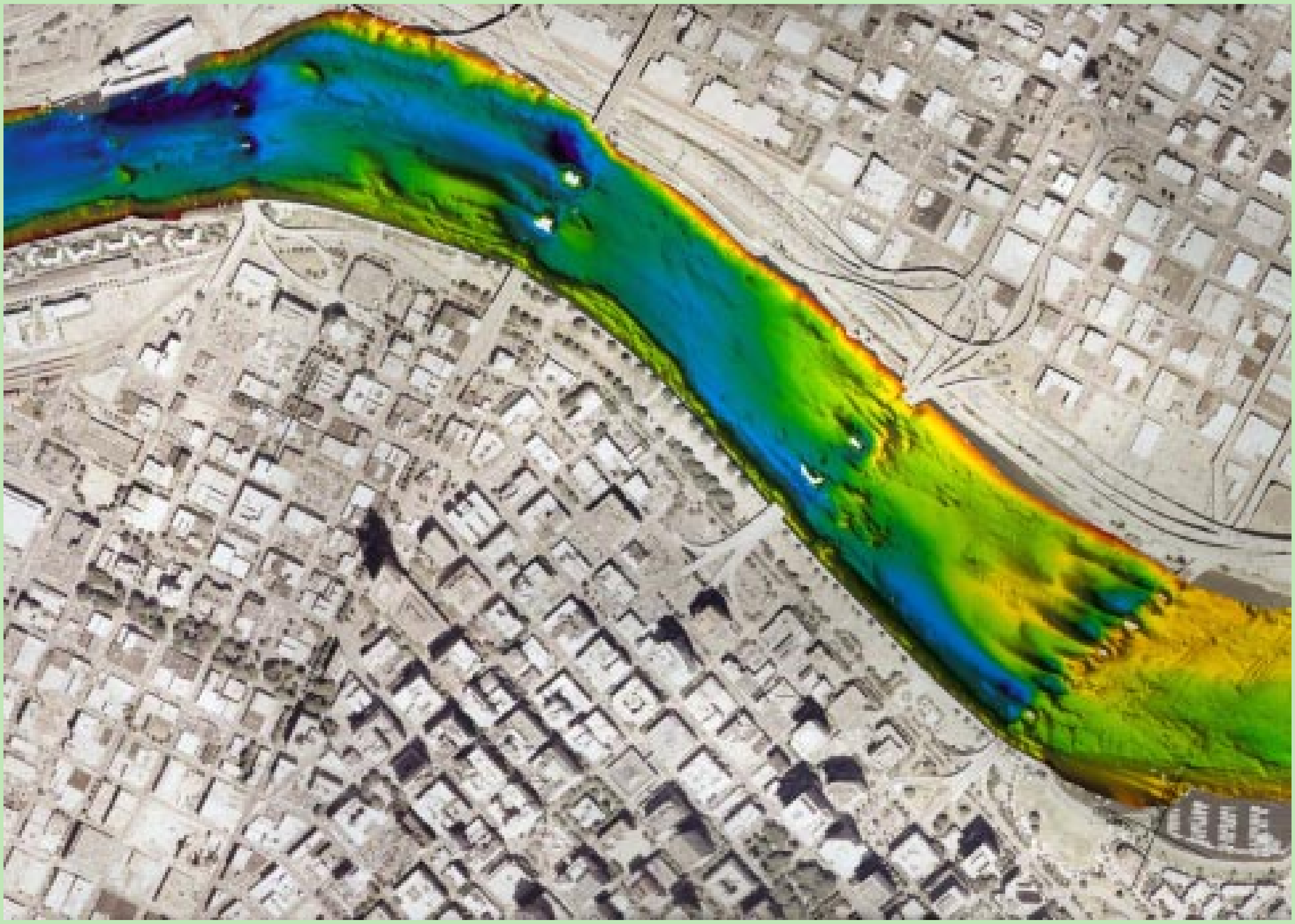
LOWER WILLAMETTE RIVER

MULTIBEAM BATHYMETRIC SURVEY REPORT

Summer 2002



Submitted to: Striplin Environmental Associates

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Privileged and Confidential: Work Product Prepared in Anticipation of Litigation

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MULTIBEAM BATHYMETRIC SURVEY REPORT

Summer 2002

Prepared by: ______________________

REGISTERED
PROFESSIONAL
LAND SURVEYOR

OREGON
JON L. DASLER
JAN. 23, 1990
2420

Reviewed by: ______________________
RENEWAL 12/31/03

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1.0 INTRODUCTION

David Evans and Associates, Inc. (DEA), under contract with Striplin Environmental Associates, conducted two additional bank-to-bank multibeam bathymetric surveys of the Lower Willamette River during the summer of 2002. The primary goal of these surveys was to create a dataset that depicts summertime riverbed elevations for 2002 that can be directly compared to the prior, January 2002, survey to determine areas of erosion and accretion within the study area. The survey was conducted from River Mile 0 (at the confluence with the Columbia River) to River Mile 15.6 (at the upper end of Ross Island), which was the same extent as the January 2002 survey, Letter of Authorization 1 (LOA 1). DEA also provided Geographical Information System (GIS) grids of the bathymetry and difference grids that depict the change in riverbed elevation from January 2002 to summer 2002.

