



AIRBORNE LIDAR PROJECT
GROUND CONTROL SURVEY REPORT



SANDY RIVER ARRA LIDAR TASK ORDER

UNITED STATES GEOLOGICAL SURVEY (USGS)

**CONTRACT NUMBER: G10PC00057
TASK ORDER NUMBER: G10PD00843**

WOOLPERT PROJECT #70395

DECEMBER 2010

LIDAR GROUND CONTROL SURVEY REPORT

Sandy River ARRA LiDAR Project

Contract Number: G10PC00057
Task order Number: G10PD00843

For:
For: United States Geological Survey (USGS)
1400 Independence Road
Rolla, Missouri 65401

By:
Woolpert, Inc.
4454 Idea Center Boulevard
Dayton, Ohio 45430.1500
Tel 937.461.5660 / Fax 937.461.0743

Summary of Contents

Ground Survey – Instrumentation and Methods.....	1-1
Instrumentation	1-1
Monumentation	1-3
Methodology	1-4
Certifications	1-8
Appendix A: CORS Data Sheets.....	1-9

Figures

Figure 1.1: GPS Base Station Locations	1-2
Figure 1.2: RTK Calibration Points used in Processing the Sandy River AOI.....	1-6
Figure 1.3: Sample Selection of Ground Control RTK Points.....	1-7

Tables

Table 1.1: Base Station Surveyed Coordinates.....	1-1
---	-----

SECTION 1: GROUND SURVEY - INSTRUMENTATION AND METHODS

During the Sandy River LiDAR survey, static (1 Hz recording frequency) ground surveys were conducted over either known or previously set monuments. Monument coordinates are provided in **Table 1.1** and illustrated in **Figure 1.1** for the task order AOI. After the airborne survey, the static GPS data are processed using triangulation with continuous operation stations (CORS) and checked using the Online Positioning User Service (OPUS) to quantify daily variance. The Online Positioning User Service (OPUS) is run by the National Geodetic Survey to process corrected monument positions. Multiple sessions are processed over the same monument to confirm antenna height measurements and reported position accuracy. Indexed by time, these GPS data records are used to correct the continuous onboard measurements of aircraft position recorded throughout the mission.

Table 1.1: Base Station Surveyed Coordinates, (NAD83/NAVD88, OPUS Corrected) Used for Kinematic Post-Processing of the Aircraft GPS Data for the Sandy River Task Order.

Base Station ID	Datum NAD83(CORS96)		Ellipsoid Height (L1 Phase center)	Number of Observations
	Latitude (North)	Longitude (West)		
CBSD1	45 26 36.07230	110 16 21.40137	215.217	4
GKSD1	45 26 36.06930	110 16 23.26705	214.312	4

Instrumentation

For this task order, all Global Navigation Satellite System (GNSS) survey work utilized a Trimble GNSS receiver model R7 with a Zephyr Geodetic Model 2 antenna with ground plane for static control points. The GNSS, Global Navigation Satellite System, consists of the U.S. GPS constellation and Soviet GLONASS constellation. The Trimble GPS R8 GNSS unit is used primarily for Real Time Kinematic (RTK) work but can also be used as a static receiver. For RTK data, the collector begins recording after remaining stationary for five seconds then calculating the pseudo range position from at least three epochs with the relative error under 1.5 cm horizontal and 2.0 cm vertical. All GPS measurements are made with dual frequency L1-L2 receivers with carrier-phase correction.

