FOR EPOCH 2002	2
TABLE 3 - ADJUSTED PRIMARY SURVEY CONTROL IN UTM11 NAD83(CSRS) CGVD20133	
TABLE 4: OKANAGEN LAKE TO SKAHA LAKE - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) CGVD2013] ..	4
TABLE 5: SKAHA LAKE TO VASEUX LAKE - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) ..	3
TABLE 6: VASEUX TO OSOYOOS LAKE 0+799 TO 7+705 - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) ..	4
TABLE 7: VASEUX TO OSOYOOS LAKE 7+507 TO 12.932 - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) ..	5
TABLE 8: VASEUX TO OSOYOOS LAKE 12+932 TO 17+289 - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) ..	6
TABLE 9: VASEUX TO OSOYOOS LAKE 17+289 TO 20+496 - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) ..	7
TABLE 10: VASEUX TO OSOYOOS LAKE 20+498 TO 26+038 - 1980 TRANSFORMED VS. SURVEYED [UTM11 NAD83(CSRS) ..	8

FIGURES

FIGURE 1: SKAHA LAKE TO VASEUX LAKE LINEAR RELATIONSHIP BETWEEN CHAINAGE AND ELEVATION	2
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APPENDICES

A PRIMARY CONTROL ADJUSTMENT REPORT	
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1 EXECUTIVE SUMMARY

WSP Canada Inc. (WSP) was contracted by Okanagan Basin Water Board (OBWB) to complete a bathymetric survey of the Okanagan River to complete updated hydraulic modelling from Okanagan Lake and Osoyoos Lake. The bathymetric survey data was utilized to accurately determine cross section profiles at 274 locations previously surveyed in 1980 and 11 additional cross section profiles requested by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD). In total, 285 cross sections were surveyed as part of this project scope.

Project datum and reference frame was established by a GNSS static control survey of monuments utilized in 1980 and 1998 surveys and tied to Canadian Active Control Station (CACS) DRAO WCDA-PGC (887006) located in Penticton, BC. Additional cross section monuments were surveyed throughout the project area and analysis completed to determine the parameters of the data transformations. Historic cross section data from 1980 and 1998 was transformed from UTM11 NAD27 to UTM11 NAD83 and elevations were updated to the Canadian Geodetic Vertical Datum of 2013 (CGVD2013) referenced to the published coordinates of DRAO WCDA-PGC (887006) (2002).

Analysis of the 2018/2019 survey compared to the 1980 and 1998 survey was completed to highlight changes in the channel, riverbed, banks and diking system. General trend of the comparison shows a stable riverbed within the improved channel and varying changes in the unimproved channel. Various changes are evident in the diking system since 1980 and very little change from the survey in 1998. Instances of erosion are present along the riverbanks between each survey epoch that could be attributed to high flows during past and recent flooding events.

2 HISTORIC DATA TRANSFORMATION

2.1 PRIMARY CONTROL

Primary survey control was determined based on an even distribution of control utilized in the 1980 survey throughout the project area. Monuments were chosen with consideration to a minimally obstructed horizon suitable for static GNSS observations, stability and current condition. The selected primary control network consists of the following monuments with published UTM11 NAD27 coordinates from the 1980 survey:

MONUMENT	NORTHING	EASTING	ELEVATION
Mon 959	5485630.722	310562.327	342.727
Mon 957	5484042.255	311713.161	343.353
Mon 953	5480874.731	311808.593	340.847
Mon 951	5467467.783	312774.794	332.405
Mon 948	5465863.872	314039.016	329.971
Mon 944	5455106.354	314775.057	303.748
Mon 918	5444524.059	312212.212	287.516
Mon 914	5441598.648	313867.913	282.635

Table 1 - UTM11 NAD27 Published Coordinates from 1980 Survey

Natural Resources Canada (NRCan) operates a Canadian Active Control System (CACS) station west of Okanagan Falls, BC that is part of the Western Canada Deformation Array – DRAO WCDA-PGC (887006). The published coordinates of DRAO at the adopted epoch for British Columbia (2002) in the UTM11 NAD83(CSRS) CGVD2013 reference frame are:

MONUMENT	NORTHING	EASTING	ELEVATION
DRAO	5466635.023	309256.447	558.555

Table 2 - UTM11 NAD83(CSRS) CGVD2013 Published Coordinates of DRAO for Epoch 2002

At the time of this project GeoBC has yet to update the elevations provincial survey control network to the CGVD2013 vertical datum. As such, the reference frame for this survey was based on the published coordinates of DRAO.

Static GNSS observations were collected for the primary control network with simultaneous occupation of all monuments. Observations available for DRAO spanning the primary control network occupation were downloaded under the Open Government Licence – Canada. Static baselines between each monument were processed and the resulting vectors utilized in a minimally constrained least-squares network adjustment holding the published coordinates of DRAO fixed in three dimensions (Northing, Easting and Elevation) (see Appendix A for full report)

The resulting coordinates provide the basis for the bathymetric survey and subsequent historical data transformation.

MONUMENT	NORTHING	EASTING	ELEVATION
Mon 959	5485839.503	310481.4238	342.880
Mon 957	5484251.055	311632.245	343.589
Mon 953	5481083.458	311727.549	341.042
Mon 951	5467676.711	312692.793	332.698
Mon 948	5466073.344	313957.582	330.153
Mon 944	5455315.877	314695.975	303.958
Mon 918	5444733.483	312131.676	287.680
Mon 914	5441807.755	313786.708	282.797

Table 3 - Adjusted Primary Survey Control in UTM11 NAD83(CSRS) CGVD2013

2.2 DATA TRANSFORMATION

Monuments referenced during the 1980 and subsequent surveys were located and surveyed at as many cross sections as time would allow. The results of the monument survey showed decisive division of the survey control between the three project areas:

- 1 Okanagan Lake to Skaha Lake
- 2 Skaha Lake to Vaseux Lake
- 3 Vaseux Lake to Osoyoos Lake

Therefore, the chosen course of action was to tailor the data transformation to each area rather than one all encompassing solution that would prove too rigid to yield accurate results over the length of the project.

The NAD27 to NAD83 data transformation can also be accomplished with the NRCan NTv2 tool that utilizes developed grid shift files to account for the high distortion in the NAD27 datum. However, the NTv2 transformation yields varying accuracies depending on geographic location. The results of the NTv2 transformation of the 1980 NAD27 published coordinates compared to the NAD83(CSRS) surveyed coordinates showed between sub-centimetre and metre differences and could not be utilized for this project.

2.2.1 OKANAGAN LAKE TO SKAHA LAKE

The 1980 survey between Okanagan Lake and Skaha Lake was referenced horizontally to the Integrated Survey Monument (ISA) network established by Surveys and Mapping Branch as noted in the A-5221-Index of the 1980 survey plans. The comparison between the published 1980 UTM11 NAD27 coordinates and the surveyed UTM11 NAD83(CSRS) supported a 3 Parameter Transformation (Translation in Northing, Easting, Elevation) with the following parameters:

ΔN: 208.757m

ΔE: -80.976m

ΔELEV: 0.195m

The resulting transformation comparison with the surveyed coordinates yields the results in Table 4 on the following page.

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED			UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED vs UTM11 NAD83(CSRS) CGVD2013 SURVEYED			
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	ΔELEV	
Mon 959	5485839.479	310481.351	342.922	5485839.503	310481.424	342.880	0.024	0.073	-0.042	
957-9	5485140.824	310720.541	342.185	5485140.798	310720.589	342.122	-0.026	0.048	-0.063	
957-3	5484591.581	311281.655	344.115	5484591.598	311281.723	344.082	0.017	0.068	-0.033	
Mon 957	5484251.012	311632.185	343.548	5484251.055	311632.245	343.589	0.043	0.060	0.041	
Mon 956	5483944.269	311786.145	342.766	5483944.295	311786.188	342.783	0.026	0.043	0.017	
955-8	5483816.551	311805.05	343.205	5483816.555	311805.057	343.220	0.004	0.007	0.015	
955-7	5483674.617	311826.059	342.825	5483674.630	311826.090	342.802	0.013	0.031	-0.023	
955-5	5483343.465	311875.075	342.655	5483343.470	311875.097	342.673	0.005	0.022	0.018	
955-4	5483193.054	311897.339	342.255	5483193.047	311897.354	342.269	-0.007	0.015	0.014	
955-3	5483044.433	311919.338	341.935	5483044.438	311919.331	341.951	0.005	-0.007	0.016	
Mon 955	5482606.591	311984.149	341.204	5482606.588	311984.134	341.219	-0.003	-0.015	0.015	
Mon 954	5482339.176	311964.251	341.338	5482339.168	311964.241	341.348	-0.008	-0.010	0.010	
953-8	5482191.535	311936.428	341.615	5482191.536	311936.399	341.606	0.001	-0.029	-0.009	
953-7	5482041.535	311908.161	341.325	5482041.503	311908.133	341.357	-0.032	-0.028	0.032	
953-6	5481898.286	311881.165	341.065	5481898.278	311881.118	341.052	-0.008	-0.047	-0.013	
953-4	5481604.439	311825.79	340.665	5481604.441	311825.715	340.625	0.002	-0.075	-0.040	
953-3	5481457.485	311798.097	340.715	5481457.467	311798.000	340.755	-0.018	-0.097	0.040	
Mon 953	5481083.488	311727.617	341.042	5481083.458	311727.549	341.042	-0.030	-0.068	0.000	
							STDEV	0.019	0.049	0.029

