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Hydraulic Laboratory Technical Memorandum PAP-1043

Scanning Sonar Survey Report-Buffalo Bill Power Plant Tailrace

Pick-Sloan Missouri Basin Program

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Hydraulic Investigations and Laboratory Services Group
Denver, Colorado

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11/17/11

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Introduction

The Technical Service Center's (TSC) Hydraulic Investigations and Laboratory Services Group (86-68460) was requested by TSC designers to perform an underwater sonar inspection of the Buffalo Bill Power Plant draft tube and tailrace. A dive inspection in January 2011 documented damage to the draft tube and tailrace concrete. High flows during the spring and summer of 2011 warranted another survey to determine if additional damage has occurred. The purpose of this sonar survey was to collect measurements and images of damage in the tailrace/draft tube area that can be used to help develop recommended repairs. There are concerns that continued damage to the area could compromise the bulkhead seal which would prevent regular maintenance from being performed.

Background

Buffalo Bill Power Plant is located on the right (south) bank of the Shoshone River approximately 5 miles west of Cody, Wyoming. The plant has three Francis turbine units which went on-line in 1992 and have a combined rating of 1.8 MW. Water for power generation is supplied from Buffalo Bill Dam, approximately 1 mile upstream from the plant.

The draft tubes are oriented to discharge northward, perpendicular to the river channel. The downstream exit of each draft tube has bulkhead slots and an embedded stainless steel bulkhead seat across the invert at elevation 5044.0 ft. There is also an upper bulkhead seat at El. 5048.5 ft. The units are bulkheaded and dewatered on a regular schedule to perform power plant maintenance.

The Shoshone Power Plant is located at the base of Buffalo Bill Dam and discharges into the Shoshone River. Its primary purpose is to maintain a minimum instream flow upstream from the Buffalo Bill Power Plant. The river outlet works at Buffalo Bill Dam is used during periods of high river flows to maintain reservoir levels. The outlet works have a capacity of 3,800 ft^3/sec.

Project Operations

During this field visit, Buffalo Bill Power Plant Units 1, 2, and 3 were releasing about 270, 265, and 255 ft^3/sec, respectively. The Shoshone Power Plant was releasing 140 ft^3/sec. In addition, flow from the river outlet works at Buffalo Bill Dam was about 1,170 ft^3/sec during power plant operations. When units were taken offline the river outlet works releases were increased to maintain Shoshone River total flow at 2,100 ft^3/sec. On August 30, 2011 sonar profile data were collected with 2 units out of service. On August 31, 2011 sonar image data were collected with all 3 units out of service.

Equipment

Scanning Sonar

A Kongsberg Mesotech MS1000 scanning sonar system (**Figure 1**) was used for the imaging and profile data collection at the power plant draft tube and tailrace structure. The MS1000 system with a 675 kHz scanning sonar was used to collect an accurate two dimensional representation of underwater structural features and detailed bathymetric data. This sonar has a range of 1.5 to 330 ft with a resolution of about 0.06 ft. A detailed specification sheet for the sonar system is included as an appendix to this report.

The scanning sonar was used in two modes for this project:

1) Profiling was performed using a cone beam which has a 1.7 ° beam angle

2) Sonar imaging was performed using a fan beam which has a 30° wide beam angle

Acoustic Doppler Current Profiler

A Teledyne/RD Instruments acoustic Doppler current profiler (Streampro, Figure 2) was used to collect vertical velocity profiles in the tailrace. A 2000 kHz Streampro was selected for this project because it had the necessary profiling range to sample the deepest depths of the tailrace/river.

Global Positioning System

A Garmin handheld GPS was used to collect GPS data at sonar scanning locations. The Garmin unit was setup with WAAS differential correction to provide horizontal position accuracy of ±7 to 9 ft.

Figure 1. Photograph of the KML MS1000 Scanning Sonar System. (Photo courtesy of Kongsberg-Mesotech Ltd)

Figure 2. Teledyne RDI Streampro (2000 kHz) in the Buffalo Bill Power Plant Tailrace.

Data Collection

The sonar imaging and profiling were performed on August 30 and 31, 2011. Mark Skoric, Jack Buffkin, Gary Catanzarite, and Bob Anderson assisted with this project. The river water temperature during sonar measurements was consistent at 54°F and the water was turbid from river outlet works releases which contained suspended sediment.

For sonar profiling, the MS1000 was deployed through the bulkhead gate openings. The sonar was oriented horizontally and was mounted in a protective cage. The cage was lowered using the Kevlar communication cable and was supported at a fixed elevation using a tripod located on the power plant deck. A guide rope was used to keep the sonar oriented parallel to the bulkhead gate seat. Sonar profiles were collected at stations located 2, 4, 6, 8, and 10 ft from the upstream bulkhead gate guide. At each station, profiles were collected at three depths (4.4, 9.9, and 12.8 ft below the water surface). The water surface was estimated to be at El. 5059.61 ft based on a measured distance of 22.29 ft from the power plant deck (El. 5081.90 ft). The sonar is equipped with a compass and pitch/roll sensors which were used to confirm the orientation of the instrument prior to collecting profile data. However, river currents made it difficult to maintain a fixed sonar orientation for all profiles. A series of profile scans were made with different scanning ranges before moving the sonar to the next station. Sonar profiles were collected from 11:00 a.m. to 3:00 p.m. on August 30, 2011.