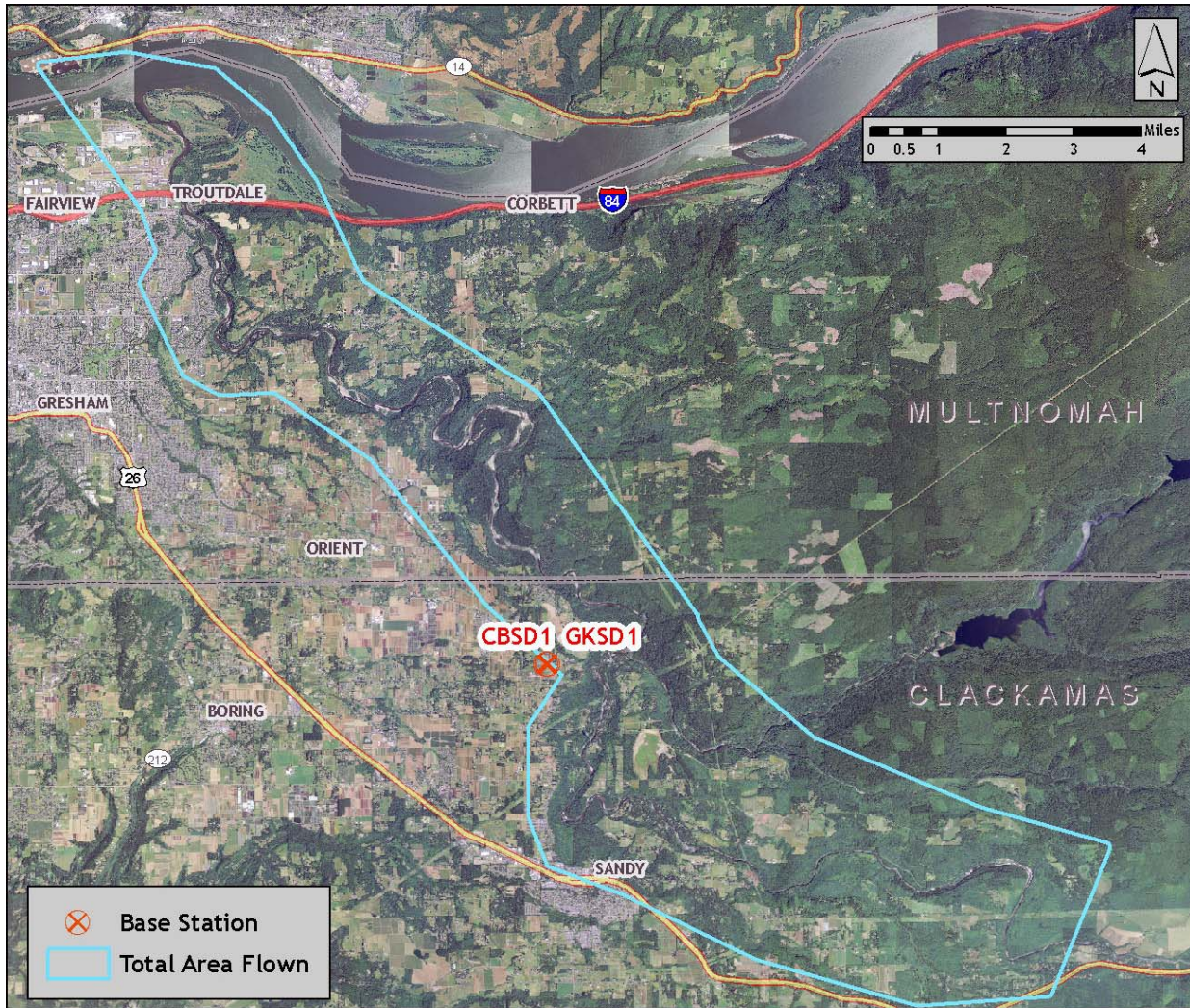


Figure 1.1: GPS base station locations covering the Sandy River Task Order AOI, displayed over 2009 NAIP Imagery

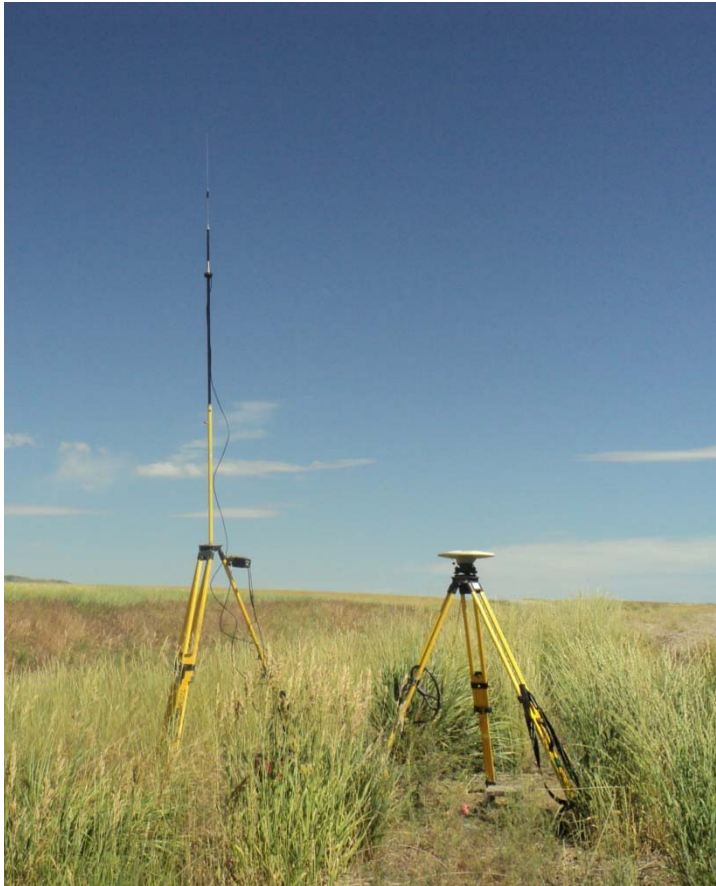
Monumentation

Whenever possible, existing and established survey benchmarks served as control points during LiDAR acquisition, including those previously set by Watershed Sciences. In addition to NGS, the county surveyor's offices and Oregon Department of Transportation (ODOT) often establish their own benchmarks. NGS benchmarks are preferred for control points. In the absence of NGS benchmarks, county surveys, or ODOT monuments, Watershed Sciences produces monuments. These monuments are spaced at a minimum of one mile apart and every effort is made to keep the monuments within the public right of way or on public lands. If monuments were required on private property, consent from the owner was required. All monumentation is created with 5/8" x 30" rebar topped with an aluminum cap with "Watershed Sciences Inc." and monument identification stamped permanently into the metal.



Methodology

The aircraft was assigned a ground survey crew member with two R7 receivers and an R8 receiver. The ground crew vehicle was equipped with standard field survey supplies and equipment including safety materials. All data points are observed for a minimum of two survey sessions lasting no fewer than six hours. At the beginning of every session the tripod and antenna are reset, resulting in two independent instrument heights and data files. Data is collected at a rate of 1Hz using a ten degree mask on the antenna.



The ground crew uploaded the GPS data to the FTP site on a daily basis to be returned to the office for professional land surveyor (PLS) oversight, quality assurance/quality control (QA/QC) review and processing. OPUS processing triangulates the monument position using three CORS stations resulting in a fully adjusted position. After multiple days of data have been collected at each monument, accuracy and error ellipses are calculated from the OPUS reports. This information leads to a rating of the monument based on FGDC-STD-007.2-1998 Part 2 table 2.1 at the 95% confidence level. When a statistical stable position is found, CORPSCON 6.0.1 software was used to convert the UTM positions to geodetic positions. This geodetic position is used for processing the LiDAR data.

All GPS measurements were made during periods with PDOP less than or equal to 3.0 and with at least six satellites in view of both a stationary reference receiver and the roving receiver. RTK positions were collected on 20% of the flight lines and on bare earth locations such as paved, gravel or stable dirt roads, and other locations where the ground is clearly visible (and is likely to remain visible) from the sky during the data acquisition and RTK measurement period(s).