Table 4: Okanagan Lake to Skaha Lake - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS) CGVD2013]

2.2.2 SKAHA LAKE TO VASEUX LAKE

Historical survey information between Skaha Lake and Vaseux Lake was referenced horizontally to Okanagan Flood Control (OFC) Monuments established by J.G.S Hirtle, BCLS as noted in the A-5221-Index of the 1980 survey plans. The comparison between the published 1980 UTM11 NAD27 coordinates and the surveyed UTM11 NAD83(CSRS) supported a 6 Parameter Horizontal Least Squares Transformation (Translation, Rotation and Scale) with the following parameters:

Translation

ΔN: 209.174m
ΔE: -81.720m

Rotation

X axis: 0°04'18"
Y axis: -0°05'45"
Z axis: 359°58'44"

Scale

Horizontal: 0.9999578760

Initially, a 7 Parameter Least Squares Transformation was attempted however, the published CGVD28 elevations in this section appeared to show a linear relationship to the CGVD2013 surveyed elevations based on the river chainage.

SKAHA TO VASEUX CHAINAGE VS ELEVATION DIFFERENCE

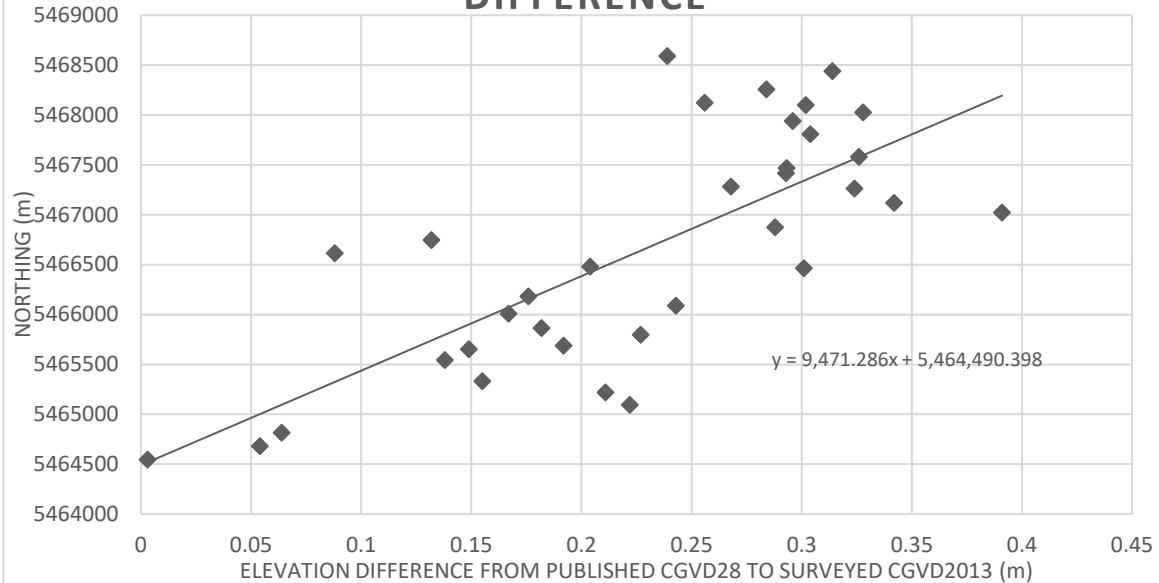


Figure 1: Skaha Lake to Vaseux Lake Linear Relationship Between Chainage and Elevation

The linear relationship between the datasets was used to update the published CGVD28 elevations to the CGVD2013 reference frame.

The resulting transformation comparison with the surveyed coordinates yields the results in Table 5 on the following page.

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED			UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED vs UTM11 NAD83(CSRS) CGVD2013 SURVEYED		
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	ΔELEV
951-6	5468307.854	312551.775	334.813	5468307.872	312551.745	334.712	0.018	-0.030	-0.101
951-5	5468235.207	312585.460	334.745	5468235.226	312585.434	334.678	0.019	-0.026	-0.067
951-4	5468148.421	312611.040	334.276	5468148.417	312611.021	334.186	-0.004	-0.019	-0.090
951-3	5468018.211	312633.623	333.812	5468018.203	312633.569	333.744	-0.008	-0.054	-0.068
951-1	5467789.199	312673.341	332.828	5467789.176	312673.275	332.806	-0.023	-0.066	-0.022
Mon 951	5467676.742	312692.848	332.741	5467676.711	312692.793	332.698	-0.031	-0.055	-0.043
950-4	5467624.562	312704.650	332.761	5467624.573	312704.604	332.723	0.011	-0.046	-0.038
950-3	5467492.310	312769.130	332.937	5467492.228	312769.147	332.888	-0.082	0.017	-0.049
950-2	5467472.257	312782.746	333.025	5467472.247	312782.752	333.034	-0.010	0.006	0.009
950-1	5467327.509	312893.835	332.000	5467327.690	312893.977	332.042	0.181	0.142	0.042
Mon 950	5467229.929	312968.728	331.639	5467229.973	312968.800	331.741	0.044	0.072	0.102
949-5	5467082.087	313057.726	331.544	5467082.092	313057.772	331.558	0.005	0.046	0.014
949-4	5466955.166	313134.129	331.230	5466955.167	313134.169	331.102	0.001	0.040	-0.128
949-2	5466690.742	313293.306	330.982	5466690.735	313293.303	330.954	-0.007	-0.003	-0.028
949-1	5466672.931	313304.028	330.830	5466672.899	313304.026	330.901	-0.032	-0.002	0.071
948-4	5466391.411	313572.559	330.651	5466391.400	313572.552	330.626	-0.011	-0.007	-0.025
948-3	5466297.804	313685.881	330.391	5466297.756	313685.866	330.443	-0.048	-0.015	0.052
948-2	5466219.245	313780.986	330.153	5466219.150	313780.921	330.137	-0.095	-0.065	-0.016
Mon 948	5466073.357	313957.599	330.138	5466073.344	313957.582	330.153	-0.013	-0.017	0.015
947-4	5466006.332	314022.540	330.170	5466006.285	314022.451	330.237	-0.047	-0.089	0.067
947-3	5465898.695	314126.830	330.109	5465898.641	314126.756	330.152	-0.054	-0.074	0.043
947-2	5465863.648	314160.786	329.995	5465863.602	314160.688	329.999	-0.046	-0.098	0.004
947-1	5465754.575	314266.467	329.913	5465754.518	314266.378	329.918	-0.057	-0.089	0.005
946-3	5465542.933	314472.910	329.371	5465542.869	314472.848	329.415	-0.064	-0.062	0.044
946-2	5465428.748	314567.623	328.999	5465428.749	314567.614	329.111	0.001	-0.009	0.112
946-1	5465303.996	314634.024	329.756	5465303.934	314633.924	329.892	-0.062	-0.100	0.136
945-19	5465026.129	314756.551	329.137	5465026.042	314756.469	329.144	-0.087	-0.082	0.007
945-18	5464890.766	314817.675	329.062	5464890.763	314817.548	329.074	-0.003	-0.127	0.012
945-17	5464755.258	314878.866	329.098	5464755.174	314878.945	329.073	-0.084	0.079	-0.025
							STDEV	0.052	0.060
									0.062

Table 5: Skaha Lake to Vaseux Lake - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS)]

2.2.3 VASEUX LAKE TO OSOYOOS LAKE

Similar to the cross sections between Skaha Lake and Vaseux Lake, the historical survey information for Vaseux Lake to Osoyoos Lake was referenced horizontally to Okanagan Flood Control (OFC) Monuments established by J.G.S Hirtle, BCLS. The comparison between the published 1980 UTM11 NAD27 coordinates and the surveyed UTM11 NAD83(CSRS) could not support a universal 7 Parameter Horizontal Least Squares Transformation (Translation, Rotation and Scale). The data transformation was best fit using multiple groupings of cross sections based on geographic proximity and a separate 7 Parameter Least Squares Transformation for each group.