The results from this survey will be used to support sediment sampling during the remedial investigation, to define shoaling and scour areas relative to previous surveys, and to support future site investigations. Survey operations were conducted in two stages. The initial survey was conducted from July 3, 2002 to July 18, 2002 (LOA 3) and data were collected from River Mile 2.0 to 11.0. After processing the data significant changes were identified. The Lower Willamette Working Group determined that it would be beneficial to document the extent of changes for the remainder of the 15-mile study area. A second survey included the remainder of the 15-mile stretch of the Willamette with a 0.5 mile overlap at each end to identify any short-term change during the summer of 2002. From September 16, 2002 to September 20, 2002 (LOA 4), data were collected between River Mile 0.0 – 2.5 (overlapping the July survey between miles 2.0 and 2.5) and from River Mile 10.5 to 15.0 (overlapping the July survey between miles 10.5 and 11.0) . This report describes control used for the survey, data acquisition methodology, and data processing procedures. In addition to this report, deliverables include a set of full size drawings and project CD-ROMs containing digital data, Arc/Info GRID files and AutoCAD drawing files of final maps.

2.0 DATUMS AND PROJECT CONTROL NETWORK

Conducting a survey on an established coordinate system, referenced by monuments, enables the survey to be reproduced at a later date with repeatable results. Using a coordinate system on a defined horizontal and vertical datum allows for utilization of data from other sources. For this survey, the horizontal datum is the North American Datum of 1983 through the 1991 adjustment (NAD83/91), State Plane Coordinate System (SPCS), Oregon North Zone. Units are International Feet (1 foot = 0.3048 meters exactly). The vertical datum for this survey is the North American Vertical Datum of 1988 (NAVD88), which is the same vertical datum that was used in the winter 2002 survey, thereby aiding in the comparison of the surveys. Table 1 is a conversion table to aid in the conversion of data based on Columbia River Datum (CRD) or the

National Geodetic Vertical Datum of 1929 through the 1947 adjustment (NGVD29/47) to NAVD88.

Table 1: Vertical Datum Conversion

River Mile	NAVD88 Elevation	NGVD29/47 Elevation	CRD Elevation
0.4	10.0’	6.8’	5.4’
	0.0’	-3.2’	-4.6’
	-10.0’	-13.2’	-14.6’
1.3	10.0’	6.8’	5.4’
	0.0’	-3.2’	-4.7’
	-10.0’	-13.2’	-14.7’
5.0	10.0’	6.7’	4.9’
	0.0’	-3.3’	-5.1’
	-10.0’	-13.3’	-15.1’
9.8	10.0’	6.5’	4.7’
	0.0’	-3.5’	-5.3’
	-10.0’	-13.5’	-15.3’
12.8	10.0’	6.5’	4.6’
	0.0’	-3.5’	-5.4’
	-10.0’	-13.5’	-15.4’
15.6	10.0’	6.5’	4.6’
	0.0’	-3.5’	-5.4’
	-10.0’	-13.5’	-15.4’

Prior to the survey, a new control point was added to the established project control network based on NAD83/91, Oregon North Zone horizontal positions and NAVD88 elevations. This point, designated “2100”, was established on the roof of DEA’s new office location at 2100 SW River Parkway and serves as an ideal location for deployment of a real-time kinematic (RTK) GPS base station for the upper portion of the project. Field notes for the placement of this point are included in Appendix A. Table 2 represents coordinates and elevations for the project control network monuments.

Table 2: Lower Willamette River, Control Network Coordinates

Monument Designation	NAD83 OR North		NAD83 OR North		NAVD88	
	North m	East m	North ft	East ft	El m	El Ft.
A81	216879.768	2322669.168	711547.800	7620305.670	9.022	29.60
BLDG10	213233.670	2325671.863	699585.530	7630157.030	10.495	34.43
DEA2828	*206352.805*	*2330026.319*	*677010.520*	*7644443.300*	*28.738*	*94.28*
2100	206776.182	2330254.088	678399.547	7645190.577	48.647	159.60
EAGLE GPS 36	211213.728	2328090.742	692958.430	7638092.990	10.146	33.29
N19	207968.621	2330368.700	682311.750	7645566.600	10.447	34.27
NELSON	202701.014	2326430.157	665029.570	7632644.870	125.250	410.93
RAINDEER	220200.425	2321017.341	722442.340	7614886.290	10.829	35.53
REF B718	211672.417	2326043.648	694463.310	7631376.800	12.600	41.34
REF N723	201209.507	2332677.212	660136.180	7653140.460	15.105	49.56
T-5-3	221705.879	2322489.162	727381.490	7619715.100	9.208	30.21
VAN CBL 0	225260.113	2325154.017	739042.370	7628458.060	9.220	30.25
WACO	209291.534	2305473.631	686652.010	7563889.870	75.229	246.81

3.0 BATHYMETRIC SURVEY

A high-resolution multibeam bathymetric survey was conducted to provide detailed three-dimensional data over the Lower Willamette River from River Mile 0 to River Mile 15.6.

3.1 Survey Vessel and Crew

The vessel for this survey was the *John B. Preston*, a 30-foot custom aluminum survey boat owned and operated by DEA. The vessel is equipped with an integrated navigation and data acquisition system, and a custom mount for the SeaBat 8101 sonar head, and it is ideal for shallow water survey operations in tight quarters.

The hydrographic survey crew consisted of a lead hydrographer and vessel operator/hydrographer from DEA. The crew has conducted numerous multibeam and side-scan sonar surveys and has had extensive training in hydrographic surveys.