In order to facilitate comparisons with LiDAR measurements, RTK measurements were not taken on highly reflective surfaces such as center line stripes or lane markings on roads. The RTK points were taken no closer than one meter to any nearby terrain breaks such as road edges or drop offs. In addition, it is desirable to include locations that can be readily identified and occupied during subsequent field visits in support of other quality control procedures described later. Examples of identifiable locations would include manhole and other flat utility structures having clearly indicated center points or other measurement locations. In the absence of utility structures, a PK nail can be driven into asphalt or concrete and marked with paint.

Multiple differential GPS units were used in the ground based real-time kinematic (RTK) portion of the survey. To collect accurate ground surveyed points, a GPS base unit was set up over monuments to broadcast a kinematic correction to a roving GPS unit. The ground crew used a roving unit to receive radio-relayed kinematic corrected positions from the base unit. This RTK survey allows precise location measurement ($\sigma \leq 1.5$ cm). **Figures 1.2 and 1.3** illustrate these hard-surface, calibration RTK locations, as well as additional ground control points measured throughout the task order AOI.



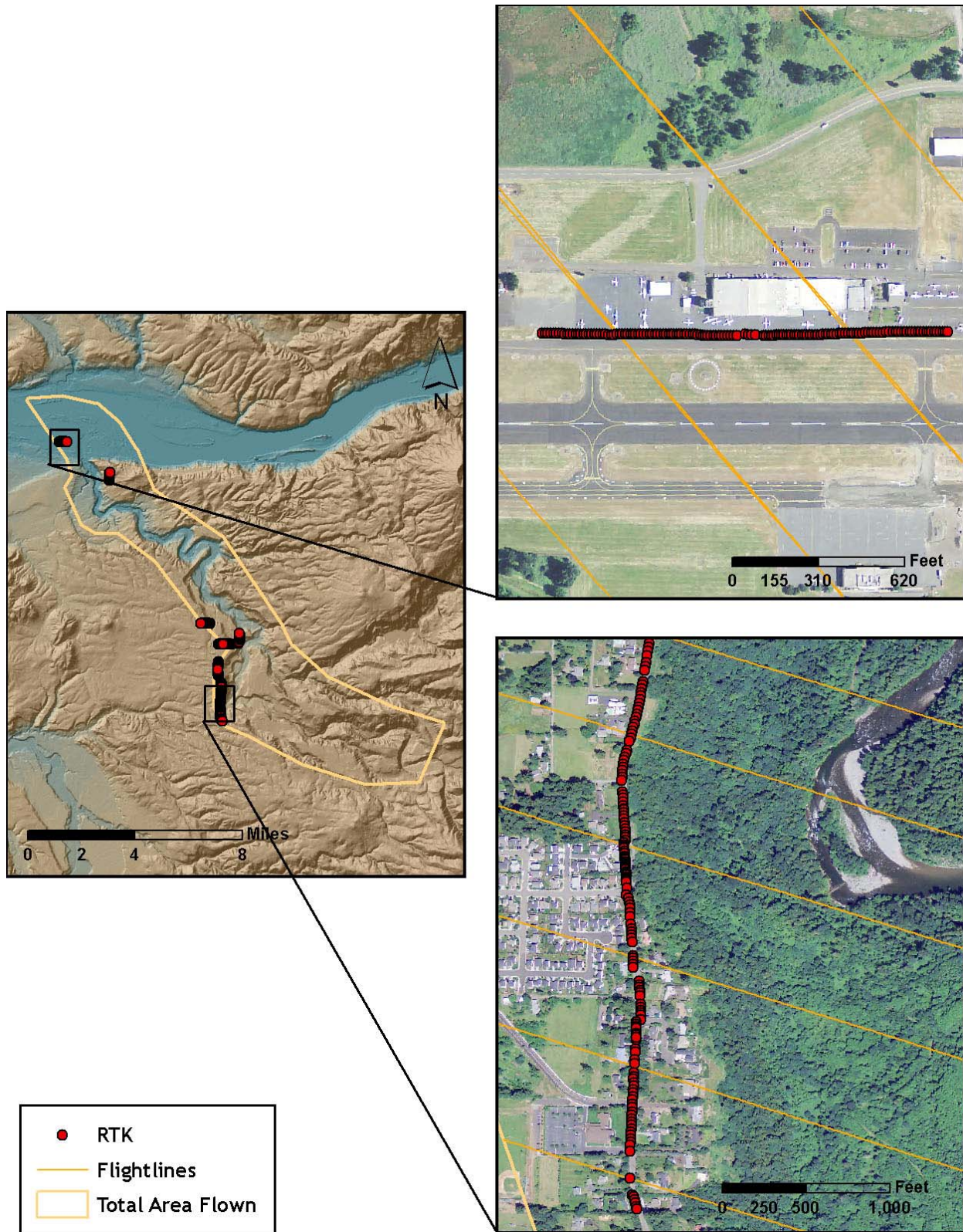


Figure 1.2: RTK calibration points used in processing the Sandy River AOI displayed over 2009 NAIP imagery and a 30 meter DEM