The evident data groupings were found to be the following historical cross section ranges:

0+799 to 7+507

7+507 to 12+932

12+932 to 17+289

17+289 to 20+496

20+496 to 26+038

The resulting parameters of the 7 Parameter Least Squares Transformation for each grouping and resulting comparison between the transformed and surveyed coordinates are shown over the next several pages:

0+799 to 7+507

TRANSLATION	ROTATION	SCALE
ΔN : 209.151m	X axis: $0^{\circ}00'15''$	Horizontal: 0.9999740219
ΔE : -81.105m	Y axis: $-0^{\circ}00'27''$	
ΔZ : -0.147m	Z axis: $00^{\circ}00'45''$	

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED				UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED vs UTM11 NAD83(CSRS) CGVD2013 SURVEYED		
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	$\Delta ELEV$	
Mon 914	5441807.775	313786.693	282.797	5441807.755	313786.708	282.797	-0.021	0.015	0.000	
Mon 912	5440377.456	314940.226	281.476	5440377.468	314940.215	281.476	0.012	-0.011	0.000	

Table 6: Vaseux to Osoyoos Lake 0+799 to 7+705 - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS)]

7+507 to 12+932

TRANSLATION	ROTATION	SCALE
ΔN: 209.380m	X axis: -0°00'02"	Horizontal: 1.0000886024
ΔE: -79.933m	Y axis: 0°00'03"	
ΔZ: 0.204m	Z axis: 0°00'39"	

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED			UTM11 NAD83(CSRS) CGVD2013 SURVEYED		
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	ΔELEV
Mon 926	5449156.912	314796.249	295.224	5449156.943	314796.226	295.214	0.031	-0.023	-0.010
925-3	5448608.182	314448.920	293.900	5448608.224	314448.918	293.911	0.042	-0.002	0.011
924-6	5448324.034	314259.289	293.665	5448323.985	314259.251	293.679	-0.049	-0.038	0.014
924-1	5447775.064	313711.822	293.113	5447774.990	313711.864	293.128	-0.074	0.042	0.015
Mon 924	5447687.784	313624.782	292.817	5447687.759	313624.809	292.845	-0.025	0.027	0.028
923-3	5447436.370	313373.314	291.306	5447436.391	313373.373	291.318	0.021	0.059	0.012
Mon 923	5447173.969	313110.856	291.167	5447173.946	313110.875	291.151	-0.023	0.019	-0.016
922-7	5447144.194	313081.286	291.210	5447144.201	313081.282	291.212	0.007	-0.004	0.002
922-6	5447037.391	312975.218	291.507	5447037.384	312975.253	291.483	-0.007	0.035	-0.024
922-4	5446827.141	312766.416	290.663	5446827.153	312766.457	290.679	0.012	0.041	0.016
922-2	5446678.449	312618.749	289.609	5446678.481	312618.784	289.632	0.032	0.035	0.023
Mon 918	5444733.465	312131.698	287.682	5444733.483	312131.676	287.680	0.018	-0.022	-0.002
							STDEV	0.034	0.030
									0.015

Table 7: Vaseux to Osoyoos Lake 7+507 to 12+932 - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS)]

12+932 to 17+289

TRANSLATION	ROTATION	SCALE
ΔN: 209.363m	X axis: -0°00'16"	Horizontal: 1.0000104786
ΔE: -79.317m	Y axis: 0°02'09"	
ΔZ: 0.174m	Z axis: 0°00'18"	

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED			UTM11 NAD83(CSRS) CGVD2013 SURVEYED			
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	ΔELEV	
931-1	5450782.125	314508.098	297.355	5450782.137	314508.055	297.286	0.012	-0.043	-0.069	
927-2	5449680.580	314907.812	296.168	5449680.586	314907.850	296.134	0.006	0.038	-0.034	
926-2	5449350.586	314873.815	295.042	5449350.571	314873.804	295.010	-0.015	-0.011	-0.032	
926-1	5449209.169	314822.201	294.968	5449209.146	314822.199	295.014	-0.023	-0.002	0.046	
							STDEV	0.014	0.029	0.042

Table 8: Vaseux to Osoyoos Lake 12+932 to 17+289 - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS)]

17+289 to 20+496

TRANSLATION	ROTATION	SCALE
ΔN: 209.503m	X axis: -0°00'04"	Horizontal: 1.0000585803
ΔE: -79.085m	Y axis: -0°00'06"	
ΔZ: 0.205m	Z axis: 359°59'56"	

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED			UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED vs UTM11 NAD83(CSRS) CGVD2013 SURVEYED			
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	ΔELEV	
945-1	5456063.862	314921.748	308.131	5456063.952	314921.745	308.144	0.090	-0.003	0.013	
Mon 945	5455937.517	314879.073	307.432	5455937.547	314879.060	307.434	0.030	-0.013	0.002	
944-11	5455866.198	314829.109	306.980	5455866.161	314829.094	306.998	-0.037	-0.015	0.018	
944-5	5455639.928	314650.442	305.821	5455639.911	314650.443	305.835	-0.017	0.001	0.014	
Mon 944	5455315.890	314695.964	303.962	5455315.877	314695.975	303.958	-0.013	0.011	-0.004	
943-2	5455052.048	314615.290	303.452	5455052.038	314615.313	303.430	-0.010	0.023	-0.022	
943-1	5455013.650	314591.287	303.582	5455013.647	314591.323	303.603	-0.003	0.036	0.021	
942-2	5454892.121	314556.813	303.010	5454892.101	314556.839	303.020	-0.020	0.026	0.010	
942-1	5454758.242	314539.312	302.768	5454758.211	314539.341	302.791	-0.031	0.029	0.023	
Mon 942	5454692.053	314530.662	302.350	5454692.017	314530.680	302.353	-0.036	0.018	0.003	
941-1	5454425.357	314545.439	301.802	5454425.358	314545.449	301.753	0.001	0.010	-0.049	
Mon 940	5454231.427	314609.950	300.969	5454231.420	314609.950	300.969	-0.007	0.000	0.000	
Mon 941	5454131.038	314612.258	300.725	5454130.860	314612.275	300.815	-0.178	0.017	0.090	
939-2	5453826.757	314642.134	300.608	5453826.630	314642.126	300.633	-0.127	-0.008	0.025	
Mon 939	5453614.823	314574.791	300.853	5453614.850	314574.774	300.853	0.027	-0.017	0.000	
938-4	5453535.821	314531.127	300.656	5453535.835	314531.092	300.653	0.014	-0.035	-0.003	
938-3	5453428.691	314438.429	300.097	5453428.709	314438.421	300.063	0.018	-0.008	-0.034	
938-2	5453370.126	314364.819	300.078	5453370.166	314364.850	300.053	0.040	0.031	-0.025	
938-1	5453302.283	314285.749	300.129	5453302.285	314285.744	300.134	0.002	-0.005	0.005	
							STDEV	0.057	0.019	0.028

Table 9: Vaseux to Osoyoos Lake 17+289 to 20+496 - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS)]

20+496 to 26+038

TRANSLATION	ROTATION	SCALE
ΔN: 209.989m	X axis: 0°00'03"	Horizontal: 1.0000498873
ΔE: -79.672m	Y axis: 0°00'16"	
ΔZ: 0.249m	Z axis: 359°59'11"	

UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED				UTM11 NAD83(CSRS) CGVD2013 SURVEYED			UTM11 NAD83(CSRS) CGVD2013 1980 TRANSFORMED vs UTM11 NAD83(CSRS) CGVD2013 SURVEYED			
MONUMENT	NORTHING	EASTING	ELEV	NORTHING	EASTING	ELEV	ΔN	ΔE	ΔELEV	
945-15	5460790.673	316086.148	330.953	5460790.695	316086.124	330.982	0.022	-0.024	0.029	
945-12	5460418.232	315993.862	329.032	5460418.271	315993.874	328.971	0.039	0.012	-0.061	
945-11	5460262.528	315935.340	329.610	5460262.480	315935.355	329.611	-0.048	0.015	0.001	
945-9	5460115.557	315926.372	329.822	5460115.566	315926.399	329.841	0.009	0.027	0.019	
945-8	5459967.269	315905.057	330.282	5459967.264	315905.065	330.283	-0.005	0.008	0.001	
945-7	5459828.139	315862.825	329.391	5459828.126	315862.837	329.404	-0.013	0.012	0.013	
945-6	5459687.446	315941.800	329.640	5459687.395	315941.743	329.626	-0.051	-0.057	-0.014	
945-4	5459422.383	316022.364	329.700	5459422.400	316022.396	329.734	0.017	0.032	0.034	
945-3	5459274.021	316038.240	329.284	5459274.026	316038.240	329.280	0.005	0.000	-0.004	
945-2	5459116.914	316061.091	329.028	5459116.940	316061.067	329.011	0.026	-0.024	-0.017	
102	5458855.067	316106.576	327.566	5458854.980	316106.542	327.541	-0.087	-0.034	-0.025	
							STDEV	0.037	0.027	0.026

Table 10:Vaseux to Osoyoos Lake 20+498 to 26+038 - 1980 Transformed vs. Surveyed [UTM11 NAD83(CSRS)]

3 FIELD SURVEY ACTIVITES

3.1 OKANAGAN LAKE TO SKAHA LAKE

In December of 2018 crews began surveying cross sections at the south end of Okanagan Lake. The bathymetric survey boat (Hydrone) was implemented and relied upon to increase productivity and data quality of the profile at the bed of the river.

The top of the dike and bank of the river were surveyed using a Trimble RTK system consisting of 2 GNSS receivers: A base station set up over a control monument and rover to record observations. Several control monuments were utilized throughout the project area and are discussed in depth in previous sections of this report.