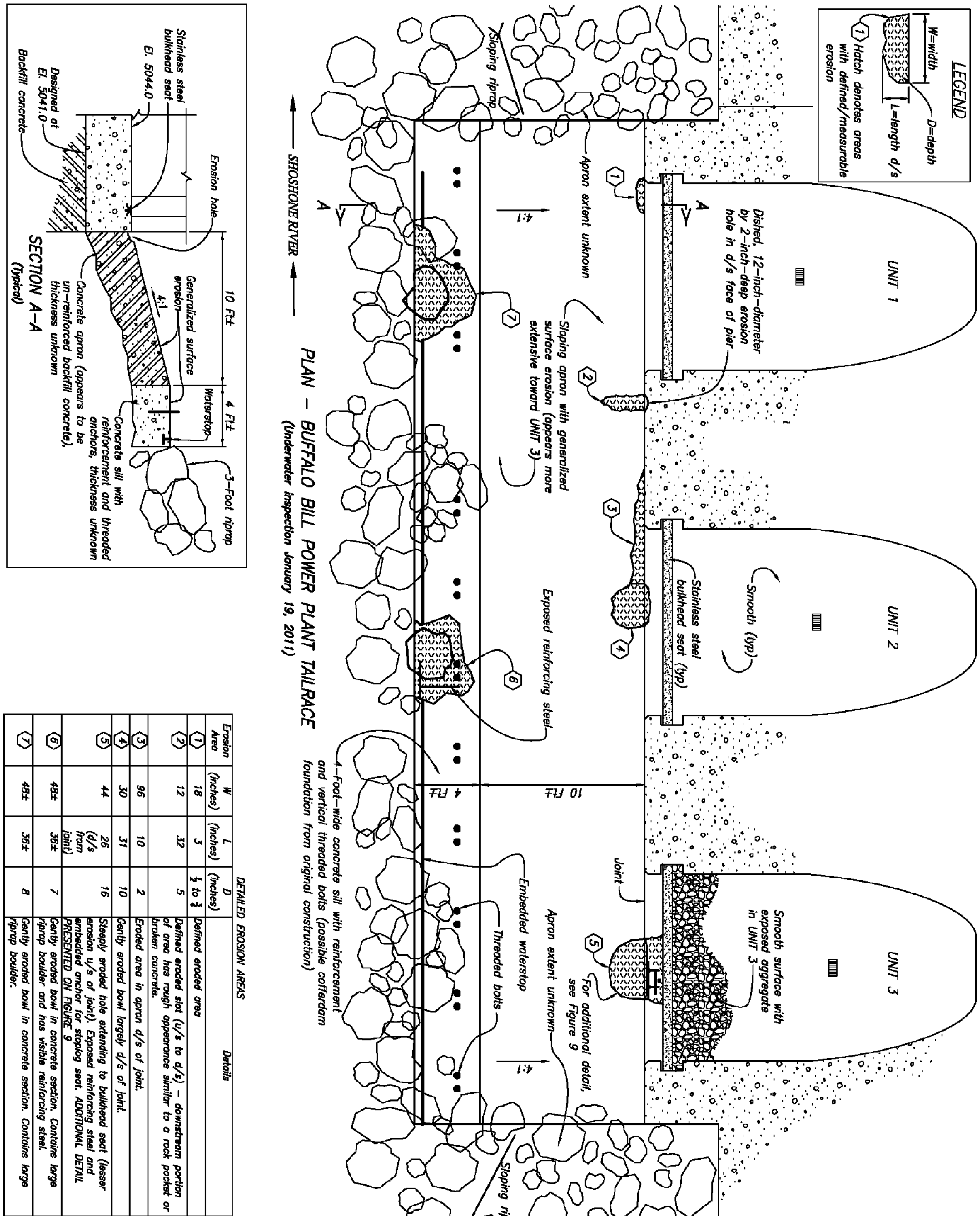
For sonar imaging, the MS1000 was deployed using a 6-ft-tall tripod that was lowered to the tailrace apron floor using a truck-mounted crane (Figure 3). The sonar was gimbal-mounted and weighted so that it remained vertically oriented while the tripod was set on the sloping apron. The sonar is equipped with tilt-pitch-roll sensors which were used to confirm the vertical orientation of the instrument prior to collecting sonar images. The sonar transducer was located 3.5 ft above the concrete apron floor. In an effort to image the apron floor, a set of sonar images were made near unit 2 with the tripod legs removed. This short tripod positioned the sonar about 0.5 ft above the apron floor. For both tripod configurations, the sonar orientation with a 15° half-beam angle made it difficult to measure damage to the concrete surface because the acoustic beam was nearly parallel to the apron slope (4H:1V). A series of 360° scans were made while moving closer and closer to the power plant draft tube structure. An acoustic target was deployed from the center of each bulkhead gate opening and is visible in long range scans, but not from tripod locations within 4 ft of the draft tube exit. Sonar image scans were collected from 11:30 a.m. to 3:00 p.m. on August 31, 2011 when all three power plant units were offline. Sonar scan images were collected at distances of 12, 8, 4, and 0 ft upstream from the face of the power plant parapet wall.