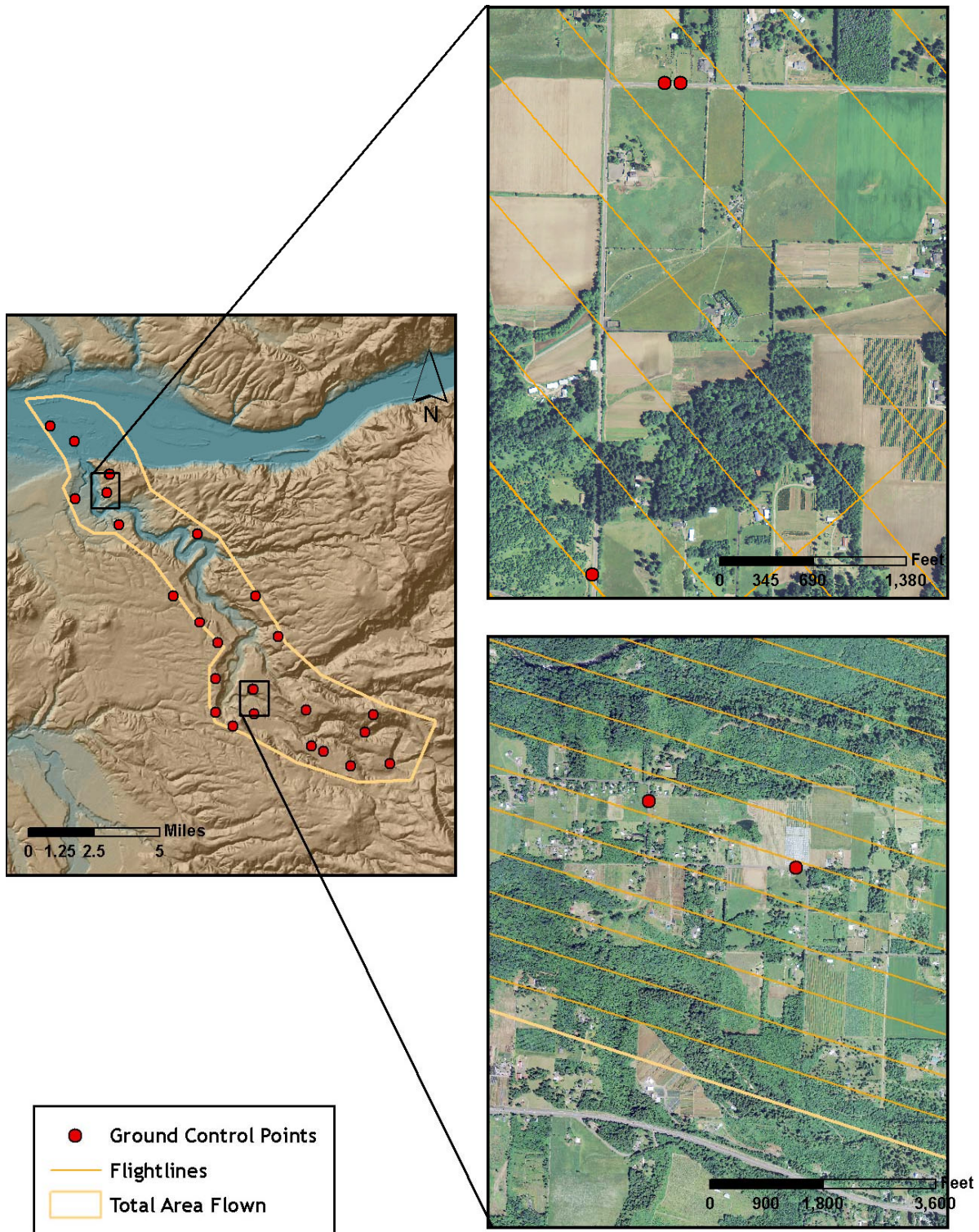


Figure 1.3: Sample selection of ground control RTK points in the Sandy River AOI displayed over 2009 NAIP imagery and a 30 meter DEM. These points were not used in the calibration of the LiDAR data.

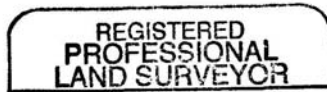
2. Certifications

Watershed Sciences provided LiDAR services for the Sandy River study area as described in this Survey Report.

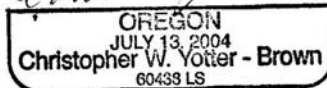
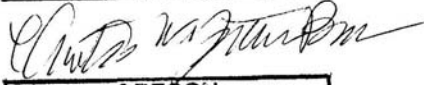
I, Christopher W. Yotter-Brown, being first dully sworn, say that as described in this Survey Report was completed by me or under my direct supervision and was completed using commonly accepted standard practices.



Christopher W. Yotter-Brown, PLS Oregon & Washington
Watershed Sciences, Inc
Portland, OR 97204



12/21/2010



RENEWAL DATE: 6/30/2012

National Geodetic Survey
DE6433 *****
DE6433 CORS - This is a GPS Continuously Operating Reference Station.
DE6433 DESIGNATION - WOODBURN COOP CORS ARP
DE6433 CORS_ID - WDBN
DE6433 PID - DE6433
DE6433 STATE/COUNTY- OR/MARION
DE6433 USGS QUAD - WOODBURN (1985)
DE6433
DE6433 *CURRENT SURVEY CONTROL
DE6433
DE6433* NAD 83(CORS)- 45 10 15.09459(N) 122 52 12.13318(W) ADJUSTED
DE6433* NAVD 88 - ** (meters) ** (feet)
DE6433
DE6433 EPOCH DATE - 2002.00
DE6433 X - -2,444,573.405 (meters) COMP
DE6433 Y - -3,783,071.649 (meters) COMP
DE6433 Z - 4,500,783.590 (meters) COMP
DE6433 ELLIP HEIGHT- 40.219 (meters) (05/??/02) ADJUSTED
DE6433 GEOID HEIGHT- -23.00 (meters) GEOID09
DE6433 HORZ ORDER - SPECIAL (CORS)
DE6433 ELLP ORDER - SPECIAL (CORS)
DE6433
DE6433. [ITRF positions](#) are available for this station.
DE6433. The coordinates were established by GPS observations
DE6433. and adjusted by the National Geodetic Survey in May 2002.
DE6433. The coordinates are valid at the epoch date displayed above.
DE6433. The epoch date for horizontal control is a decimal equivalence
DE6433. of Year/Month/Day.
DE6433
DE6433
DE6433. The PID for the CORS L1 Phase Center is DG5348.
DE6433
DE6433. The XYZ, and position/ellipsoidal ht. are equivalent.
DE6433
DE6433. The ellipsoidal height was determined by GPS observations
DE6433. and is referenced to NAD 83.
DE6433
DE6433. The geoid height was determined by GEOID09.
DE6433
DE6433;
DE6433; North East Units Scale Factor Converg.
DE6433; SPC OR N - 169,880.178 2,313,732.665 MT 0.99989458 -1 40 50.9
DE6433; SPC OR N - 557,349.67 7,590,986.43 iFT 0.99989458 -1 40 50.9
DE6433
DE6433! - Elev Factor x Scale Factor = Combined Factor
DE6433! SPC OR N - 0.99999369 x 0.99989458 = 0.99988828
DE6433
DE6433 SUPERSEDED SURVEY CONTROL
DE6433
DE6433. No superseded survey control is available for this station.
DE6433
DE6433_U.S. NATIONAL GRID SPATIAL ADDRESS: 10TER1021201939(NAD 83)
DE6433_MARKER: STATION IS THE ANTENNA REFERENCE POINT OF THE GPS ANTENNA
DE6433
DE6433 STATION DESCRIPTION