The vast majority of cross sections promoted the use of the bathymetric survey boat which records depth soundings and an associated elevation. This system consisted of an RC pontoon boat equipped with an RTK rover and sonar unit. The Hydrone navigated across the river at each cross section and along the center of the channel between cross sections to record the thalweg.

In areas where the water was less than 0.5m (approx.) the Hydrone could not be utilized due to limitations of the sonar technology. In this situation chest waders were required and the bed was surveyed on foot.

3.2 SKAHA LAKE TO VASEUX LAKE

South of Skaha Lake below the dam at Okanagan Falls proved to be much more challenging than areas north of Skaha Lake. Increased water flow, rocky cliffs on the west bank and winter weather forced the crew to take extra precautions to mitigate safety hazards.

The southern portion of this section presented uniform banks and slow-moving water allowing the crew to complete cross sections promptly. Minimal ice buildup and vehicle access allowed utilization of the Hydrone. By the end of January 2019, the crew had completed cross sections up to Vaseux Lake.



3.3 VASEUX LAKE TO OSOYOOS LAKE

North of McIntyre Bluff and the rockfall below added some complexity and consideration regarding safe access to the west bank of the river. This was mitigated using kayaks.

The additional cross sections added below McIntyre Dam proved to be a challenge but with some planning, discussions on safety and creative thinking the crew was able to successfully complete the cross sections by coordinating with the dams operations personnel. The flow rates were decreased for short periods of time to allow cross sections to be surveyed on foot.



Considerations were made for salmon habitat below McIntyre Bluff extending to the north end of Oliver. Working closely with the Okanagan Nation Alliance (ONA) representatives the crew determined exactly which cross sections were to be postponed until after spawning season. Any cross sections in the salmon habitat which warranted the use of the bathymetric survey boat were also completed as the ONA condoned its low impact use in these areas. In the spring after the spawning season the crew returned to any restricted areas and completed the survey on foot.

Through the town of Oliver extending south to Osoyoos Lake the Okanagan river is primarily a uniform channel. Crews worked diligently with the end goal in sight. Vehicular access on both sides of the dike combined with slow moving water promoted use of the bathymetric survey boat. Crews worked from one drop structure to the next, utilizing them for quick access to the opposite bank. By the beginning of March 2019 the bulk of the survey work was completed as crews reached Osoyoos Lake.

4 COMMENTARY ON RESULTS

4.1 OKANAGAN LAKE TO SKAHA LAKE

Forty-three (43) cross sections were surveyed from Okanagan Lake to Skaha Lake. Historical cross sections in this area were completed during the 1980 survey. Generally, the 2018/2019 cross sections compare very well to the 1980 cross sections within the water course. There are slight variations where the riverbed shows erosion and accretion in the channel especially near the bottom of the banks. Significant changes in the riverbed are evident at cross sections 3+234 and 3+362 which falls near the bridge at Green Mountain Road and the inlet from Shingle Creek. Substantial changes to the left bank and dike over these cross sections due to Highway 97 upgrades since the 1980 survey could be the contributing factor to the riverbed differences.

The right dike for this section has remained stable with little change to note. However, notable changes are evident in the left dike from where Highway 97 begins to parallel the river, at cross section 4+206, to cross section 2+319.

4.2 SKAHA LAKE TO VASEUX LAKE

Cross sections surveyed from Skaha Lake to Vaseux Lake totalled Forty (40) with datasets available from the 1980 and 1998 surveys for comparison. Generally, the 2018/2019 cross sections compare closely with the 1980 and 1998 cross sections within the water course. There are slight variations where the riverbed shows erosion and accretion in the channel over the three epochs. The 2018/2019 survey shows more detail along the cross section within the river compared to the previous surveys. The increased detail can be attributed to the difference in methodology and use of single beam sonar technology.

The diking system in this section shows stability with only minor variations to note between the three surveys. Minor erosion along the face of the dikes is evident in some of the cross sections as shown in cross section 31+650. Past and recent flooding events could possibly contribute to this variation as this portion of the dikes looks to be relatively unchanged from the 1980 to the 1998 survey.

4.3 VASEUX LAKE TO OSOYOOS LAKE

The section from Vaseux Lake to Osoyoos Lake makes up Two Hundred Two (202) cross sections of the Two Hundred Eighty-Five (285) total. In this section, the survey from 1998 completed cross sections from 20+548 to 0+799. From cross section 25+265 to 20+661 only cross sections from the 1980 survey were available for comparison. The cross sections from Vaseux Lake to Osoyoos Lake can be segment in three (3) distinct areas, namely:

- 1 Cross Sections 25+265 to 24+219 – Improved Channel
 - 2 Cross Sections XS-MT01 to 18+336 – Unimproved Channel
 - 3 Cross Sections 18+251 to 0+799
-

4.3.1 CROSS SECTIONS 25+265 TO 24+219 – IMPROVED CHANNEL

The riverbed in this section show only minor variations from the 1980 survey to the 2018/2019 survey. This section is void of an established diking system. As such, the riverbanks in this area compare very well between the two surveys with very little notable change evident.

4.3.2 CROSS SECTIONS XS-MT01 TO 18+336 – UNIMPROVED CHANNEL

This section of the river shows the most variation between the 1980, 1998 and 2018/2019 surveys which is expected of a natural river channel. There are significant changes in the location of the thalweg, riverbed and banks throughout the unimproved channel. Some of the most significant variation can be attributed to the Highway 97 bridge upgrades between cross section 20+548 and 20+496. Overall, the 2018/2019 survey compares more closely to the 1998 survey which is expected as the channel moves over time.

The diking system in this section shows no significant changes between survey epochs and appears to be relatively stable.

4.3.3 CROSS SECTIONS 18+251 TO 0+799

Much of this section shows a stable riverbed between the 1980, 1998, and 2018/2019 surveys. Minor changes in the riverbed due to erosion and accretion are evident but nothing significantly notable with the exception in the area of the recently constructed offset dike near Oliver, BC from cross sections 17+289 to 16+419. There are clear changes in the channel where this dike has been constructed.

Similar to the riverbed, the diking system in this area has remained virtually unchanged since 1980 with the only exception being the offset dike near Oliver, BC.

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APPENDIX

A

PRIMARY CONTROL
ADJUSTMENT REPORT

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312
MicroSurvey STAR*NET-PRO Version 9,1,4,7868
Run Date: Sun Mar 24 2019 10:58:42

Summary of Files Used and Option Settings

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Project Folder and Data Files

Project Name 181-16858-00_SURVEY CONTROL NETWORK ADJUSTMENT
(UTM11NAD83CGVD2013A)_20190312
Project Folder \\FSRVCLONAS1.FOCUSCORP.CA\GEOF2FCAD\...\TBC\ADJUSTMENT
Data File List 1. 181-16858-00_Survey Control Network Adjustment
(UTM11NAD83CGVD2013a)_20190312.dat
2. 181-16858-00_Survey Control Network Adjustment
(UTM11NAD83CGVD2013a)_20190312.gps

Project Option Settings

STAR*NET Run Mode	: Adjust with Error Propagation
Type of Adjustment	: 3D
Project Units	: Meters; DMS
Coordinate System	: UTM83-11
Geoid Height Model	: C:\PROGRAMDATA\...\CGG2013AN83.BYN
Longitude Sign Convention	: Positive West
Input/Output Coordinate Order	: North-East
Angle Data Station Order	: At-From-To
Distance/Vertical Data Type	: Slope/Zenith
Convergence Limit; Max Iterations	: 0.001000; 15
Default Coefficient of Refraction	: 0.070000
Create Coordinate File	: Yes
Create Geodetic Position File	: No
Create Ground Scale Coordinate File	: No
Create Dump File	: No
GPS Vector Standard Error Factors	: None
GPS Vector Centering (Meters)	: 0.0000
GPS Vector Transformations	: Solve for Scale and Rotations

↑

Summary of Unadjusted Input Observations

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Number of Entered Stations (Meters) = 1