Figure 3. Photograph of tripod and sonar (in cage) with weights that were used to image the tailrace and draft tubes at Buffalo Bill Power Plant. The truck-mounted crane was used to deploy the sonar on the tailrace's sloping apron.

Sonar Profiles

Unit 1- The January 2011 dive report stated: "There was only minimal damage observed at the end of the unit 1 draft tube. Other than the general surface erosion on the apron concrete, one defined erosion area was located just downstream of the right corner of the draft tube and one area just to the left of the draft tube (see areas 1 and 2 on Figure 4). The first area extended about 18 inches from the right wall toward the center, had a depth of ½ to ¾ inches and extended 3 inches downstream. There was a small amount (10 to 15 stones) of 1- to 3-inch-diameter rounded material in this area."

Sonar profiles were collected at 5 stations along the bulkhead gate slot. Figure 5 shows an east wall profile that did not reveal the minor erosion on the right corner of the draft tube that was observed by the divers. Furthermore, the profile did not detect the ½ to ¾ inch depression in the apron concrete, but it is possible that the depression was filled with gravel. Figure 6 is a close-up sonar image collected along the unit 1 draft tube centerline (6 ft from the east wall). This image did not reveal any significant erosion around the bulkhead seal plate. Damaged area 2 in Figure 4 could not be profiled with the sonar deployed through the bulkhead slot.



Erosion Area	W (inches)	L (inches)	D (inches)	Details
1	18	3	½ to ¾	Defined eroded area
2	12	32	5	Defined eroded slot (u/s to d/s) – downstream portion of area has rough appearance similar to a rock pocket or broken concrete.
3	96	10	2	Eroded area in apron d/s of joint.
4	30	31	10	Gently eroded bowl largely d/s of joint.
5	44	26 (d/s from joint)	16	Steeply eroded hole extending to bulkhead seat (lesser erosion u/s of joint). Exposed reinforcing steel and embedded anchor for stoplog seat. ADDITIONAL DETAIL PRESENTED ON FIGURE 9
6	48±	36±	7	Gently eroded bowl in concrete section. Contains large riprap boulder and has visible reinforcing steel.
7	48±	36±	8	Gently eroded bowl in concrete section. Contains large riprap boulder.

Figure 4. Drawings of tailrace and draft tube damage observed by Reclamation divers during their January 2011 underwater inspection.