3.2 Positioning and Navigation

Horizontal positions were acquired with an Applanix POS/MV combined DGPS and inertial navigation system augmented by a Trimble MS 750 dual-frequency RTK receiver. The January 2002 survey strictly utilized Differential Global Positioning System (DGPS) positioning methods as the POS/MV used in the survey had difficulty maintaining RTK positions through high multipath or loss of satellite signals. Advancements in the POS/MV firmware enabled the use of RTK GPS in the summer survey, although the system still reverted to DGPS positions in some high multipath environments. The use of RTK GPS positioning techniques will improve horizontal positioning from +/- 1 meter to +/- 0.1 meters. RTK correctors were obtained from an RTK GPS base station deployed at three different sites to cover the survey area. They included “2100” for the upper river, “BLDG10” for the middle section and “RAINDEER” for the lower section. Figure 1 shows the location of monuments used for RTK GPS base station deployment.

Differential correctors were obtained real-time via radio broadcasts from the Continuously Operating Reference Station (CORS) site at Appleton, Washington.

The POS/MV system integrates two GPS receivers with a motion reference unit. This system not only provides position data, but it also provides vessel heading and motion information (roll, pitch, and heave) to compute X, Y, Z data from the multibeam sonar measurements.

Position data were used in real time to provide navigation information to the vessel operator and was time-tagged and logged with multibeam and other ancillary data. The planned survey lines and the actual survey track were displayed with multibeam swath coverage in real time on a monitor located at the helm to aid in a systematic survey of the area.

3.3 Water Surface Observations

As all bathymetric data is time tagged and recorded relative to the water surface, accurate water surface observations in the vicinity of the survey are required to account for tides and changes in river flow. Water surface measurements were obtained by RTK GPS with on-the-fly ambiguity resolution. An RTK GPS base station was deployed at three separate locations to provide real-time GPS correctors. RTK correctors were applied to the shipboard GPS for logging water surface elevations at one-second intervals. An ellipsoid separation model, developed for the January 2002 survey (LOA 1), was used in Hypack MAX software for on-the-fly conversion from the WGS84 ellipsoid (ellipsoid from which GPS heights are derived) to NAVD88. One-second observations were graphically viewed and edited for outliers, artifacts from multipath, or loss of satellites. After editing of the one-second data, a 60-second average of RTK GPS observations was used for correcting multibeam soundings to NAVD88 elevations.

Water surface elevations obtained by RTK GPS were checked against established staff gauges installed previously by DEA at Port of Portland Terminals 2, 4 and 5 as well as Corps of Engineers staff gauges and the Morrison Bridge staff and automated gauge.

3.4 Multibeam Data Acquisition

Soundings were acquired with a Reson SeaBat 8101 multibeam bathymetric sonar using a frequency of 240kHz. The system records 101 soundings in a single sonar ping. Additionally, DEA's 8101 includes options such as a stick projector for enhanced shallow water performance and the ability to output side scan sonar imagery. The stick projector option on the Reson SeaBat 8101 improves the system performance in shallow water (depths less than 150 feet).

Multibeam data were obtained by running lines parallel with the shoreline for the length of the project. When possible, survey lines were run to match those from the January 2002 survey to maintain consistency between survey coverages. As with the prior survey, the sonar head was mounted with a 15-degree offset angle for horizontal orientation of the outer starboard beam. This enabled coverage over a range of 90 degrees from nadir (straight down) to starboard and 60 degrees from nadir to port with a recorded depth every 1.5 degrees. Sonar swaths were recorded at a rate of 20Hz as the vessel transited along the survey track lines. With this configuration, shoreline data were collected as far up the bank as

FIGURE 1: CONTROL NETWORK FOR THE LOWER WILLAMETTE RIVER

LEGEND

CONTROL MONUMENT

RTK BASE STATION

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possible by making shoreline runs with the starboard side toward shore. This allowed mapping under piers and barges with a shallow draft. Survey lines offshore of the shoreline runs were clipped at 60 degrees (120 degree total swath width) during processing to improve data quality. Running with a 120-degree swath (60 degrees to port and starboard), the system provided 3.5 times the water depth coverage in a single pass. The total swath width of full coverage mapping in a single pass varied with the water depth.

The most vital measurements in a multibeam survey are heading and roll angles. To account for vessel heading, heave (vertical movement), pitch and roll, an Applanix POS/MV motion reference sensor was utilized. By utilizing vessel speed over ground provided by the DGPS and heading data, the POS/MV can isolate horizontal accelerations from vessel turns and provide highly accurate motion data. The POS/MV system was also used to record vessel heading (yaw) from which the sonar beam orientation was derived. The POS/MV provides a higher degree of accuracy for heading measurements than a conventional gyrocompass.

Multibeam data were recorded simultaneously on two systems. The primary acquisition system was a Triton Elics Isis system that provided precise time tagging of the sensor data and real-time data displays for quality control. The displays include real-time side scan imagery from the multibeam sonar. The secondary acquisition system was the navigation and survey control computer running Coastal Oceanographics HYPACK MAX software. Both systems acquired and time-tagged all sensor data including multibeam sonar slant-range measurements, position, heading, heave, pitch and roll. The Coastal Oceanographics HYSWEEP program allowed the swath bathymetric data to be displayed as a painted-color-by-depth image on the navigation screen. This real-time display gave the hydrographers immediate indications of data quality and coverage.