Fixed Stations	N	E	Elev	Description
DRAO	5466635.0230	309256.4470	558.5550	

Number of GPS Vector Observations (Meters) = 41

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

From	DeltaX	StdErrX	CorrelXY	HI
To	DeltaY	StdErrY	CorrelXZ	HT
	DeltaZ	StdErrZ	CorrelYZ	
(V1 PostProcessed 14-DEC-2018 16:13:37.0 181-16858-00-000-00_20181214_static_r1.asc)				
102	-7230.9945	0.0042	0.8446	0.000
DRAO	-8736.6021	0.0065	-0.8257	0.000
	-9290.1397	0.0084	-0.8830	
(V2 PostProcessed 14-DEC-2018 16:13:37.0 181-16858-00-000-00_20181214_static_r1.asc)				
102	542.4269	0.0029	0.8486	0.000
100	3808.3542	0.0043	-0.8371	0.000
	3061.9573	0.0055	-0.8815	
(V3 PostProcessed 14-DEC-2018 16:46:37.0 181-16858-00-000-00_20181214_static_r1.asc)				
102	1008.6062	0.0021	0.7595	0.000
101	2189.5036	0.0029	-0.7547	0.000
	2057.1414	0.0037	-0.8298	
(V4 PostProcessed 14-DEC-2018 18:01:52.0 181-16858-00-000-00_20181214_static_r1.asc)				
102	-3204.8943	0.0034	0.8463	0.000
104	-11200.7161	0.0053	-0.8158	0.000
	-9724.1156	0.0068	-0.8845	
(V5 PostProcessed 14-DEC-2018 21:35:27.0 181-16858-00-000-00_20181214_static_r1.asc)				
105	-983.2651	0.0051	0.8496	0.000
DRAO	10063.4759	0.0094	-0.8185	0.000
	7452.8936	0.0118	-0.9256	
(V6 PostProcessed 14-DEC-2018 16:08:37.0 181-16858-00-000-00_20181214_static_r1.asc)				
100	-7773.4293	0.0051	0.8767	0.000
DRAO	-12544.9671	0.0076	-0.8643	0.000
	-12352.0973	0.0098	-0.8977	
(V7 PostProcessed 14-DEC-2018 16:46:37.0 181-16858-00-000-00_20181214_static_r1.asc)				
DRAO	8239.6049	0.0060	0.8823	0.000
101	10926.1072	0.0088	-0.8601	0.000
	11347.3034	0.0118	-0.8973	
(V8 PostProcessed 14-DEC-2018 18:01:52.0 181-16858-00-000-00_20181214_static_r1.asc)				

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

DRAO	4026.1051	0.0023	0.7912	0.000
104	-2464.1048	0.0036	-0.7666	0.000
	-433.9581	0.0045	-0.8540	

(V9 PostProcessed 14-DEC-2018 16:46:37.0
 181-16858-00-000-00_20181214_static_r1.asc)

100	466.1810	0.0021	0.7393	0.000
101	-1618.8472	0.0029	-0.7365	0.000
	-1004.8201	0.0036	-0.8149	

(V10 PostProcessed 14-DEC-2018 18:01:52.0
 181-16858-00-000-00_20181214_static_r1.asc)

104	4213.5041	0.0051	0.8801	0.000
101	13390.2243	0.0073	-0.8302	0.000
	11781.2835	0.0098	-0.8856	

(V11 PostProcessed 14-DEC-2018 18:01:52.0
 181-16858-00-000-00_20181214_static_r1.asc)

100	-3747.3296	0.0058	0.8850	0.000
104	-15009.0843	0.0084	-0.8462	0.000
	-12786.0814	0.0110	-0.8867	

(V12 PostProcessed 14-DEC-2018 21:35:27.0
 181-16858-00-000-00_20181214_static_r1.asc)

105	3042.8436	0.0034	0.8335	0.000
104	7599.3700	0.0062	-0.8097	0.000
	7018.9199	0.0077	-0.9245	

(V13 PostProcessed 14-DEC-2018 21:35:27.0
 181-16858-00-000-00_20181214_static_r1.asc)

102	-6247.7299	0.0052	0.8350	0.000
105	-18800.0778	0.0094	-0.8124	0.000
	-16743.0381	0.0118	-0.9239	

(V27 PostProcessed 06-MAR-2019 18:23:30.0 181-16858-00-000-00_20190306_static.asc)

102	-7230.9969	0.0031	0.8252	0.000
DRAO	-8736.6076	0.0051	-0.8004	0.000
	-9290.1380	0.0064	-0.8836	

(V28 PostProcessed 06-MAR-2019 18:23:30.0 181-16858-00-000-00_20190306_static.asc)

102	-8415.9173	0.0051	0.8355	0.000
3001	-23062.7983	0.0086	-0.8146	0.000
	-20879.6868	0.0107	-0.8887	

(V29 PostProcessed 06-MAR-2019 18:58:55.0 181-16858-00-000-00_20190306_static.asc)

102	-3768.9331	0.0040	0.8456	0.000
103	-9522.7397	0.0064	-0.8093	0.000
	-8705.8176	0.0080	-0.8914	

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

(V30 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)
102 -7878.2610 0.0055 0.8335 0.000
3000 -20736.0587 0.0090 -0.8098 0.000
-18897.5888 0.0113 -0.8870

(V31 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)
102 -6247.7050 0.0050 0.8280 0.000
105 -18800.0727 0.0080 -0.8067 0.000
-16743.0466 0.0100 -0.8923

(V32 PostProcessed 06-MAR-2019 18:14:50.0 181-16858-00-000-00_20190306_static.asc)
DRAO -1184.9277 0.0037 0.8296 0.000
3001 -14326.1944 0.0062 -0.8025 0.000
-11589.5482 0.0077 -0.8870

(V33 PostProcessed 06-MAR-2019 18:58:55.0 181-16858-00-000-00_20190306_static.asc)
103 -3462.0672 0.0022 0.7673 0.000
DRAO 786.1576 0.0034 -0.7355 0.000
-584.3337 0.0041 -0.8519

(V34 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)
500233 4910.1338 0.0043 0.8282 0.000
DRAO 15984.9845 0.0072 -0.7947 0.000
14436.4449 0.0088 -0.8850

(V35 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)
DRAO -647.2715 0.0036 0.8319 0.000
3000 -11999.4549 0.0060 -0.7967 0.000
-9607.4523 0.0073 -0.8845

(V36 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)
105 -983.2825 0.0035 0.8346 0.000
DRAO 10063.4780 0.0058 -0.8007 0.000
7452.9019 0.0071 -0.8935

(V37 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)
DRAO -4453.5208 0.0086 0.8577 0.000
500245 -18733.1380 0.0142 -0.8253 0.000
-16317.5274 0.0177 -0.8912

(V38 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)
500233 3725.2156 0.0022 0.7668 0.000
3001 1658.8053 0.0035 -0.7510 0.000
2846.8867 0.0043 -0.8553

(V39 PostProcessed 06-MAR-2019 18:58:55.0 181-16858-00-000-00_20190306_static.asc)
103 -4646.9891 0.0061 0.8570 0.000

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

3001	-13540.0804	0.0100	-0.8171	0.000
	-12173.8665	0.0122	-0.8983	

(V40 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

3001	537.6511	0.0020	0.7248	0.000
3000	2326.7455	0.0031	-0.7144	0.000
	1982.0982	0.0038	-0.8327	

(V41 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

105	-2168.2137	0.0027	0.8087	0.000
3001	-4262.7152	0.0043	-0.7892	0.000
	-4136.6648	0.0054	-0.8821	

(V42 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

3001	-3268.5939	0.0022	0.7833	0.000
500245	-4406.9553	0.0035	-0.7705	0.000
	-4727.9758	0.0043	-0.8590	

(V43 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

103	-2478.7812	0.0036	0.8360	0.000
105	-9277.3426	0.0058	-0.8055	0.000
	-8037.2277	0.0072	-0.8932	

(V44 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

103	-7915.5787	0.0059	0.8478	0.000
500245	-17947.0249	0.0093	-0.8184	0.000
	-16901.8465	0.0116	-0.8875	

(V45 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

103	-4109.3375	0.0055	0.8502	0.000
3000	-11213.3370	0.0088	-0.8101	0.000
	-10191.7702	0.0109	-0.8938	

(V46 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

105	-1630.5628	0.0023	0.7541	0.000
3000	-1935.9677	0.0036	-0.7400	0.000
	-2154.5721	0.0044	-0.8511	

(V47 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

3000	-3806.2486	0.0027	0.8135	0.000
500245	-6733.6925	0.0043	-0.7972	0.000
	-6710.0699	0.0055	-0.8726	

(V48 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

105	-5436.8084	0.0034	0.8231	0.000
500245	-8669.6677	0.0054	-0.8056	0.000
	-8864.6275	0.0069	-0.8852	

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312
 (V49 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

500233	456.6262	0.0019	0.7026	0.000
500245	-2748.1493	0.0028	-0.6990	0.000
	-1881.0878	0.0035	-0.8130	

(V50 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)

102	-12141.1311	0.0054	0.8325	0.000
500233	-24721.5951	0.0089	-0.8099	0.000
	-23726.5795	0.0111	-0.8868	

(V51 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)

500233	8372.1991	0.0057	0.8407	0.000
103	15198.8688	0.0092	-0.8003	0.000
	15020.7617	0.0113	-0.8884	

(V52 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

500233	4262.8677	0.0028	0.8103	0.000
3000	3985.5440	0.0045	-0.7884	0.000
	4828.9880	0.0056	-0.8743	

(V53 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

500233	5893.4297	0.0032	0.8238	0.000
105	5921.5184	0.0051	-0.8006	0.000
	6983.5468	0.0064	-0.8873	

(V54 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

102	-11684.5069	0.0061	0.8398	0.000
500245	-27469.7488	0.0098	-0.8230	0.000
	-25607.6649	0.0124	-0.8857	