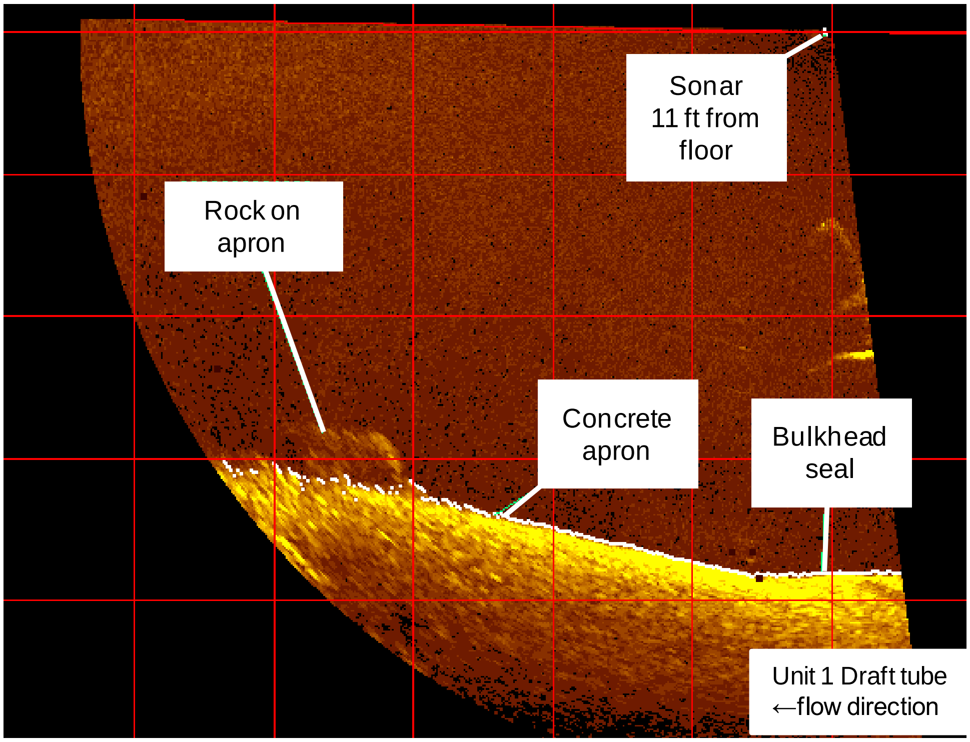


Figure 5. Sonar profile collected 2 ft from the right (east) side of the unit 1 draft tube. No significant erosion damage was detected for erosion area 1 on figure 4. It is possible the erosion area is filled with sediment. A large piece of riprap was located about 8 ft from the draft tube-apron construction joint. The grid spacing is 3.0 ft/division and the scanning range was 15 ft.

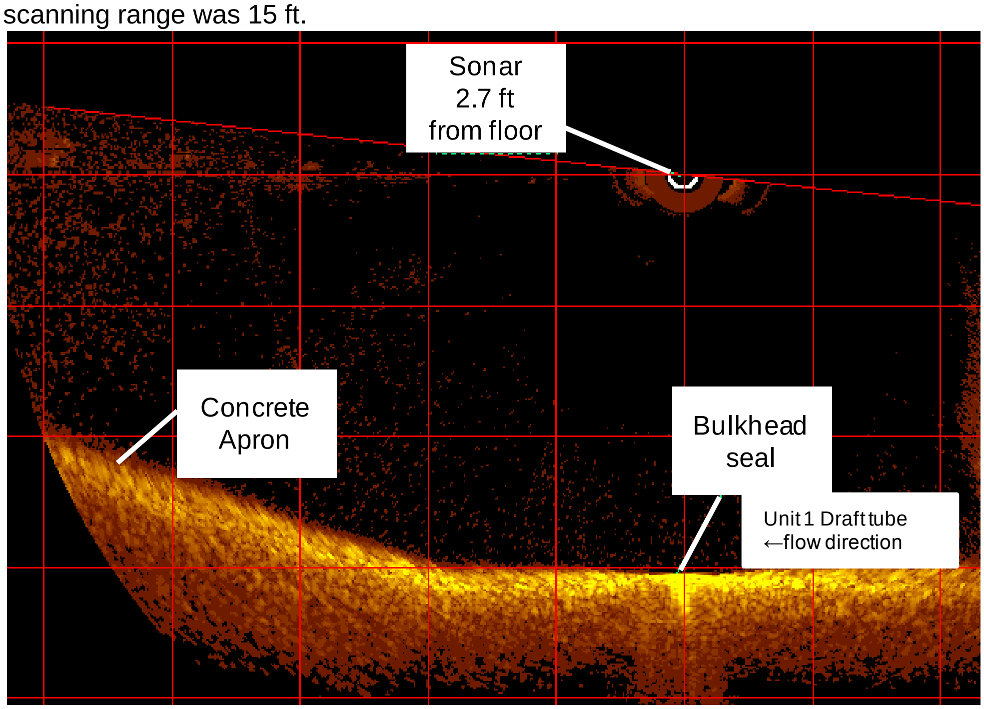


Figure 6. Close-up sonar profile collected 6 ft from the right (east) wall of the unit 1 draft tube. No significant erosion damage was detected in the vicinity of the bulkhead seat. The grid spacing is 0.9 ft/division and the scanning range was 4.5 ft.

Unit 2 -The January 2011 dive report stated: "There was measurable damage across about half of the end of the draft tube (see areas 3 and 4 on Figure 4) and was comprised of two distinct areas which were connected. The first area of erosion was a band along the joint between the apron and the power plant. This extended from about 48 inches to the right of the right draft tube wall to a point about 48 inches to the left of the right draft tube wall. This strip was about 2 inches deep and extended a maximum of about 10 inches downstream from the joint. At the time of the inspection, the eroded area contained about 2 gallons of 1- to 3-inch-diameter rounded rock and one sub-rounded boulder with a 28 inch maximum dimension. The boulder and most of the smaller rock were located in this erosion hole just to the right of the right draft tube wall and were likely held captive in eddy currents at this location during power releases."

Sonar profiles were collected at 5 stations along the bulkhead gate slot. Figure 7 shows a typical profile that shows erosion damage areas near the centerline of the unit 2 draft tube. The length (L) of the erosion hole is about 45 inches which is larger than the length divers reported for erosion area 4 in Figure 4. However, the profile doesn't indicate a 10 in. depth for erosion area 4. It is likely that the hole is partially filled with rocks. Furthermore, the profile also shows the apron sill which has an uneven surface which is consistent with erosion area 6 in Figure 4.

Figure 8 is a sonar profile collected 2 ft from the right (east) wall of the unit 2 draft tube. A slight depression was detected that is consistent with damage area 3. New erosion damage may be present in the vicinity of the bulkhead seal plate as indicated by a lack of profile points (white dots) and by a strong reflection located below the seat plate.