Detailed measurements of the sound velocity profile through the water column are crucial in multibeam surveys. Changes in the velocity profile will not only affect acoustic distance measurements, but can also cause refraction or bending of the sonar path as it passes through layers in the water column with different velocities. For this survey, a SeaBird SBE 19 SeaCat CTD profiler was used to measure conductivity, temperature, and depth at one-second intervals as the probe was lowered to just above the riverbed. The CTD measurements were used to compute an accurate velocity profile and were applied to the data during processing.

To confirm alignment of the multibeam sensor with the sonar swath and verify delay times applied to the time-tagged sensor data, a patch test was conducted. This consisted of a series of lines run in a specific pattern, which were used in pairs to analyze roll, pitch, and heading alignment angles with the sonar swath, as well as latency (time delays) in the time tagging of the sensor data.

To confirm the draft of the sonar head, lead line soundings were performed at the sonar head and compared to logged multibeam depths.

4.0 DATA PROCESSING

Post-processing of multibeam data was conducted utilizing Caris HIPS multibeam analysis and presentation software. Patch test data was analyzed and any alignment corrections were applied. The Caris HIPS system allows simultaneous viewing of the side scan and multibeam data to analyze anomalies on the riverbed during post-processing. Water-level data were applied to adjust all depth measurements to NAVD88 from the RTK GPS processed data. Velocity profiles were generated from CTD measurements taken in the field and used to correct slant range measurements and compensate for any ray path bending.

Processing began with review of each survey line using the Caris swath editor. Verified water surface correctors were applied to the data set at this time. Position and sensor data were reviewed and accepted. Sounding data were reviewed and edited for data flyers. Sounding data, including sonar beams reflecting from sediment in the water column or noise due to aeration in the water column, were carefully reviewed before flagged as rejected. In each case, data were not eliminated, and they can be re-accepted in the future if required.

After swath editing, all data were reviewed through the Caris HIPS subset editing program to ensure no flyers remained in the data set, or to re-accept data previously flagged in the swath editor. In the Caris subset editor, a set of lines was reviewed together for line-to-line comparison to ensure agreement to one another in a Caris session. A series of subsets was made to cover the survey area using multiple lines for each Caris session.

4.1 Data Export and Mapping

The project technical specifications call for no finer than a 10-by-10-foot grid of the data. To take advantage of the level of detail the multibeam bathymetric survey provided, a 3-foot gridded data set was exported from Caris HIPS. This gridding process selects the average depth from all accepted multibeam data on a 3-by-3-foot grid. Data were divided into sections that corresponded to final drawing sheet numbers and exported. All original data were archived at full resolution. If required at a later date, specific areas of interest can readily be remodeled at a higher resolution. It should be noted that the data are not biased for least depth as is the standard for a navigation survey, and data should not be used for navigation purposes.

For bathymetric contouring, the 3-foot averaged export of accepted multibeam data was imported for each sheet into Plus-3 Terramodel software for generation of a digital terrain model (DTM). Elevation contours were generated from the DTM at a 2-foot interval based on NAVD88. After review of the DTM, the accepted data were exported as an ASCII text file by sheet.

A sun-illuminated image of the multibeam data was generated in Caris HIPS at a 3-foot pixel resolution, and georeferenced TIFF files for each sheet were exported. The sun-illuminated image was color coded by depth and demonstrates the extent of coverage over the survey area. Sun-illuminated images provide a more detailed presentation of the high-resolution multibeam bathymetric data than contouring and aid in the interpretation of river bedforms. The images were used as a quality control check to determine if subtle artifacts remained in the data set and incorporated in the deliverables.