DE6433
DE6433'DESCRIBED BY NATIONAL GEODETIC SURVEY 2002
DE6433'STATION IS A GPS CORS. LATEST INFORMATION INCLUDING POSITIONS AND
DE6433'VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
DE6433'BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
DE6433' FTP CORS.NGS.NOAA.GOV: CORS/COORD AND CORS/STATION_LOG
DE6433' HTTP://WWW.NGS.NOAA.GOV/CORS.

National Geodetic Survey

DG5352 *****
DG5352 CORS - This is a GPS Continuously Operating Reference Station.
DG5352 DESIGNATION - STAYTON COOP CORS ARP
DG5352 CORS_ID - STAY
DG5352 PID - DG5352
DG5352 STATE/COUNTY- OR/MARION
DG5352 USGS QUAD - STAYTON (1986)
DG5352
DG5352 *CURRENT SURVEY CONTROL
DG5352

DG5352* NAD 83(CORS)- 44 49 50.53070(N) 122 49 15.03602(W) ADJUSTED
DG5352* NAVD 88 - *(meters) *(feet)

DG5352 EPOCH DATE - 2002.00
DG5352 X - -2,455,840.114 (meters) COMP
DG5352 Y - -3,807,675.150 (meters) COMP
DG5352 Z - -4,474,103.711 (meters) COMP
DG5352 ELLIP HEIGHT- 111.266 (meters) (03/??/04) ADJUSTED
DG5352 GEOID HEIGHT- -23.16 (meters) GEOID09
DG5352 HORZ ORDER - SPECIAL (CORS)
DG5352 ELLP ORDER - SPECIAL (CORS)
DG5352
DG5352. [ITRF positions](#) are available for this station.
DG5352. The coordinates were established by GPS observations
DG5352. and adjusted by the National Geodetic Survey in March 2004.
DG5352. The coordinates are valid at the epoch date displayed above.
DG5352. The epoch date for horizontal control is a decimal equivalence
DG5352. of Year/Month/Day.
DG5352
DG5352
DG5352. The PID for the CORS L1 Phase Center is DG5353.
DG5352
DG5352. The XYZ, and position/ellipsoidal ht. are equivalent.
DG5352
DG5352. The ellipsoidal height was determined by GPS observations
DG5352. and is referenced to NAD 83.
DG5352
DG5352. The geoid height was determined by GEOID09.
DG5352
DG5352; North East Units Scale Factor Converg.
DG5352; SPC OR N- 131,985.082 2,316,512.177 MT 0.99991189 -1 38 45.3
DG5352; SPC OR N- 433,021.92 7,600,105.57 iFT 0.99991189 -1 38 45.3
DG5352
DG5352! - Elev Factor x Scale Factor = Combined Factor
DG5352! SPC OR N - 0.99998255 x 0.99991189 = 0.99989445
DG5352
DG5352 SUPERSEDED SURVEY CONTROL
DG5352
DG5352. No superseded survey control is available for this station.
DG5352
DG5352_U.S. NATIONAL GRID SPATIAL ADDRESS: 10TEQ1416164159(NAD 83)
DG5352_MARKER: STATION IS THE ANTENNA REFERENCE POINT OF THE GPS ANTENNA
DG5352
DG5352 STATION DESCRIPTION

DG5352
DG5352 DESCRIBED BY NATIONAL GEODETIC SURVEY 2004
DG5352 STATION IS A GPS CORS. LATEST INFORMATION INCLUDING POSITIONS AND
DG5352 VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
DG5352 BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
DG5352 FTP CORS.NGS.NOAA.GOV: CORS/COORD AND CORS/STATION_LOG
DG5352 HTTP://WWW.NGS.NOAA.GOV/CORS.

National Geodetic Survey

DH5847 *****
DH5847 CORS - This is a GPS Continuously Operating Reference Station.
DH5847 DESIGNATION - MSH_NRIDGEWA2004 CORS ARP
DH5847 CORS_ID - P695
DH5847 PID - DH5847
DH5847 STATE/COUNTY- WA/SKAMANIA
DH5847 USGS QUAD - MOUNT ST HELENS (1983)
DH5847
DH5847 *CURRENT SURVEY CONTROL
DH5847
DH5847* NAD 83(CORS)- 46 11 56.33717(N) 122 09 51.11058(W) ADJUSTED
DH5847* NAVD 88 - *(meters) *(feet)
DH5847
DH5847 EPOCH DATE - 2002.00
DH5847 X - -2,354,987.189 (meters) COMP
DH5847 Y - -3,744,843.704 (meters) COMP
DH5847 Z - 4,582,039.088 (meters) COMP
DH5847 ELLIP HEIGHT- 2016.020 (meters) (09/??/05) ADJUSTED
DH5847 GEOID HEIGHT- -20.23 (meters) GEOID09
DH5847 HORZ ORDER - SPECIAL (CORS)
DH5847 ELLP ORDER - SPECIAL (CORS)
DH5847
DH5847. [ITRF positions](#) are available for this station.
DH5847. The coordinates were established by GPS observations
DH5847. and adjusted by the National Geodetic Survey in September 2005.
DH5847. The coordinates are valid at the epoch date displayed above.
DH5847. The epoch date for horizontal control is a decimal equivalence
DH5847. of Year/Month/Day.
DH5847
DH5847
DH5847. The PID for the CORS L1 Phase Center is DH5848.
DH5847
DH5847. The XYZ, and position/ellipsoidal ht. are equivalent.
DH5847
DH5847. The ellipsoidal height was determined by GPS observations
DH5847. and is referenced to NAD 83.
DH5847
DH5847. The geoid height was determined by GEOID09.
DH5847
DH5847; North East Units Scale Factor Converg.
DH5847; SPC WA S - 97,571.467 371,566.272 MT 0.99993718 -1 12 31.9
DH5847; SPC WA S - 320,115.72 1,219,047.01 sFT 0.99993718 -1 12 31.9
DH5847
DH5847! - Elev Factor x Scale Factor = Combined Factor
DH5847! SPC WA S - 0.99968406 x 0.99993718 = 0.99962126
DH5847
DH5847 SUPERSEDED SURVEY CONTROL
DH5847
DH5847. No superseded survey control is available for this station.
DH5847
DH5847 U.S. NATIONAL GRID SPATIAL ADDRESS: 10TES6448516495(NAD 83)
DH5847_MARKER: STATION IS THE ANTENNA REFERENCE POINT OF THE GPS ANTENNA
DH5847
DH5847 STATION DESCRIPTION