Figure 9 is a close-up sonar profile collected 6 ft from the right (east) wall of the unit 2 draft tube. An eroded area was detected at the toe of the apron slope which is consistent in dimension with damage area 4 in Figure 4. There also appears to be some new concrete erosion just downstream from the bulkhead seat.

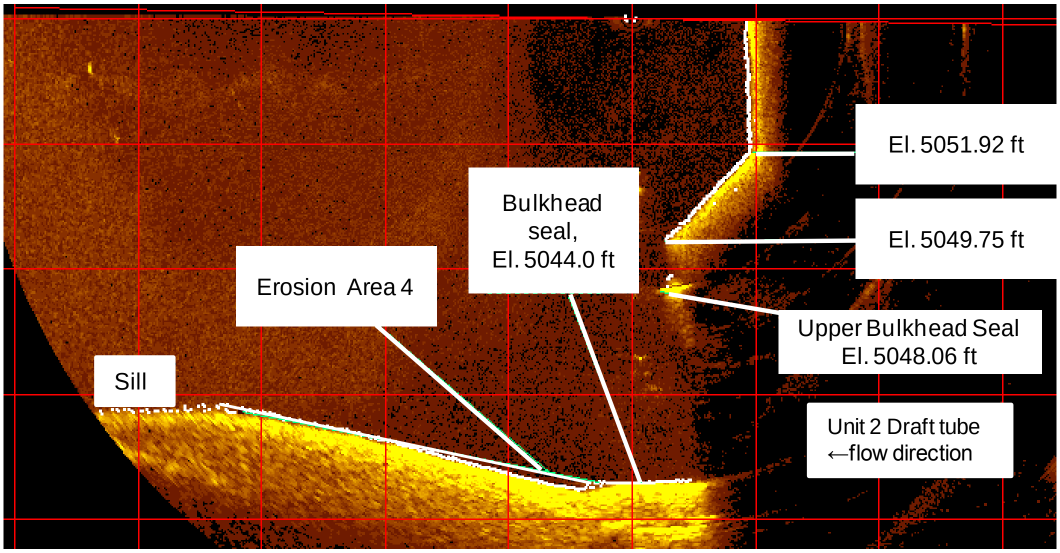


Figure 7. Sonar profile collected 6 ft from the right (west) wall of the unit 2 draft tube. The vertical feature is the bulkhead guide wall and the upper bulkhead seal. Erosion area 4 is shown with a depth of about 3 in. and a length of 45 in. The hole appears to be partially filled with sediment. The grid spacing is 3.0 ft/division and the scanning range was 15 ft.

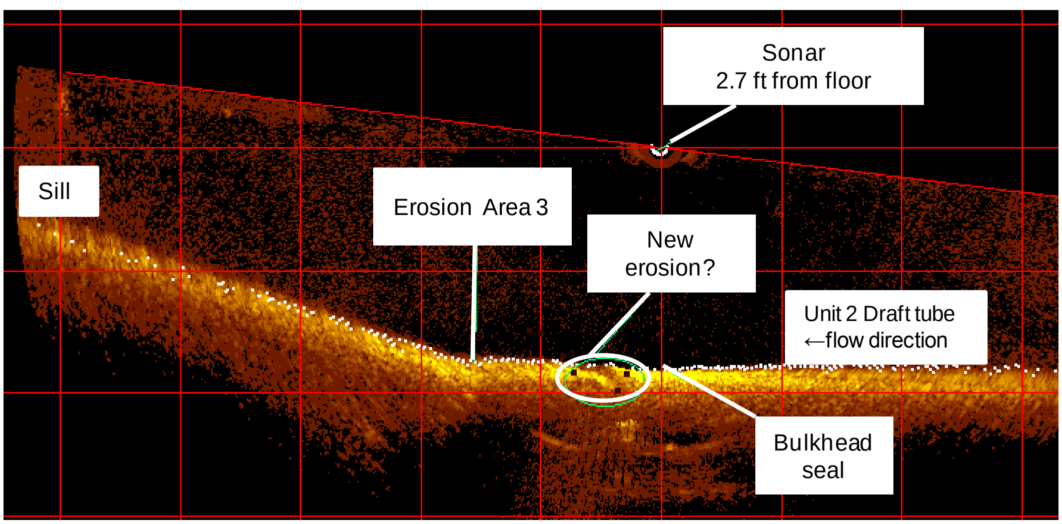


Figure 8. Sonar profile collected 2 ft from the right (east) wall of the unit 2 draft tube. A slight depression was detected that is consistent with damage area 3. New erosion damage may be present in the vicinity of the bulkhead seal plate. The grid spacing is 1.5 ft/division and the scanning range was 7.5 ft.