4.2 GIS Processing

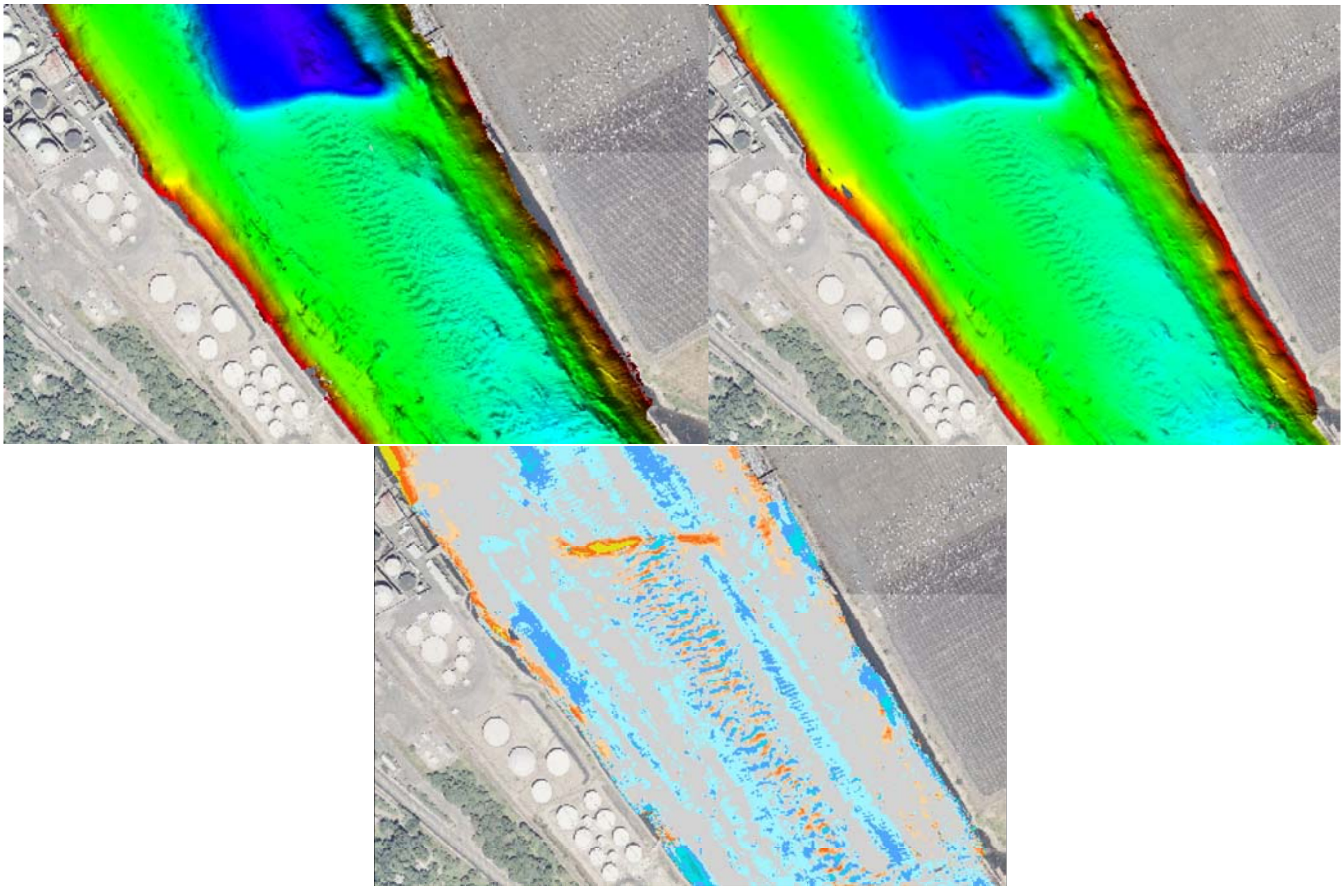
ArcView 3.3 was used to create the difference grids for this survey. ESRI grids with a 3-foot cell size were generated from the averaged exports of the multibeam data. Difference grids were created using the Raster Calculator function in ArcView. Grid extent, cell size and the horizontal position of the grid nodes were consistent between surveys to ensure accuracy in the output grids. The values of the grid nodes for the summer 2002 survey were subtracted from the grid node values for the January 2002 survey to produce the difference grids.

A color scale was applied to the difference grids to aid in the analysis of the riverbed change. The color palette was designed to accentuate various levels of riverbed change that were defined by the scope of the project. All areas that changed ±0.25 feet, which is the approximate vertical error budget of the survey, were colored gray. Areas of accretion (or shoaling) were given red and orange hues while those areas that eroded were given blue hues. The color values correspond to the magnitude of the difference. For example, areas shaded with dark blues signify changes greater than light blues. The results of this difference analysis are illustrated in Figure 2. Both the winter and summer sun-illuminated imagery depict sediment waves and a deep hole downstream. The difference image accentuates the sediment wave migration and accretion on the upstream side of the hole.

Differences were detected along steep slopes that may be the result of minor positioning differences between surveys. The use of RTK positioning will improve the repeatability of the surveys. Slight differences may also be observed as long linear streaks in the difference images. Some of these minor differences, less than 0.50 feet, may be the result of lower quality outer beam measurements from the multibeam sonar. Future surveys can be used for further analysis of these areas.

Extreme differences were defined in the color palette by purple (greater than 10 feet) and brown (greater than -30 feet). These extreme values are present at and around bridge piles throughout the survey area. Most of these areas do not represent change, but rather differences in depths collected along the vertical structure of the bridge piles or bulkheads at piers from the two surveys. Some of these areas represent actual change and are the result of dredging operations. An example of such an area is at the northeast end of Ross Island.

Winter 2002 Summer 2002



Difference Analysis

Figure 2: Winter and Summer 2002 Sun-Illuminated Images and Difference Analysis

During the differing analysis, erroneous soundings were identified on sheets 6 and 7 in the original January 2002 dataset. These soundings were removed from the January 2002 (LOA 1) bathymetry grids, and new versions of these grids were issued as a revision with the difference grids on November 22, 2002. The revisions to the winter survey were used to produce the difference grids to keep erroneous soundings from creating invalid differences for the summer 2002 analysis as well as for future surveys.

4.3 Multibeam Bathymetric Data Presentation

Results of the multibeam survey were presented as bathymetric contours and sun-illuminated imagery. Difference analysis was presented as a color-coded image. Table 3 is a summary of hard copy deliverables for the Summer 2002 survey. A detailed listing of all digital deliverables produced to date is included in Appendix A.

Table 3. Hard Copy Deliverables for Summer 2002 Multibeam Bathymetric Survey

	Contours and Images for River Miles 2.0 – 11.0	**Contours and Images for River Miles 0.0-2.5 / 10.5-15.6**	**Difference Image Jan.-July 2002**	**Difference Image Jan.-Sept. 2002**	**Difference Image July-Sept. 2002**
Survey Date:	July 2002	September 2002	July 2002	September 2002	September 2002
Delivery Date:	October 2002	December 2002	October 2002	December 2002	December 2002
Sheet 1		√		√	
Sheet 2	√	√	√		√
Sheet 3	√		√		
Sheet 4	√		√		
Sheet 5	√	√	√		√
Sheet 6		√		√	
Sheet 7		√		√	

Multibeam bathymetric contours were imported into AutoCAD and presented as a series of bathymetric contour maps (B1-B7) at a scale of 1"=400'. Aerial photographs from a 2000 aerial survey were provided by the Port of Portland to use as a base map. The aerials provided an excellent reference to the bathymetric data.