▲

Adjustment Statistical Summary

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Iterations = 3

Number of Stations = 11

Number of Observations = 123

Number of Unknowns = 30

Number of Redundant Obs = 93

Observation	Count	Sum Squares of StdRes	Error Factor
GPS Deltas	123	798.721	2.931
Total	123	798.721	2.931

Warning: The Chi-Square Test at 5.00% Level Exceeded Upper Bound

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312
 Lower/Upper Bounds (0.856/1.143)

↑

Adjusted Station Information

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Adjusted Coordinates (Meters)

Station	N	E	Elev	Description
DRAO	5466635.0230	309256.4470	558.5550	
102	5481083.4576	311727.5491	341.0421	
100	5485839.5027	310481.4238	342.8797	
101	5484251.0551	311632.2454	343.5889	
104	5466073.3437	313957.5818	330.1529	
105	5455315.8770	314695.9754	303.9576	
3001	5448992.7500	314699.0590	295.0408	
103	5467676.7105	312692.7932	332.6982	
3000	5452041.9641	314121.6613	298.4835	
500233	5444733.4826	312131.6763	287.6799	
500245	5441807.7545	313786.7083	282.7971	

Adjusted Positions and Ellipsoid Heights (Meters)

Station	Latitude	Longitude	Ellip Ht	Geoid Ht
DRAO	49-19-21.409769	119-37-29.876602	542.2303	-16.3247
102	49-27-11.560667	119-35-52.213675	324.7238	-16.3183
100	49-29-44.013697	119-37-02.245695	326.5196	-16.3601
101	49-28-53.920471	119-36-02.368663	327.2409	-16.3480
104	49-19-08.461985	119-33-36.276355	313.8144	-16.3385
105	49-13-21.259266	119-32-41.804553	287.5059	-16.4517
3001	49-09-56.701984	119-32-31.157529	278.4951	-16.5457
103	49-19-58.938171	119-34-41.575458	316.3470	-16.3512
3000	49-11-34.718957	119-33-04.715424	281.9702	-16.5133
500233	49-07-36.102824	119-34-30.667071	271.1112	-16.5687
500245	49-06-03.264244	119-33-04.223953	266.1638	-16.6333
			Average:	-16.4321

Convergence Angles (DMS) and Grid Factors at Stations

(Grid Azimuth = Geodetic Azimuth - Convergence)

(Elevation Factor Includes a Geoid Height Correction at Each Station))

Station	Convergence Angle	----- Factors -----		
		Scale	x Elevation	= Combined
DRAO	-1-59-28.86	1.00004694	0.99991504	0.99996197
102	-1-58-28.59	1.00003542	0.99994912	0.99998454
100	-1-59-26.38	1.00004120	0.99994884	0.99999004
101	-1-58-39.33	1.00003586	0.99994872	0.99998458
104	-1-56-31.16	1.00002518	0.99995083	0.99997601
105	-1-55-39.76	1.00002182	0.99995495	0.99997677

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

3001	-1-55-25.76	1.00002181	0.99995636	0.99997817
103	-1-57-22.21	1.00003098	0.99995043	0.99998141
3000	-1-55-54.03	1.00002444	0.99995581	0.99998026
500233	-1-56-52.13	1.00003359	0.99995752	0.99999110
500245	-1-55-44.01	1.00002599	0.99995829	0.99998427
Project Averages:	-1-57-13.84	1.00003120	0.99994963	0.99998083

▲

Adjusted Observations and Residuals

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Adjusted GPS Vector Observations (Meters)

Datum Transformations

Scale Factor 1.000000000000 :	0.000000 PPM (Unsolvable)
Rotation Around North Axis :	-0.000000 Sec (Unsolvable)
Rotation Around East Axis :	-0.000000 Sec (Unsolvable)
Rotation Around Vert Axis :	-0.000000 Sec (Unsolvable)

From File:Line	Component	Adj Value	Residual	StdErr	StdRes
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To

(V1 PostProcessed 14-DEC-2018 16:13:37.0

181-16858-00-000-00_20181214_static_r1.asc)

102	Delta-N	-14525.5598	-0.0056	0.0026	2.2	2:4
DRAO	Delta-E	-1972.3626	-0.0015	0.0020	0.8	
	Delta-U	200.6482	-0.0029	0.0110	0.3	
	Length	14660.2306				

(V2 PostProcessed 14-DEC-2018 16:13:37.0

181-16858-00-000-00_20181214_static_r1.asc)

102	Delta-N	4710.3286	0.0046	0.0017	2.7	2:9
100	Delta-E	-1409.3324	0.0007	0.0013	0.5	
	Delta-U	-0.1004	0.0013	0.0072	0.2	
	Length	4916.6465				

(V3 PostProcessed 14-DEC-2018 16:46:37.0

181-16858-00-000-00_20181214_static_r1.asc)

102 2:14	Delta-N	3162.4808	0.0050	0.0014	3.7*	
101	Delta-E	-204.4181	0.0008	0.0012	0.7	
	Delta-U	1.7291	-0.0009	0.0048	0.2	
	Length	3169.0810				

(V4 PostProcessed 14-DEC-2018 18:01:52.0

181-16858-00-000-00_20181214_static_r1.asc)

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312
 102 Delta-N -14924.7252 0.0045 0.0021 2.1
 2:19
 104 Delta-E 2745.4391 0.0032 0.0016 2.0
 Delta-U -28.9761 -0.0047 0.0089 0.5
 Length 15175.1671

(V5 PostProcessed 14-DEC-2018 21:35:27.0
 181-16858-00-000-00_20181214_static_r1.asc)
 105 Delta-N 11130.1686 -0.0051 0.0030 1.7
 2:24
 DRAO Delta-E -5817.7897 -0.0174 0.0025 7.0*
 Delta-U 242.3567 -0.0045 0.0154 0.3
 Length 12561.2924

(V6 PostProcessed 14-DEC-2018 16:08:37.0
 181-16858-00-000-00_20181214_static_r1.asc)
 100 Delta-N -19236.1762 0.0001 0.0028 0.0
 2:29
 DRAO Delta-E -558.0231 -0.0006 0.0021 0.3
 Delta-U 186.6546 -0.0126 0.0129 1.0
 Length 19245.1735

(V7 PostProcessed 14-DEC-2018 16:46:37.0
 181-16858-00-000-00_20181214_static_r1.asc)
 DRAO Delta-N 17688.1749 -0.0065 0.0033 2.0
 2:34
 101 Delta-E 1761.5191 -0.0006 0.0025 0.3
 Delta-U -239.7804 -0.0127 0.0154 0.8
 Length 17777.2882

(V8 PostProcessed 14-DEC-2018 18:01:52.0
 181-16858-00-000-00_20181214_static_r1.asc)
 DRAO Delta-N -397.9937 -0.0094 0.0016 6.1*
 2:39
 104 Delta-E 4717.8741 0.0050 0.0012 4.0*
 Delta-U -230.1698 -0.0086 0.0058 1.5
 Length 4740.2229

(V9 PostProcessed 14-DEC-2018 16:46:37.0
 181-16858-00-000-00_20181214_static_r1.asc)
 100 Delta-N -1547.5376 0.0002 0.0014 0.1
 2:44
 101 Delta-E 1205.3139 0.0003 0.0012 0.2
 Delta-U 0.4197 0.0035 0.0047 0.7
 Length 1961.5439

(V10 PostProcessed 14-DEC-2018 18:01:52.0
 181-16858-00-000-00_20181214_static_r1.asc)

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312
 104 Delta-N 18088.7003 -0.0211 0.0030 7.0*
 2:49
 101 Delta-E -2940.8118 -0.0033 0.0021 1.6
 Delta-U -12.9227 -0.0125 0.0128 1.0
 Length 18326.2004

(V11 PostProcessed 14-DEC-2018 18:01:52.0
 181-16858-00-000-00_20181214_static_r1.asc)
 100 Delta-N -19633.9538 0.0178 0.0034 5.3*
 2:54
 104 Delta-E 4159.8306 0.0029 0.0023 1.2
 Delta-U -44.3050 -0.0102 0.0144 0.7
 Length 20069.8354

(V12 PostProcessed 14-DEC-2018 21:35:27.0
 181-16858-00-000-00_20181214_static_r1.asc)
 105 Delta-N 10726.7842 -0.0050 0.0020 2.5
 2:59
 104 Delta-E -1100.1322 -0.0161 0.0017 9.3*
 Delta-U 17.1856 -0.0007 0.0101 0.1
 Length 10783.0648

(V13 PostProcessed 14-DEC-2018 21:35:27.0
 181-16858-00-000-00_20181214_static_r1.asc)
 102 Delta-N -25650.5790 0.0027 0.0030 0.9
 2:64
 105 Delta-E 3853.0589 0.0165 0.0027 6.2*
 Delta-U -90.0035 0.0052 0.0155 0.3
 Length 25938.5113

(V27 PostProcessed 06-MAR-2019 18:23:30.0 181-16858-00-000-00_20190306_static.asc)
 102 Delta-N -14525.5598 -0.0021 0.0020 1.1
 2:69
 DRAO Delta-E -1972.3626 -0.0021 0.0015 1.4
 Delta-U 200.6482 -0.0080 0.0084 1.0
 Length 14660.2306