DH5847'DESCRIBED BY NATIONAL GEODETIC SURVEY 2005
DH5847'STATION IS A GPS CORS. LATEST INFORMATION INCLUDING POSITIONS AND
DH5847'VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
DH5847'BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
DH5847' FTP CORS.NGS.NOAA.GOV: CORS/COORD AND CORS/STATION_LOG
DH5847' HTTP://WWW.NGS.NOAA.GOV/CORS.

OPUS Reports:

FILE: 46722730.10o 000090864
Station ID: CBSD1

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 01, 2010
RINEX FILE: 4672273p.10o TIME: 19:41:16 UTC

SOFTWARE: page5 1009.28 master.pl 1009103 START: 2010/09/30 15:55:00
EPHEMERIS: igr16034.eph [rapid] STOP: 2010/09/30 23:59:00
NAV FILE: brdc2730.10n OBS USED: 18793 / 19586 : 96%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 72 / 79 : 91%
ARP HEIGHT: 1.800 OVERALL RMS: 0.016(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)	ITRF00 (EPOCH:2010.7475)
X: -2393599.225(m) 0.047(m)	-2393600.002(m) 0.047(m)
Y: -3790233.867(m) 0.021(m)	-3790232.656(m) 0.021(m)
Z: 4522206.881(m) 0.038(m)	4522206.930(m) 0.038(m)
LAT: 45 26 36.06932 0.035(m)	45 26 36.08449 0.035(m)
E LON: 237 43 36.73293 0.044(m)	237 43 36.67294 0.044(m)
W LON: 122 16 23.26707 0.044(m)	122 16 23.32706 0.044(m)
EL HGT: 214.318(m) 0.039(m)	213.926(m) 0.039(m)
ORTHO HGT: 236.917(m) 0.074(m) [NAVD88 (Computed using GEOID03)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.110	198951.139
Easting (X) [meters]	556844.944	2361300.881
Convergence [degrees]	0.51795039	-1.25747882
Point Scale	0.99963973	0.99990605
Combined Factor	0.99960614	0.99987245

US NATIONAL GRID DESIGNATOR: 10TER5684432460(NAD 83)

BASE STATIONS USED			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133 55755.0
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036 80573.2
DH5847	P695 MSH_NRIDGEWA2004 CORS ARP	N461156.337	W1220951.110 84445.6

NEAREST NGS PUBLISHED CONTROL POINT
AJ8136 1S4E26E N452714.920 W1221612.826 1222.5

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: 46722740.10o 000091844
Station ID: CBSD1

NGS OPUS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 04, 2010
RINEX FILE: 4672274q.10o TIME: 18:23:32 UTC

SOFTWARE: page5 1009.28 master.pl 1009103 START: 2010/10/01 16:12:00
EPHEMERIS: igr16035.eph [rapid] STOP: 2010/10/01 23:26:30
NAV FILE: brdc2740.10n OBS USED: 15933 / 17300 : 92%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 85 / 99 : 86%
ARP HEIGHT: 1.4933 OVERALL RMS: 0.018(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7502)

X:	-2393565.229(m)	0.038(m)	-2393566.006(m)	0.038(m)
Y:	-3790255.977(m)	0.042(m)	-3790254.766(m)	0.042(m)
Z:	4522207.588(m)	0.034(m)	4522207.637(m)	0.034(m)
LAT:	45 26 36.07288	0.017(m)	45 26 36.08805	0.017(m)
E LON:	237 43 38.59874	0.032(m)	237 43 38.53876	0.032(m)
W LON:	122 16 21.40126	0.032(m)	122 16 21.46124	0.032(m)
EL HGT:	215.202(m)	0.055(m)	214.810(m)	0.055(m)
ORTHO HGT:	237.800(m)	0.098(m) [NAVD88 (Computed using GEOID03)]		

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.587	198950.359
Easting (X) [meters]	556885.475	2361341.418
Convergence [degrees]	0.51831974	-1.25711126
Point Scale	0.99963979	0.99990605
Combined Factor	0.99960606	0.99987231

US NATIONAL GRID DESIGNATOR: 10TER5688532460(NAD 83)

BASE STATIONS USED			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133 55789.2
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036 80595.1
DH5847	P695 MSH_NRIDGEWA2004 CORS ARP	N461156.337	W1220951.110 84441.4

NEAREST NGS PUBLISHED CONTROL POINT			
AJ8136	1S4E26E	N452714.920	W1221612.826 1215.6

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: 46722750.T01.10o 000091934
Station ID: CBSD1

NGS OPUS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 04, 2010
RINEX FILE: 4672275q.10o TIME: 19:42:00 UTC