Sun-illuminated imagery of the bathymetric data was overlaid on the aerial base maps and a set of sun-illuminated drawings (S1-S7) was developed in AutoCAD. The drawings included a color depth legend in NAVD88 and CRD to aid in the depth determination. The colors used to define the depth are from a rainbow spectrum that provides three-dimensional viewing of the drawings and reveals detailed riverbed relief when viewed with special glasses. The ChromaDepth glasses are available from Chromatek, Inc. at http://www.chromatek.com.

Difference images were computed from the January minus July 2002 survey (D2-D5), January minus September (D1, D6 and D7), and July minus September (D2 and D5). The images were imported into AutoCAD and overlaid on the project base drawings. To accentuate areas of no data, the river background was clipped to the limits of the survey coverage.

APPENDIX A
DECEMBER 2002 DIGITAL DATA CATALOG

December 2002 Digital Data Catalog					
	LOA1 (January 2002)				
	Autocad files			Autocad plot files	
	Bathymetry	Sun-illuminated	Contours	Bathymetry	Sun-illuminated
Sheet 1	bathy_01.dwg	sunil_01.dwg	sh1_con.dwg	bathy_01.plt	sunil_01.plt
Sheet 2	bathy_02.dwg	sunil_02.dwg	sh2_con.dwg	bathy_02.plt	sunil_02.plt
Sheet 3	bathy_03.dwg	sunil_03.dwg	sh3_con.dwg	bathy_03.plt	sunil_03.plt
Sheet 4	bathy_04.dwg	sunil_04.dwg	sh4_con.dwg	bathy_04.plt	sunil_04.plt
Sheet 5	bathy_05.dwg	sunil_05.dwg	sh5_con.dwg	bathy_05.plt	sunil_05.plt
Sheet 6	bathy_06.dwg	sunil_06.dwg	sh6_con.dwg	bathy_06.plt	sunil_06.plt
Sheet 7	bathy_07.dwg	sunil_07.dwg	sh7_con.dwg	bathy_07.plt	sunil_07.plt
	Imagery with worldfile				
	Sun-illuminated bathymetry images				
Sheet 1	sheet1_1m_ev50_az45.tif				
Sheet 2	sheet2_1m_ev55_az20.tif				
Sheet 3	sheet3_1m_ev55_az350.tif				
Sheet 4	sheet4_1m_b_ev55_az350.tif				
Sheet 5	sheet5_1m_ev55_az350.tif				
Sheet 6	sheet6_1m_ev55_az340.tif				
Sheet 7	sheet7_1m_ev55_az45.tif				
	ArcGRID				
	1m Bathymetry	10ft Bathymetry	10ft Bathymetry and Lidar		
Sheet 1	sh1_loa4_1m.e00	sht1_bath10ft.e00	sht1_bath_lid.e00		
Sheet 2	sht2_loa3_1m.e00	sht2_bath10ft.e00	sht2_bath_lid.e00		
Sheet 3	sht3_loa3_1m.e00	sht3_bath10ft.e00	sht3_bath_lid.e00		
Sheet 4	sht4_loa3_1m.e00	sht4_bath10ft.e00	sht4_bath_lid.e00		
Sheet 5	sht5_loa3_1m.e00	sht5_bath10ft.e00	sht5_bath_lid.e00		
Sheet 6	sht6_loa4_1m.e00	sht6_bath10ft.e00	sht6_bath_lid.e00		
Sheet 7	sht7_loa4_1m.e00	sht7_bath10ft.e00	sht7_bath_lid.e00		
	ASCII Points				
	1m XYZ	1m XYZ	10ft XYZ		
Sheet 1	sht1_bathy_1m_xyz.txt	na	sht1_bath10ft_xyz.txt		
Sheet 2	sht2_bathy_1m_xyz.txt	na	sht2_bath10ft_xyz.txt		
Sheet 3	sht3_bathy_1m_xyz.txt	na	sht3_bath10ft_xyz.txt		
Sheet 4	sht4_bathy_1m_xyz_east.txt	sht4_bathy_1m_xyz_west.txt	sht4_bath10ft_xyz.txt		
Sheet 5	sht5_bathy_1m_xyz_east.txt	sht5_bathy_1m_xyz_west.txt	sht5_bath10ft_xyz.txt		
Sheet 6	sht6_bathy_1m_xyz.txt	na	sht6_bath10ft_xyz.txt		
Sheet 7	sht7_bathy_1m_xyz.txt	na	sht7_bath10ft_xyz.txt		
	Other files				
	bathym_10ft.e00	10 ft bathymetry moasic			
	bathlid_merge.e00	bathymetry and lidar moasic			
	Loa1_tracks.dxf	survey tracklines			