(V28 PostProcessed 06-MAR-2019 18:23:30.0 181-16858-00-000-00_20190306_static.asc)
 102 Delta-N -31969.9111 -0.0093 0.0032 2.9
 2:74
 3001 Delta-E 4073.1656 -0.0047 0.0025 1.9
 Delta-U -127.7212 -0.0011 0.0140 0.1
 Length 32228.5930

(V29 PostProcessed 06-MAR-2019 18:58:55.0 181-16858-00-000-00_20190306_static.asc)
 102 Delta-N -13365.7810 -0.0020 0.0025 0.8
 2:79
 103 Delta-E 1426.2305 0.0017 0.0019 0.9

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

	Delta-U	-22.5525	0.0061	0.0106	0.6
	Length	13441.6794			

(V30 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

102	Delta-N	-28942.2962	-0.0097	0.0035	2.8
2:84					
3000	Delta-E	3391.4625	-0.0095	0.0027	3.5*
	Delta-U	-109.3778	-0.0024	0.0148	0.2
	Length	29140.5300			

(V31 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

102	Delta-N	-25650.5790	-0.0045	0.0030	1.5
2:89					
105	Delta-E	3853.0589	-0.0027	0.0024	1.1
	Delta-U	-90.0035	0.0226	0.0132	1.7
	Length	25938.5113			

(V32 PostProcessed 06-MAR-2019 18:14:50.0 181-16858-00-000-00_20190306_static.asc)

DRAO	Delta-N	-17442.8825	-0.0024	0.0024	1.0
2:94					
3001	Delta-E	6051.7027	0.0020	0.0018	1.1
	Delta-U	-290.4733	0.0021	0.0101	0.2
	Length	18465.1464			

(V33 PostProcessed 06-MAR-2019 18:58:55.0 181-16858-00-000-00_20190306_static.asc)

103	Delta-N	-1158.4251	-0.0071	0.0015	4.7*
2:99					
DRAO	Delta-E	-3398.9444	0.0117	0.0012	9.4*
	Delta-U	224.8742	0.0093	0.0054	1.7
	Length	3597.9633			

(V34 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)

500233	Delta-N	21791.9085	0.0082	0.0028	2.9
2:104					
DRAO	Delta-E	-3619.2458	0.0005	0.0021	0.2
	Delta-U	232.8341	-0.0196	0.0116	1.7
	Length	22091.6371			

(V35 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

DRAO	Delta-N	-14415.4786	-0.0013	0.0023	0.6
2:109					
3000	Delta-E	5368.9161	-0.0028	0.0018	1.6
	Delta-U	-278.8204	0.0022	0.0097	0.2
	Length	15385.3510			

(V36 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

105	Delta-N	11130.1686	-0.0054	0.0022	2.5
2:114					

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

DRAO	Delta-E	-5817.7897	-0.0013	0.0017	0.7
	Delta-U	242.3567	-0.0152	0.0094	1.6
	Length	12561.2924			

(V37 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

DRAO	Delta-N	-24655.2332	-0.0047	0.0054	0.9
2:119	Delta-E	5388.8293	0.0065	0.0039	1.7
500245	Delta-U	-326.0352	0.0114	0.0233	0.5
	Length	25239.3800			

(V38 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)

500233	Delta-N	4344.1626	-0.0012	0.0015	0.8
2:124	Delta-E	2421.1257	0.0017	0.0012	1.4
3001	Delta-U	5.4445	0.0018	0.0056	0.3
	Length	4973.2915			

(V39 PostProcessed 06-MAR-2019 18:58:55.0 181-16858-00-000-00_20190306_static.asc)

103	Delta-N	-18604.9967	0.0071	0.0037	1.9
2:129	Delta-E	2642.1171	-0.0129	0.0028	4.7*
3001	Delta-U	-65.5578	-0.0232	0.0162	1.4
	Length	18791.7796			

(V40 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

3001	Delta-N	3028.1708	-0.0025	0.0014	1.8
2:134	Delta-E	-679.4719	0.0026	0.0012	2.1
3000	Delta-U	2.7195	0.0002	0.0050	0.0
	Length	3103.4671			

(V41 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

105	Delta-N	-6319.5851	0.0048	0.0017	2.8
2:139	Delta-E	215.6965	0.0044	0.0014	3.1*
3001	Delta-U	-12.1481	0.0005	0.0071	0.1
	Length	6323.2767			

(V42 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

3001	Delta-N	-7211.6903	0.0034	0.0015	2.3
2:144	Delta-E	-670.7607	-0.0006	0.0012	0.5
500245	Delta-U	-16.4474	-0.0001	0.0057	0.0
	Length	7242.8356			

(V43 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

103	Delta-N	-12285.5424	0.0065	0.0022	3.0
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181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

2:149

105	Delta-E	2423.6465	-0.0010	0.0017	0.6
	Delta-U	-41.1434	0.0070	0.0095	0.7
	Length	12522.3922			

(V44 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

103	Delta-N	-25816.9291	0.0045	0.0036	1.3
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2:154

500245	Delta-E	1974.7997	-0.0119	0.0027	4.4*
	Delta-U	-102.7855	-0.0126	0.0153	0.8
	Length	25892.5516			

(V45 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)

103	Delta-N	-15577.1729	0.0070	0.0034	2.1
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2:159

3000	Delta-E	1961.1978	-0.0118	0.0025	4.7*
	Delta-U	-53.7166	-0.0226	0.0144	1.6
	Length	15700.2388			

(V46 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)

105	Delta-N	-3291.4450	0.0047	0.0016	3.0
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2:164

3000	Delta-E	-463.8936	0.0081	0.0013	6.1*
	Delta-U	-6.4026	0.0059	0.0058	1.0
	Length	3323.9808			

(V47 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

3000	Delta-N	-10239.8497	-0.0009	0.0018	0.5
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2:169

500245	Delta-E	9.9696	0.0040	0.0014	2.9
	Delta-U	-24.0338	0.0001	0.0072	0.0
	Length	10239.8828			

(V48 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

105	Delta-N	-13531.2818	-0.0019	0.0021	0.9
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2:174

500245	Delta-E	-454.7832	0.0058	0.0017	3.5*
	Delta-U	-35.7248	-0.0083	0.0090	0.9
	Length	13538.9693			

(V49 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)

500233	Delta-N	-2867.8304	-0.0007	0.0014	0.5
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2:179

500245	Delta-E	1753.5203	-0.0025	0.0012	2.1
	Delta-U	-5.8333	0.0025	0.0046	0.5
	Length	3361.4460			

(V50 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312
 102 Delta-N -36314.6993 -0.0105 0.0034 3.1*
 2:184
 500233 Delta-E 1653.3373 -0.0037 0.0027 1.4
 Delta-U -157.2998 0.0071 0.0146 0.5
 Length 36352.6568

(V51 PostProcessed 06-MAR-2019 19:00:10.0 181-16858-00-000-00_20190306_static.asc)
 500233 Delta-N 22949.3804 -0.0005 0.0036 0.1
 2:189
 103 Delta-E -220.2473 0.0111 0.0027 4.1*
 Delta-U 3.9071 0.0071 0.0150 0.5
 Length 22950.4375

(V52 PostProcessed 06-MAR-2019 19:05:53.0 181-16858-00-000-00_20190306_static.asc)
 500233 Delta-N 7372.0366 -0.0016 0.0018 0.9
 2:194
 3000 Delta-E 1740.3275 0.0001 0.0014 0.0
 Delta-U 6.3577 -0.0040 0.0074 0.5
 Length 7574.6751

(V53 PostProcessed 06-MAR-2019 19:50:25.0 181-16858-00-000-00_20190306_static.asc)
 500233 Delta-N 10663.6726 -0.0017 0.0020 0.9
 2:199
 105 Delta-E 2202.9078 -0.0040 0.0016 2.5
 Delta-U 7.0925 0.0038 0.0084 0.5
 Length 10888.8368

(V54 PostProcessed 06-MAR-2019 20:56:20.0 181-16858-00-000-00_20190306_static.asc)
 102 Delta-N -39181.9230 -0.0092 0.0038 2.4
 2:204
 500245 Delta-E 3407.7134 -0.0066 0.0029 2.3
 Delta-U -179.9269 0.0046 0.0162 0.3
 Length 39330.2425

↑

Adjusted Bearings (DMS) and Horizontal Distances (Meters)

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(Relative Confidence of Bearing is in Seconds)

NOTE - Adjustment Failed the Chi-Square Test

Angular and Distance Errors are Scaled by Total Error Factor

From	To	Grid Bearing	Grid Dist	95% RelConfidence		
				Grnd Dist	Brg	Dist
100	101	S35-55-23.25E	1961.5188	0.75	0.0074	3.7753
			1961.5438			
100	102	S14-40-55.08E	4916.5835	0.27	0.0079	1.5995
			4916.6462			
100	104	S09-58-27.40E	20069.4972	0.08	0.0098	0.4897
			20069.8315			