SOFTWARE: page5 1009.28 master40.pl 100910 START: 2010/10/02 16:13:00
EPHEMERIS: igr16036.eph [rapid] STOP: 2010/10/02 23:47:00
NAV FILE: brdc2750.10n OBS USED: 17398 / 18985 : 92%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 96 / 102 : 94%
ARP HEIGHT: 1.4500 OVERALL RMS: 0.016(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7530)

X:	-2393565.244(m)	0.046(m)	-2393566.021(m)	0.046(m)
Y:	-3790255.993(m)	0.028(m)	-3790254.782(m)	0.028(m)
Z:	4522207.588(m)	0.021(m)	4522207.637(m)	0.021(m)
LAT:	45 26 36.07238	0.025(m)	45 26 36.08755	0.025(m)
E LON:	237 43 38.59855	0.046(m)	237 43 38.53857	0.046(m)
W LON:	122 16 21.40145	0.046(m)	122 16 21.46143	0.046(m)
EL HGT:	215.217(m)	0.024(m)	214.825(m)	0.024(m)
ORTHO HGT:	237.815(m)	0.053(m)	[NAVD88 (Computed using GEOID03)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.571	198950.344
Easting (X) [meters]	556885.471	2361341.414
Convergence [degrees]	51831970	-1.25711130
Point Scale	0.99963979	0.99990605
Combined Factor	0.99960606	0.99987231

US NATIONAL GRID DESIGNATOR: 10TER5688532460(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133	55789.2
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036	80595.1
DH5847	P695 MSH_NRIDGEWA2004 CORS ARP	N461156.337	W1220951.110	84441.4

NEAREST NGS PUBLISHED CONTROL POINT

AJ8136	1S4E26E	N452714.920	W1221612.826	1215.6
--------	---------	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: 46722781.T01.10o 000094645
Station ID: CBSD1

NGS OPUS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 07, 2010
RINEX FILE: 4672278r.10o TIME: 21:28:44 UTC

SOFTWARE: page5 1009.28 master10.pl 100910 START: 2010/10/05 17:02:00
EPHEMERIS: igr16042.eph [rapid] STOP: 2010/10/06 01:06:00
NAV FILE: brdc2780.10n OBS USED: 19512 / 20908 : 93%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 93 / 109 : 85%
ARP HEIGHT: 1.4580 OVERALL RMS: 0.017(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7613)

X:	-2393565.253(m)	0.089(m)	-2393566.031(m)	0.089(m)
Y:	-3790255.996(m)	0.041(m)	-3790254.785(m)	0.041(m)
Z:	4522207.580(m)	0.047(m)	4522207.629(m)	0.047(m)
LAT:	45 26 36.07203	0.036(m)	45 26 36.08718	0.036(m)
E LON:	237 43 38.59827	0.063(m)	237 43 38.53825	0.063(m)
W LON:	122 16 21.40173	0.063(m)	122 16 21.46175	0.063(m)
EL HGT:	215.217(m)	0.081(m)	214.825(m)	0.081(m)
ORTHO HGT:	237.815(m)	0.140(m)	[NAVD88 (Computed using GEOID03)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.560	198950.333
Easting (X) [meters]	556885.465	2361341.407
Convergence [degrees]	0.51831964	-1.25711135
Point Scale	0.99963979	0.99990605
Combined Factor	0.99960606	0.99987231

US NATIONAL GRID DESIGNATOR: 10TER5688532460(NAD 83)

BASE STATIONS USED			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
DK4151	P446 KELSO AIR WA2007 CORS ARP	N460656.367	W1225333.976 88938.0
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133 55789.1
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036 80595.1

NEAREST NGS PUBLISHED CONTROL POINT			
AJ8136	1S4E26E	N452714.920	W1221612.826 1215.6

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.
FILE: 76002730.10o 000090872

FILE: 76002730.10o 000090872
Station ID: GKSD1

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 01, 2010
RINEX FILE: 7600273q.10o TIME: 19:45:09 UTC

SOFTWARE: page5 1009.28 master2.pl 1009103 START: 2010/09/30 16:09:00
EPHEMERIS: igr16034.eph [rapid] STOP: 2010/09/30 23:58:30
NAV FILE: brdc2730.10n OBS USED: 17061 / 18612 : 92%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 76 / 90 : 84%
ARP HEIGHT: 1.419 OVERALL RMS: 0.017(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7475)

X:	-2393565.244(m)	0.030(m)	-2393566.021(m)	0.030(m)
Y:	-3790256.004(m)	0.047(m)	-3790254.793(m)	0.047(m)
Z:	4522207.591(m)	0.031(m)	4522207.640(m)	0.031(m)
LAT:	45 26 36.07223	0.022(m)	45 26 36.08740	0.022(m)
E LON:	237 43 38.59882	0.036(m)	237 43 38.53884	0.036(m)
W LON:	122 16 21.40118	0.036(m)	122 16 21.46116	0.036(m)
EL HGT:	215.226(m)	0.045(m)	214.833(m)	0.045(m)
ORTHO HGT:	237.824(m)	0.083(m)	[NAVD88 (Computed using GEOID03)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.567	198950.339
Easting (X) [meters]	556885.477	2361341.419
Convergence [degrees]	0.51831975	-1.25711125
Point Scale	0.99963979	0.99990605
Combined Factor	0.99960606	0.99987231

US NATIONAL GRID DESIGNATOR: 10TER5688532460(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133	55789.2
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036	80595.1
DH5847	P695 MSH_NRIDGEWA2004 CORS ARP	N461156.337	W1220951.110	84441.4

NEAREST NGS PUBLISHED CONTROL POINT

AJ8136	1S4E26E	N452714.920	W1221612.826	1215.6
--------	---------	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: 76002740.10o 000091854
Station ID: GKSD1

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 04, 2010
RINEX FILE: 7600274p.10o TIME: 18:28:15 UTC