December 2002 Digital Data Catalog					
	LOA3 (July 2002)				
	Autocad files				
	Bathymetry	Sun-illuminated	Difference	2ft Contours	5ft Contours
Sheet 1	na	na	na	na	na
Sheet 2	bathy_02.dwg	sunil_02.dwg	diff_02.dwg	sh2_con.dwg	sh2_5ft.dwg
Sheet 3	bathy_03.dwg	sunil_03.dwg	diff_03.dwg	sh3_con.dwg	sh3_5ft.dwg
Sheet 4	bathy_04.dwg	sunil_04.dwg	diff_04.dwg	sh4_con.dwg	sh4_5ft.dwg
Sheet 5	bathy_05.dwg	sunil_05.dwg	diff_05.dwg	sh5_con.dwg	sh5_5ft.dwg
Sheet 6	na	na	na	na	na
Sheet 7	na	na	na	na	na
	Imagery with worldfile				
	Sun-illuminated bathymetry images	Bathymetry difference 3v1			
Sheet 1	na	na			
Sheet 2	sheet2_1m-24_v5.tif	diff_2			
Sheet 3	sheet3_1m.tif	diff_3			
Sheet 4	sheet4_1m.tif	diff_4			
Sheet 5	sheet5_1m.tif	diff_5-new			
Sheet 6	na	na			
Sheet 7	na	na			
	ArcGRID				
	1m Bathymetry	Bathymetry difference 3v1			
Sheet 1	na	na			
Sheet 2	sh2_loa3_1m.e00	diff_2.e00			
Sheet 3	sh3_loa3_1m.e00	diff_3.e00			
Sheet 4	sh4_loa3_1m.e00	diff_4.e00			
Sheet 5	sh5_loa3_1m.e00	diff_5b.e00			
Sheet 6	na	na			
Sheet 7	na	na			
	ASCII Points				
	1m XYZ				
Sheet 1	na				
Sheet 2	sh2_loa3_1m_xyz.txt				
Sheet 3	sh3_loa3_1m_xyz.txt				
Sheet 4	sh4_loa3_1m_xyz.txt				
Sheet 5	sh5_loa3_1m_xyz.txt				
Sheet 6	na				
Sheet 7	na				
	Other files				
	Loa3_tracks.dxf	survey tracklines			

December 2002 Digital Data Catalog						
	LOA4 (September 2002)					
	Autocad files					
	Bathymetry	Sun-illuminated	Difference	2ft Contours	2ft Contours	Contour labels
Sheet 1	bathy_01.dwg	sunil_01.dwg	diff_01.dwg	sh1_con.dwg	sh1_5ft.dwg	sh1_labels.dwg
Sheet 2	bathy_02.dwg	sunil_02.dwg	diff_02.dwg	sh2_con.dwg	sh2_5ft.dwg	sh2_labels.dwg
Sheet 3	na	na	na	na	na	na
Sheet 4	na	na	na	na	na	na
Sheet 5	bathy_05.dwg	sunil_05.dwg	diff_05.dwg	sh5_con.dwg	sh5_5ft.dwg	sh5_labels.dwg
Sheet 6	bathy_06.dwg	sunil_06.dwg	diff_06.dwg	sh6_con.dwg	sh6_5ft.dwg	sh6_labels.dwg
Sheet 7	bathy_07.dwg	sunil_07.dwg	diff_07.dwg	sh7_con.dwg	sh7_5ft.dwg	sh7_labels.dwg
	Imagery with worldfile					
	Sun-illuminated bathymetry images	Bathymetry difference 4v1	Bathymetry difference 4v3			
Sheet 1	sheet1_loa4.tif	diff1_4v1.tif	na			
Sheet 2	sheet2_loa4.tif	diff2_4v1.tif	diff2_4v3.tif			
Sheet 3	na	na	na			
Sheet 4	na	na	na			
Sheet 5	sheet5_loa4.tif	diff5_4v1.tif	diff5_4v3.tif			
Sheet 6	sheet6_loa4.tif	diff6_4v1.tif	na			
Sheet 7	sheet7_loa4.tif	diff7_4v1.tif	na			
	ArcGRID					
	1m Bathymetry	Bathymetry difference 4v1	Bathymetry difference 4v3			
Sheet 1	sh1_loa4_1m.e00	diff1_4v1.e00	na			
Sheet 2	sh2_loa4.e00	diff2_4v1.e00	diff2_4v3.e00			
Sheet 3	na	na	na			
Sheet 4	na	na	na			
Sheet 5	sh5_loa4.e00	diff5_4v1.e00	diff5_4v3.e00			
Sheet 6	sht6_loa4.e00	diff6_4v1.e00	na			
Sheet 7	sh7_loa4.e00	diff7_4v1.e00	na			
					LOA1 UPDATE	
	ASCII Points				ArcGRID	
	1m XYZ				1m Bathymetry	
Sheet 1	sh1_loa4_1m_xyz.txt				na	
Sheet 2	sh2_loa4_1m_xyz.txt				na	
Sheet 3	na				na	
Sheet 4	na				na	
Sheet 5	sh5_loa4_1m_xyz.txt				na	
Sheet 6	sh6_loa4_1m_xyz.txt				sh6_loa1_msk.e00	
Sheet 7	sh7_loa4_1m_xyz.txt				sh7_loa1_msk.e00	
	Other files					
	Loa4_tracks.dxf	survey tracklines				