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312						
100	DRAO	S03-38-59.00W	19243.5082 19243.9645	0.08	0.0091	0.4717
101	102	S01-43-24.03E	3169.0309 3169.0800	0.40	0.0074	2.3237
101	104	S07-17-23.36E	18325.8392 18326.1955	0.08	0.0095	0.5189
101	DRAO	S07-40-51.21W	17775.5170 17775.9881	0.08	0.0088	0.4927
102	103	S04-07-04.85E	13441.4495 13441.6768	0.10	0.0084	0.6243
102	104	S08-27-01.96E	15174.8662 15175.1632	0.09	0.0079	0.5223
102	105	S06-34-17.43E	25937.9985 25938.4846	0.05	0.0072	0.2770
102	3000	S04-42-45.62E	29140.0089 29140.4987	0.05	0.0080	0.2760
102	3001	S05-17-25.24E	32227.9907 32228.5599	0.04	0.0080	0.2468
102	500233	S00-38-13.09E	36352.2214 36352.6172	0.04	0.0082	0.2262
102	500245	S03-00-04.23E	39329.6452 39330.1989	0.04	0.0084	0.2146
102	DRAO	S09-42-19.22W	14658.2266 14658.6169	0.07	0.0065	0.4429
103	105	S09-12-18.93E	12522.0983 12522.3590	0.11	0.0078	0.6269
103	3000	S05-13-18.43E	15699.9032 15700.2012	0.09	0.0086	0.5450
103	3001	S06-07-43.98E	18791.3672 18791.7415	0.07	0.0085	0.4527
103	500233	S01-24-03.56W	22950.0884 22950.3929	0.06	0.0088	0.3818
103	500245	S02-25-17.08E	25892.0748 25892.5029	0.06	0.0089	0.3445
103	DRAO	S73-08-09.40W	3590.7643 3590.8657	0.42	0.0062	1.7255
104	105	S03-55-35.87E	10782.7786 10783.0327	0.13	0.0083	0.7681
104	DRAO	N83-11-12.29W	4734.5699 4734.7164	0.33	0.0060	1.2642
105	3000	S09-56-58.80W	3323.9046 3323.9762	0.34	0.0066	1.9818
105	3001	S00-01-40.59E	6323.1277 6323.2703	0.18	0.0066	1.0399
105	500233	S13-37-16.38W	10888.6500 10888.8244	0.11	0.0069	0.6325
105	500245	S03-51-03.31W	13538.6905 13538.9525	0.09	0.0071	0.5261

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312

105	DRAO	N25-40-01.47W	12558.3254 12558.7095	0.09	0.0062	0.4947
3000	3001	S10-43-21.16E	3103.4005 3103.4651	0.36	0.0064	2.0755
3000	500233	S15-13-53.38W	7574.5589 7574.6673	0.16	0.0069	0.9053
3000	500245	S01-52-28.38W	10239.6894 10239.8706	0.12	0.0070	0.6855
3000	DRAO	N18-26-16.77W	15382.7071 15383.1496	0.08	0.0072	0.4665
3001	500233	S31-04-49.98W	4973.2095 4973.2860	0.24	0.0063	1.2602
3001	500245	S07-14-12.08W	7242.6891 7242.8251	0.16	0.0066	0.9142
3001	DRAO	N17-08-41.67W	18462.7143 18463.2630	0.07	0.0071	0.3870
500233	500245	S29-29-45.83E	3361.4009 3361.4423	0.36	0.0064	1.9149
500233	DRAO	N07-28-44.43W	22089.4639 22089.9734	0.06	0.0076	0.3420
500245	DRAO	N10-20-27.82W	25237.2053 25237.8703	0.05	0.0078	0.3107

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Error Propagation

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Station Coordinate Standard Deviations (Meters)
 NOTE - Adjustment Failed the Chi-Square Test
 Standard Deviations are Scaled by Total Error Factor

Station	N	E	Elev
DRAO	0.000000	0.000000	0.000000
102	0.002662	0.002062	0.011239
100	0.003709	0.002910	0.015354
101	0.003581	0.002843	0.014361
104	0.003120	0.002449	0.012694
105	0.002665	0.002139	0.011479
3001	0.002977	0.002365	0.012262
103	0.003052	0.002431	0.011990
3000	0.003004	0.002385	0.012274
500233	0.003103	0.002465	0.012714
500245	0.003227	0.002564	0.013164

Station Coordinate Error Ellipses (Meters)
 NOTE - Adjustment Failed the Chi-Square Test
 Error Ellipses are Scaled by Total Error Factor
 Confidence Region = 95%

Station	Semi-Major Axis	Semi-Minor Axis	Azimuth of Major Axis	Elev
DRAO	0.000000	0.000000	0-00	0.000000
102	0.006518	0.005046	1-42	0.022028
100	0.009080	0.007122	1-26	0.030093
101	0.008770	0.006954	2-47	0.028147
104	0.007646	0.005982	4-29	0.024880
105	0.006535	0.005224	5-22	0.022499
3001	0.007288	0.005787	1-46	0.024034
103	0.007487	0.005930	6-16	0.023501
3000	0.007355	0.005835	2-37	0.024057
500233	0.007597	0.006030	2-28	0.024919
500245	0.007899	0.006274	1-08	0.025800

Relative Error Ellipses (Meters)

NOTE - Adjustment Failed the Chi-Square Test

Relative Error Ellipses are Scaled by Total Error Factor

Confidence Region = 95%

Stations From	To	Semi-Major Axis	Semi-Minor Axis	Azimuth of Major Axis	Vertical
100	101	0.007879	0.006586	2-34	0.022770
100	102	0.007970	0.006412	1-13	0.025392
100	104	0.009943	0.007642	3-44	0.032770
100	DRAO	0.009080	0.007122	1-26	0.030093
101	102	0.007372	0.006088	2-57	0.022087
101	104	0.009600	0.007411	5-09	0.030959
101	DRAO	0.008770	0.006954	2-47	0.028147
102	103	0.008433	0.006573	4-59	0.027882
102	104	0.008010	0.006149	4-32	0.026780
102	105	0.007231	0.005763	4-17	0.025400
102	3000	0.008064	0.006387	1-55	0.026986
102	3001	0.007973	0.006312	1-14	0.026869
102	500233	0.008226	0.006514	1-48	0.027569
102	500245	0.008447	0.006690	0-42	0.028222
102	DRAO	0.006518	0.005046	1-42	0.022028
103	105	0.007964	0.006287	6-46	0.026492
103	3000	0.008609	0.006774	5-02	0.027854
103	3001	0.008563	0.006743	4-35	0.027845
103	500233	0.008768	0.006904	4-51	0.028421
103	500245	0.008940	0.007043	3-43	0.028993
103	DRAO	0.007487	0.005930	6-16	0.023501
104	105	0.008336	0.006675	6-55	0.029000
104	DRAO	0.007646	0.005982	4-29	0.024880
105	3000	0.006602	0.005431	3-10	0.020976
105	3001	0.006577	0.005384	2-23	0.021392
105	500233	0.006926	0.005641	3-00	0.022510
105	500245	0.007125	0.005797	1-15	0.023091

181-16858-00_Survey Control Network Adjustment (UTM11NAD83CGVD2013a)_20190312					
105	DRAO	0.006535	0.005224	5-22	0.022499
3000	3001	0.006478	0.005364	0-10	0.019584
3000	500233	0.006929	0.005650	0-55	0.021521
3000	500245	0.007021	0.005708	179-20	0.021859
3000	DRAO	0.007355	0.005835	2-37	0.024057
3001	500233	0.006551	0.005402	0-05	0.020070
3001	500245	0.006647	0.005445	178-21	0.020454
3001	DRAO	0.007288	0.005787	1-46	0.024034
500233	500245	0.006679	0.005558	179-18	0.019564
500233	DRAO	0.007597	0.006030	2-28	0.024919
500245	DRAO	0.007899	0.006274	1-08	0.025800

Elapsed Time = 00:00:03

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47
01 00000001 Top of File
01 00000005 Summary of Files Used and Option Settings
02 00000008 Project Folder and Data Files
02 00000015 Project Option Settings
01 00000036 Summary of Unadjusted Input Observations
02 00000039 Entered Stations
03 00000041 Fixed Coordinates
02 00000044 GPS Vector Observations
01 00000255 Adjustment Statistical Summary
01 00000275 Adjusted Station Information
02 00000278 Adjusted Coordinates
02 00000293 Adjusted Positions and Ellipsoid Heights
02 00000309 Convergence Angles and Grid Factors at Stations
01 00000328 Adjusted Observations and Residuals
02 00000331 Adjusted GPS Vector Observations
01 00000588 Adjusted Bearings and Horizontal Distances
01 00000673 Error Propagation
02 00000676 Station Coordinate Standard Deviations
02 00000693 Station Coordinate Error Ellipses
02 00000712 Relative Error Ellipses
01 00000757 End of File
0000B40D
STAR*NET
0001AE72

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