SOFTWARE: page5 1009.28 master23.pl 100910 START: 2010/10/01 15:58:00
EPHEMERIS: igr16035.eph [rapid] STOP: 2010/10/01 23:19:00
NAV FILE: brdc2740.10n OBS USED: 17177 / 17891 : 96%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 63 / 69 : 91%
ARP HEIGHT: 1.8000 OVERALL RMS: 0.015(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7502)

X:	-2393599.229(m)	0.036(m)	-2393600.006(m)	0.036(m)
Y:	-3790233.871(m)	0.069(m)	-3790232.660(m)	0.069(m)
Z:	4522206.884(m)	0.028(m)	4522206.933(m)	0.028(m)
LAT:	45 26 36.06926	0.049(m)	45 26 36.08443	0.049(m)
E LON:	237 43 36.73287	0.067(m)	237 43 36.67289	0.067(m)
W LON:	122 16 23.26713	0.067(m)	122 16 23.32711	0.067(m)
EL HGT:	214.324(m)	0.023(m)	213.932(m)	0.023(m)
ORTHO HGT:	236.923(m)	0.052(m)	[NAVD88 (Computed using GEOID03)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.109	198951.137
Easting (X) [meters]	556844.943	2361300.880
Convergence [degrees]	0.51795038	-1.25747883
Point Scale	0.99963973	0.99990605
Combined Factor	0.99960614	0.99987245

US NATIONAL GRID DESIGNATOR: 10TER5684432460(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133	55755.0
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036	80573.2
DH5847	P695 MSH_NRIDGEWA2004 CORS ARP	N461156.337	W1220951.110	84445.6

NEAREST NGS PUBLISHED CONTROL POINT

AJ8136	1S4E26E	N452714.920	W1221612.826	1222.5
--------	---------	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: 76002750.T01.10o 000091938
Station ID: GKSD1

NGS OPUS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 04, 2010
RINEX FILE: 7600275q.10o TIME: 19:48:21 UTC

SOFTWARE: page5 1009.28 master50.pl 100910 START: 2010/10/02 16:31:00
EPHEMERIS: igr16036.eph [rapid] STOP: 2010/10/02 23:39:00
NAV FILE: brdc2750.10n OBS USED: 17399 / 18128 : 96%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 66 / 73 : 90%
ARP HEIGHT: 1.8000 OVERALL RMS: 0.015(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7530)

X:	-2393599.216(m)	0.073(m)	-2393599.993(m)	0.073(m)
Y:	-3790233.855(m)	0.037(m)	-3790232.644(m)	0.037(m)
Z:	4522206.879(m)	0.059(m)	4522206.928(m)	0.059(m)
LAT:	45 26 36.06962	0.015(m)	45 26 36.08479	0.015(m)
E LON:	237 43 36.73298	0.053(m)	237 43 36.67300	0.053(m)
W LON:	122 16 23.26702	0.053(m)	122 16 23.32700	0.053(m)
EL HGT:	214.306(m)	0.079(m)	213.914(m)	0.079(m)
ORTHO HGT:	236.905(m)	0.138(m) [NAVD88 (Computed using GEOID03)]		

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.120	198951.148
Easting (X) [meters]	556844.945	2361300.882
Convergence [degrees]	0.51795041	-1.25747881
Point Scale	0.99963973	0.99990605
Combined Factor	0.99960614	0.99987245

US NATIONAL GRID DESIGNATOR: 10TER5684432460(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133	55755.0
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036	80573.2
DH5847	P695 MSH_NRIDGEWA2004 CORS ARP	N461156.337	W1220951.110	84445.5

NEAREST NGS PUBLISHED CONTROL POINT

AJ8136 1S4E26E N452714.920 W1221612.826 1222.5

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: 76002780.T01.10o 000094642
Station ID: GKSD1

NGS OPUS SOLUTION REPORT
=====

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: <http://www.ngs.noaa.gov/OPUS/about.html#accuracy>

USER: cyotter@watershedsciences.com DATE: October 07, 2010
RINEX FILE: 7600278q.10o TIME: 21:25:12 UTC

SOFTWARE: page5 1009.28 master50.pl 100910 START: 2010/10/05 16:59:00
EPHEMERIS: igr16042.eph [rapid] STOP: 2010/10/06 01:10:00
NAV FILE: brdc2780.10n OBS USED: 20973 / 21592 : 97%
ANT NAME: TRM55971.00 NONE # FIXED AMB: 65 / 77 : 84%
ARP HEIGHT: 1.8000 OVERALL RMS: 0.013(m)

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2010.7613)

X:	-2393599.215(m)	0.040(m)	-2393599.993(m)	0.040(m)
Y:	-3790233.860(m)	0.012(m)	-3790232.649(m)	0.012(m)
Z:	4522206.869(m)	0.034(m)	4522206.918(m)	0.034(m)
LAT:	45 26 36.06931	0.006(m)	45 26 36.08446	0.006(m)
E LON:	237 43 36.73314	0.030(m)	237 43 36.67312	0.030(m)
W LON:	122 16 23.26686	0.030(m)	122 16 23.32688	0.030(m)
EL HGT:	214.301(m)	0.044(m)	213.909(m)	0.044(m)
ORTHO HGT:	236.900(m)	0.082(m) [NAVD88 (Computed using GEOID03)]		

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	5032460.110	198951.139
Easting (X) [meters]	556844.949	2361300.886
Convergence [degrees]	0.51795044	-1.25747878
Point Scale	0.99963973	0.99990605
Combined Factor	0.99960614	0.99987246

US NATIONAL GRID DESIGNATOR: 10TER5684432460(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK4151	P446 KELSO AIR WA2007 CORS ARP	N460656.367	W1225333.976	88916.2
DE6433	WDBN WOODBURN COOP CORS ARP	N451015.094	W1225212.133	55755.0
DG5352	STAY STAYTON COOP CORS ARP	N444950.530	W1224915.036	80573.2

NEAREST NGS PUBLISHED CONTROL POINT

AJ8136	1S4E26E	N452714.920	W1221612.826	1222.5
--------	---------	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.