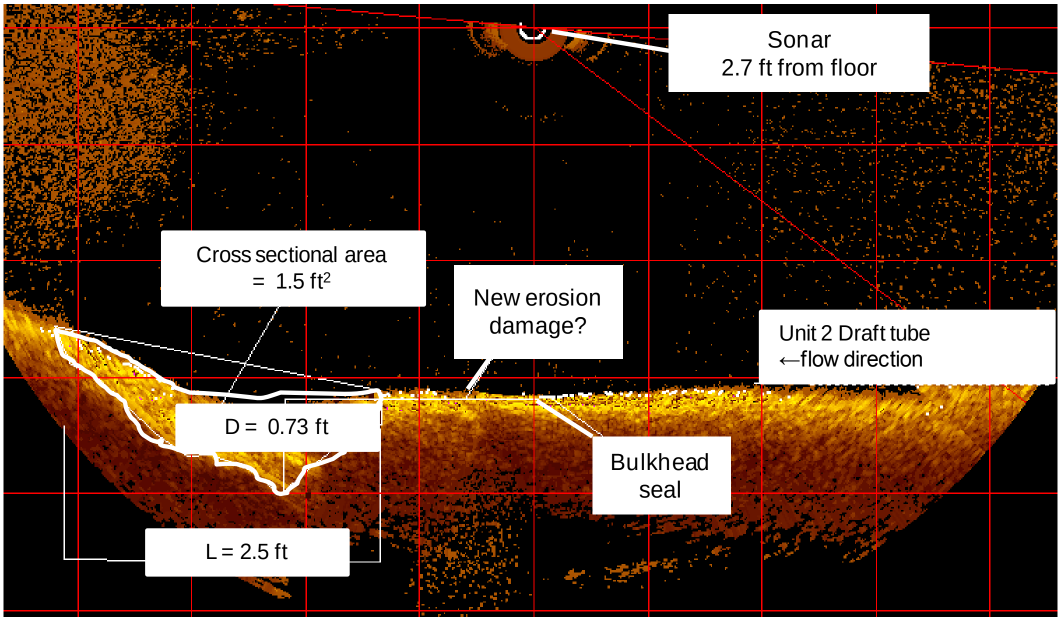


Figure 9. Close-up sonar profile collected 6 ft from the right (east) wall of the unit 2 draft tube. A damaged area was imaged which is consistent in dimension with erosion area 4. There also appears to be new erosion damage just downstream from the seat. The grid spacing is 0.9 ft/division and the scanning range was 4.5 ft.

Unit 3 -The January 2011 dive report stated: "There was a large erosion hole at the end of the unit 3 draft tube near the tube centerline (see Figure 10). The hole had a maximum depth of about 16 inches measured from the level of the stainless steel bulkhead seat. The top of the hole was about 44 inches wide with gently sloping side walls for the top several inches. Upstream to downstream the top of the hole measured about 39 inches and extended upstream to the edge of the bulkhead seat. The hole extended about 26 inches downstream from the joint. Below the top 4 inches of the hole, the hole became very steep with nearly vertical side walls. This steep portion of the hole was bounded roughly by the joint on the upstream side and extended about 18 to 20 inches downstream and had a width of about 32 inches."

Other damage noted by the divers was to the unit 3 draft tube invert upstream of the bulkhead seat. The bulkhead seat was scratched, dented, with rounded edges both upstream and downstream. The surface of the seat was constructed flush with the concrete invert; therefore, this exposure of the upstream seat edge and rounding are indications of concrete material loss in the unit 3 draft tube invert.

Sonar profiles were collected at 5 stations along the unit 3 bulkhead gate slot. Figures 11 and 12 show typical profiles that define erosion damage areas near the centerline of the unit 3 draft tube and they correspond with section A-A in Figure 10. The length (L) of the erosion hole is about 3.1 ft (37 in.) which is larger than what divers reported for erosion area 5 in Figure 10. The hole depth could not be accurately determined from the sonar profile because the hole appears to be filled with rocks. However, the hole cross sectional area was estimated using a measuring tool in the MS1000 software which computed an area of about 3.1 ft^2 (Figure 11). The difference between the profile points and the image is an indication that the hole is partially filled with larger rocks which allows the sonar to receive acoustic reflections from inside the hole. Furthermore, Figure 12 appears to show the steep face of the erosion hole observed by the divers. Sonar scans at other unit 3 stations did not detect any significant erosion damage along the east or west side of the draft tube. Figures 13 and 14 are examples of scans at stations 6 and 8 ft which show reduced erosion damage with distance from the draft tube centerline.

