Entrix Inc.

LiDAR Survey of Lower Elwha River
Clallam County, WA

June 2009

Summary

LiDAR data and digital aerial photography was collected by TRSI over the Lower Elwha River Project Area in Clallam County, WA from April 4th to April 6th, 2009. Additional GPS control data was collected on April 20th, 2009.

Project Size: 91.66 km^2
Projection: NAD 1983 HARN State Plane Washington North Zone
Datum: NAVD 1988
Delivery Unit: U.S. Survey Feet (USFT)

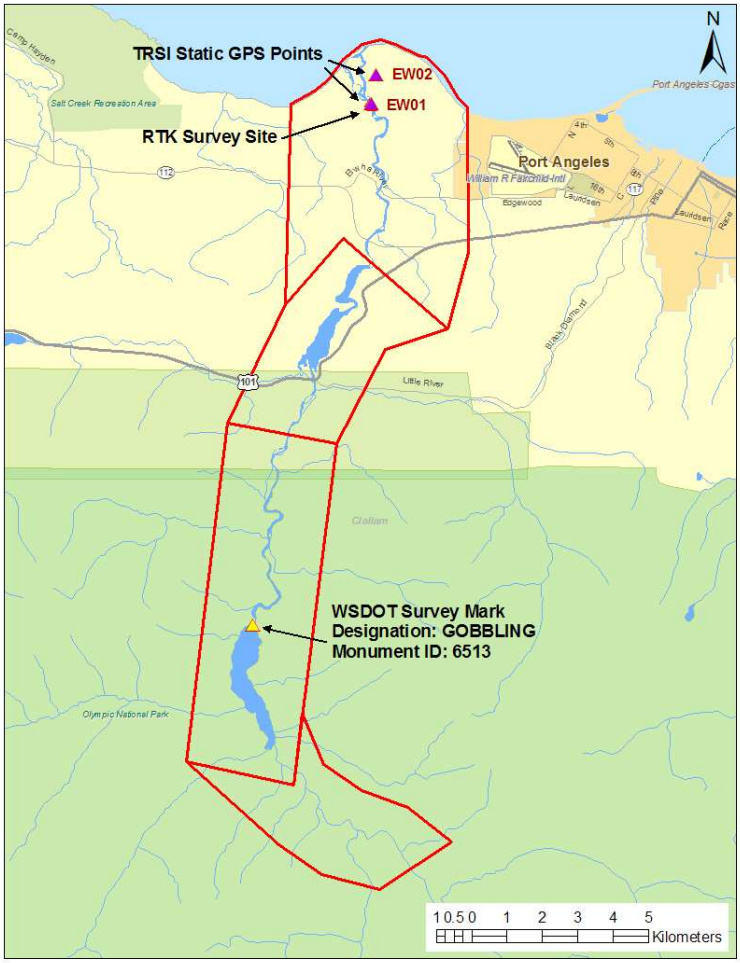

Figure 1. Lower Elwha River Project Boundary showing ground survey locations.

Project Specifications

LiDAR Accuracy

- LiDAR to have a relative accuracy of better than +/- 15cm on hard surfaces and an absolute accuracy better than 30cm

Control

- Acquire a total of 25 ground validation control points, including static GPS control points as well as RTK points

Deliverables

LiDAR

- 1 ft DEM – ASCII file format
- 1 ft DSM – ASCII file format
- Ground classed ground LiDAR points – ASCII file format

A list of the file deliverables is available in Entrix_LowerElwhaRiver_Manifest.txt. Metadata for each deliverable has also been provided. These files have been checked to be sure they meet the standards of the deliverables.

Calibration

Calibration flights were flown during data acquisition over the Port Angeles airport in Washington, U.S.A. These flights were conducted by flying perpendicular directions over the airport runway. These flightlines were used to calibrate the LiDAR data and correct for roll, pitch and heading variations between flights. A base station pass was also carried out to solve for range scale. Additional control points throughout the project area were checked against derived calibration values to confirm the validity of the LiDAR data.

Data Checks and Accuracy Verification

TRSI collected 22 RTK points in the project area. These points were used to calibrate the LiDAR point cloud and check the accuracy of the LiDAR points. Table 1 below shows the difference between the LiDAR DEM elevations and the RTK point elevations for each individual RTK point. Table 2 provides a summary of the accuracy statistics for RTK points. The results indicate that the LiDAR DEM provided by TRSI achieved a relative accuracy better than +/- 15 cm and an absolute accuracy within +/- 30 cm.