APPENDIX B

FIELD NOTES FROM GPS OBSERVATIONS

STRE0000-0002

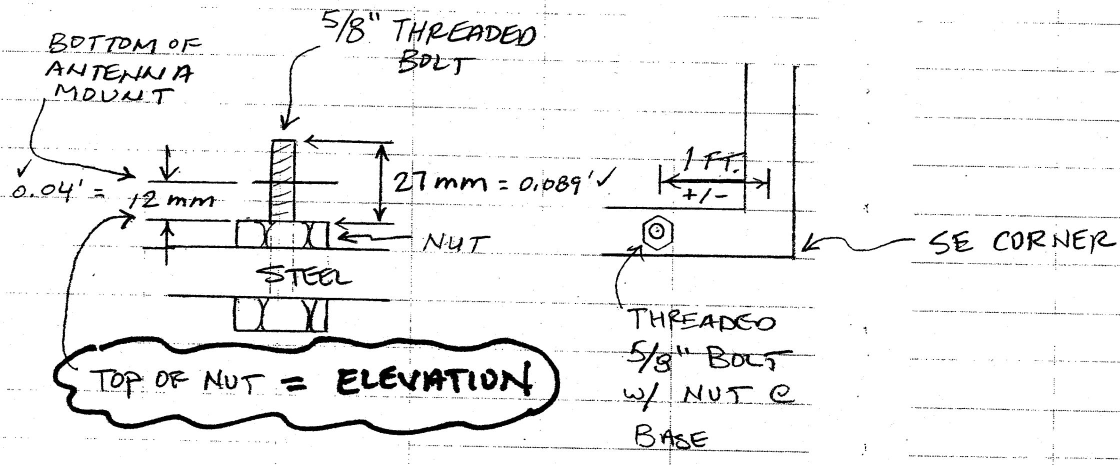
9-16-02 KJM CLOUDY ~~60°~~ 65 F

TRIMBLE 4800 #0185 ✓
#2100 ✓

SET THREADED BOLT @ TOP SE CORNER 14'± HIGH UTILITY ENCLOSURE ON ROOF OF 2100 SW RIVER PARKWAY BUILDING

HI = 0.012m ✓ TO BOTTOM OF ✓ ANTENNA MOUNT

START @ 1335 ✓ 0185 259 0
STOP @ 1712 ✓

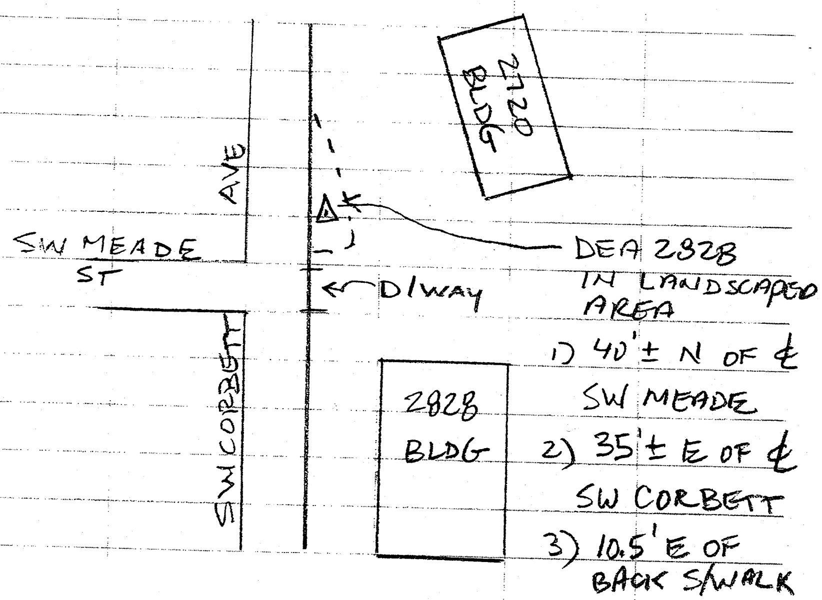


STRE0000-0002

TRIMBLE 4800 #0182 ✓
DEA 2828 ✓
FD. 2" ALUM. CAP ON 5/8" IRON ROD. ALUM. CAP IS PUNCHED & STAMPED "DEA INC".

HI = 1.500 m. ✓ FIXED HEIGHT ✓
TRIPOD TO BOTTOM ANT. MOUNT.

START @ 1406 ✓ 0182 2590
STOP @ 1445 ✓



9-16-02 KJM CLOUDY 65°F

TRIMBLE 4800 #0182 ✓
DEA ROOF ✓
FD 4 FT RANGE POLE CLAMPED TO 1 FT. HIGH VENT PIPE. 5/8" THREADED TOP IS MONUMENT. SEE P. (61)
HI = 0.004 m ✓ (4 mm) TO BOTTOM OF ANTENNA MOUNT. ✓

START @ 1500 ✓ 0182 2591
STOP @ 1520 ✓

STRE 0000-0002

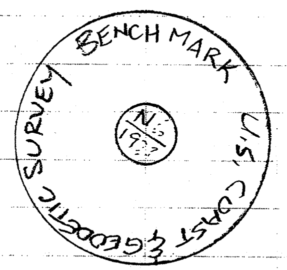
9-16-02 KJM CLOUDY 65°F

TRIMBLE 4800 #0182 ✓
STA N19 ✓

FD 3½" BRASS CAP ON WILLAMETTE RIVER HARBOR WALL. SEE PAGES (57) & (60) IN THIS BOOK.

HI = 2.000 m. ✓ FIXED HEIGHT TRIPOD ✓ TO BOTTOM OF ANTENNA MOUNT

START @ 1550 ✓ 01822592
STOP @ 1630 ✓



TOP OF CAP (CENTER) HAS BEEN DAMAGED (SCRAPED) - CANNOT READ ALL OF STAMPING.