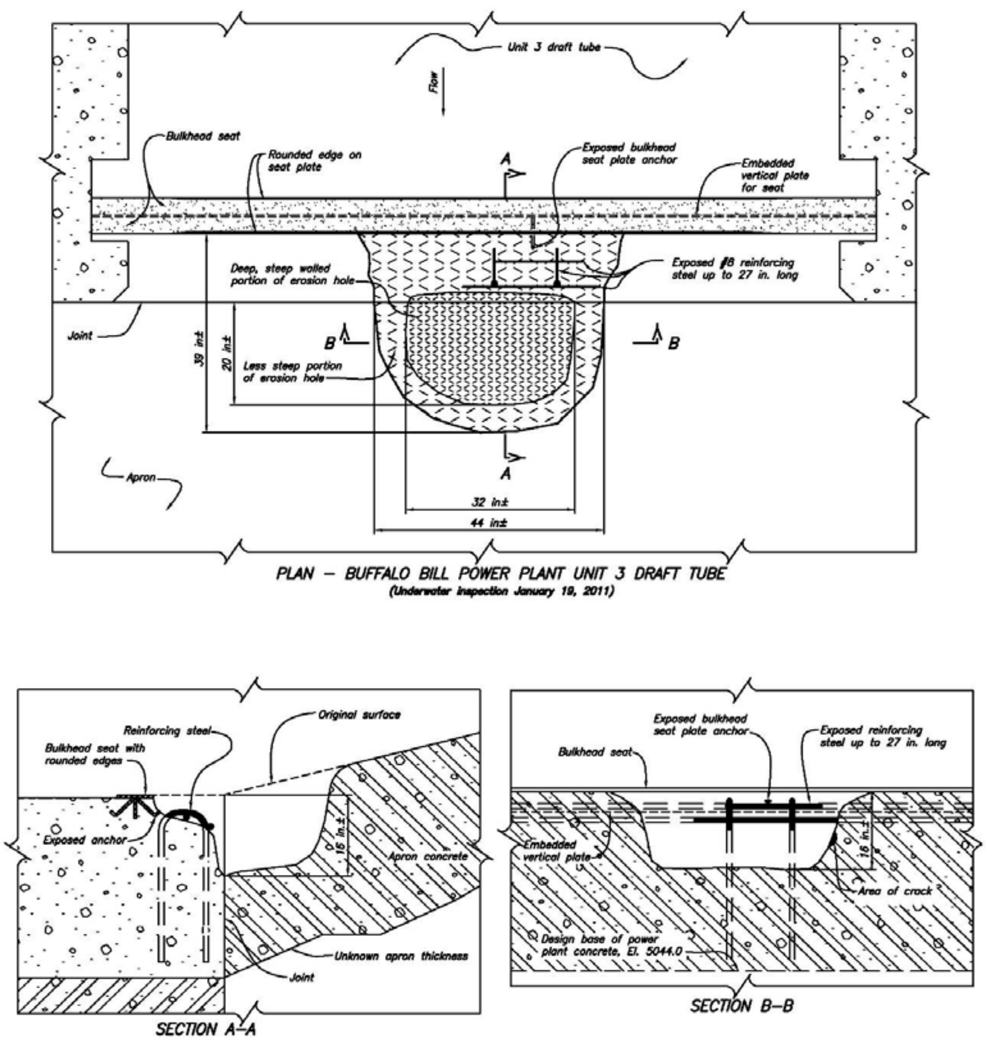


Figure 10. Drawings of unit 3 tailrace and draft tube erosion damage observed by Reclamation divers during their January 2011 underwater inspection.

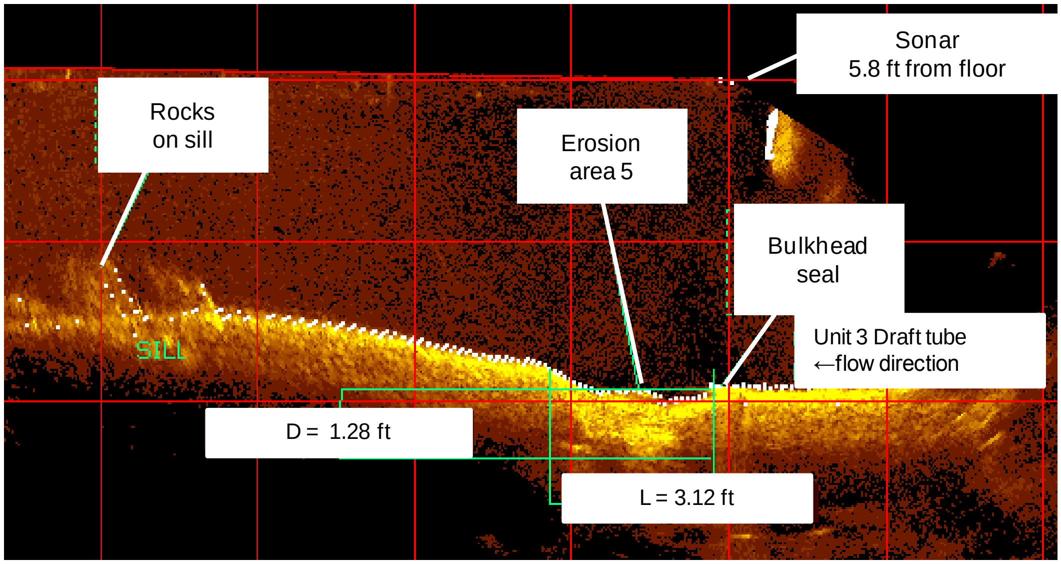


Figure 11. Sonar profile collected 4 ft from the right (west) wall of the unit 3 draft tube. The vertical feature near the sonar is the bulkhead guide wall. Erosion area 5 is shown with an apparent depth of about 1.28 ft (15.6 in.) and a length of 3.12 ft (37 in.). The erosion hole appears to be partially filled with rocks. Several large rocks were detected on the apron sill. The grid spacing is 3.0 ft/division and the scanning range was 15 ft.