Number	Easting (USFT)	Northing (USFT)	Control z (USFT)	LiDAR z (USFT)	Dz (USFT)	Dz (m)
PN200	975582.239	426069.533	27.352	27.220	-0.132	-0.040
PN201	975538.150	426097.887	24.915	24.760	-0.155	-0.047
PN202	975471.816	426128.637	23.179	22.620	-0.559	-0.170
PN203	975439.492	426168.266	21.476	21.180	-0.296	-0.090
PN204	975416.094	426217.276	21.768	21.460	-0.308	-0.094
PN205	975394.202	426263.690	21.608	21.420	-0.188	-0.057
PN206	975366.333	426275.533	20.276	19.980	-0.296	-0.090
PN207	975381.963	426197.383	20.823	20.440	-0.383	-0.117
PN208	975426.148	426146.165	21.450	21.030	-0.420	-0.128
PN209	975449.857	426128.737	21.302	21.120	-0.182	-0.055
PN210	975465.651	426112.602	23.468	22.940	-0.528	-0.161
PN211	975487.597	426086.279	27.319	27.060	-0.259	-0.079
PN212	975504.574	426064.713	29.117	28.710	-0.407	-0.124
PN213	975537.677	426054.844	32.064	31.540	-0.524	-0.160
PN214	975589.686	426046.676	26.099	25.810	-0.289	-0.088
PN215	975636.195	426037.224	25.328	25.100	-0.228	-0.069
PN216	975679.067	426020.572	23.891	23.680	-0.211	-0.064
PN217	975607.962	425967.709	25.095	24.760	-0.335	-0.102
PN218	975602.614	425896.592	22.339	22.140	-0.199	-0.061
PN219	975585.128	425871.758	21.079	20.980	-0.099	-0.030
PN220	975619.017	425887.626	22.703	22.440	-0.263	-0.080
PN221	975656.454	425841.888	22.579	22.360	-0.219	-0.067

Table 1. LiDAR control report for RTK points.

	USFT	Meters
Average dz	-0.295	-0.090
Minimum dz	-0.559	-0.170
Maximum dz	-0.099	-0.030
Average magnitude	0.295	0.090
Root mean square	0.321	0.098
Std deviation	0.129	0.039

Table 2. LiDAR control report summary for RTK points.

Static Control

TRSI collected three static GPS control points within the project area. Table 3 displays the difference between the LiDAR DEM elevations and the static GPS control point elevations. Table 4 provides a summary of these statistics. The CORS stations NEAH (Neah Bay) and PABH (Pacific Beach) were used to process the static GPS points. Each static setup consisted of a dual frequency Ashtech ZXtreme GPS receiver with a corresponding Ashtech Geodetic IV antenna setup.

Figure 2. TRSI Static GPS point EW01.

Figure 3. TRSI Static GPS point EW02.

Figure 4. WSDOT Benchmark. Designation: GOBBLING; Monument ID: 6513

Number	Description	Easting (USFT)	Northing (USFT)	Control z (USFT)	LiDAR z (USFT)	Dz (USFT)	Dz (m)
6513	WSDOT Benchmark	963201.162	377856.296	616.515	616.380	-0.135	-0.041
EW01	TRSI Static	975591.740	426062.725	27.116	26.900	-0.216	-0.066
EW02	TRSI Static	976124.239	428751.344	23.524	23.360	-0.164	-0.050

Table 3. LiDAR control report for static GPS control points.

	USFT	Meters
Average dz	-0.172	-0.052
Minimum dz	-0.216	-0.066
Maximum dz	-0.135	-0.041
Average magnitude	0.172	0.052
Root mean square	0.175	0.053
Std deviation	0.041	0.012

Table 4. LiDAR control report summary for static GPS control points.

TRSI established two independent static GPS control points within the project boundary. These points were used to create a network solution with a Washington State Department of Transportation monument (WSDOT). The difference in orthometric height between the TRSI solution and the published WSDOT values is indicated in Table 5 and is within 5 cm. Complete information on the WSDOT survey mark 6513 can be found at the Washington State Department of Transportation website: http://www.wsdot.wa.gov/monument/report.cfm?monumentid=6513.

	Orthometric Height (NAV88)		
Monument ID	**TRSI (m)**	**WSDOT (m)**	**Difference (m)**
6513	187.914	187.862	0.052

Table 5. Vertical accuracy check of WSDOT monument 6513.

Point Cloud Density

Point cloud density is dependent on flying height and flightline overlap. The LiDAR points were filtered and classified and the final ground point density ranged from 0.1 to 0.5 points/m^2.