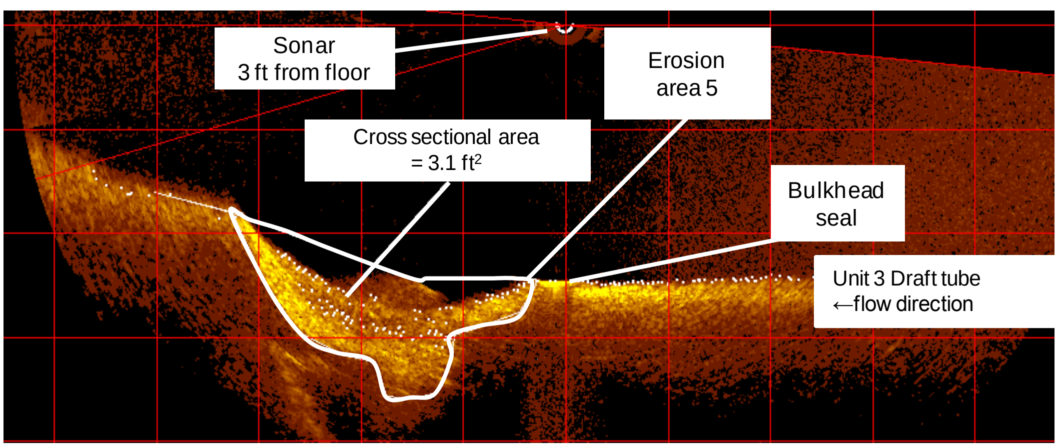


Figure 12. Close-up sonar profile collected 4 ft from the right (west) wall of the unit 3 draft tube. At this location a profile through erosion area 5 is shown with an apparent depth of at least 12 inches and a length of about 42 inches. An estimate of the cross sectional area of the eroded hole is 3.1 ft^2. The erosion hole appears to be partially filled with gravel and rocks. The grid spacing is 1.2 ft/division and the scanning range was 6.0 ft.

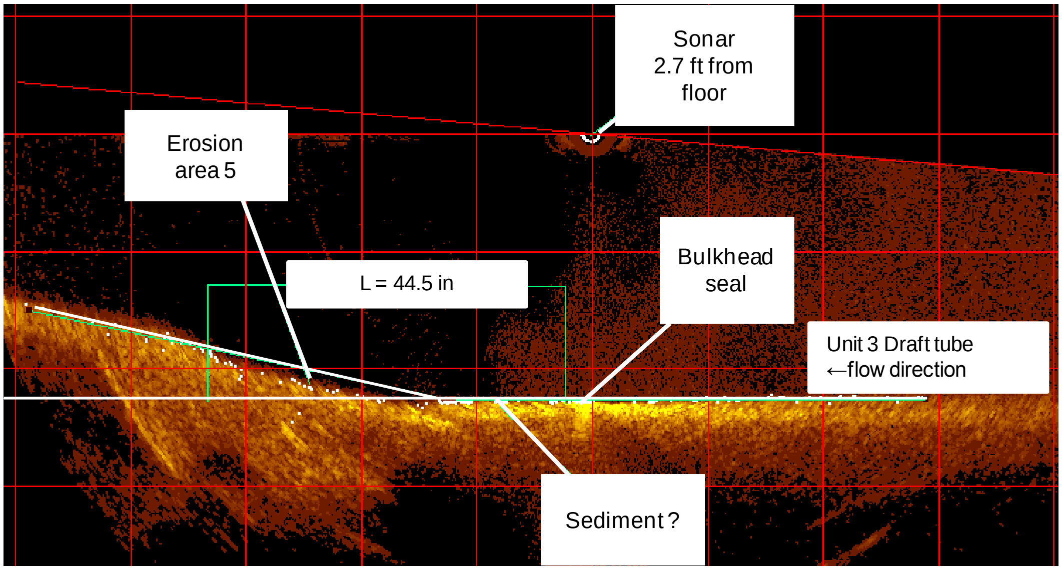


Figure 13. Close-up sonar profile collected 6 ft from the right (east) wall of the unit 3 draft tube. A depression was detected that is consistent with erosion area 5, and the length (L) of the damage appears to have expanded from 39 to 44.5 inches. There appears to be a slight depression on the upstream side of the bulkhead seat that might be filled with sediment. The grid spacing is 1.2 ft/division and the scanning range was 6 ft.

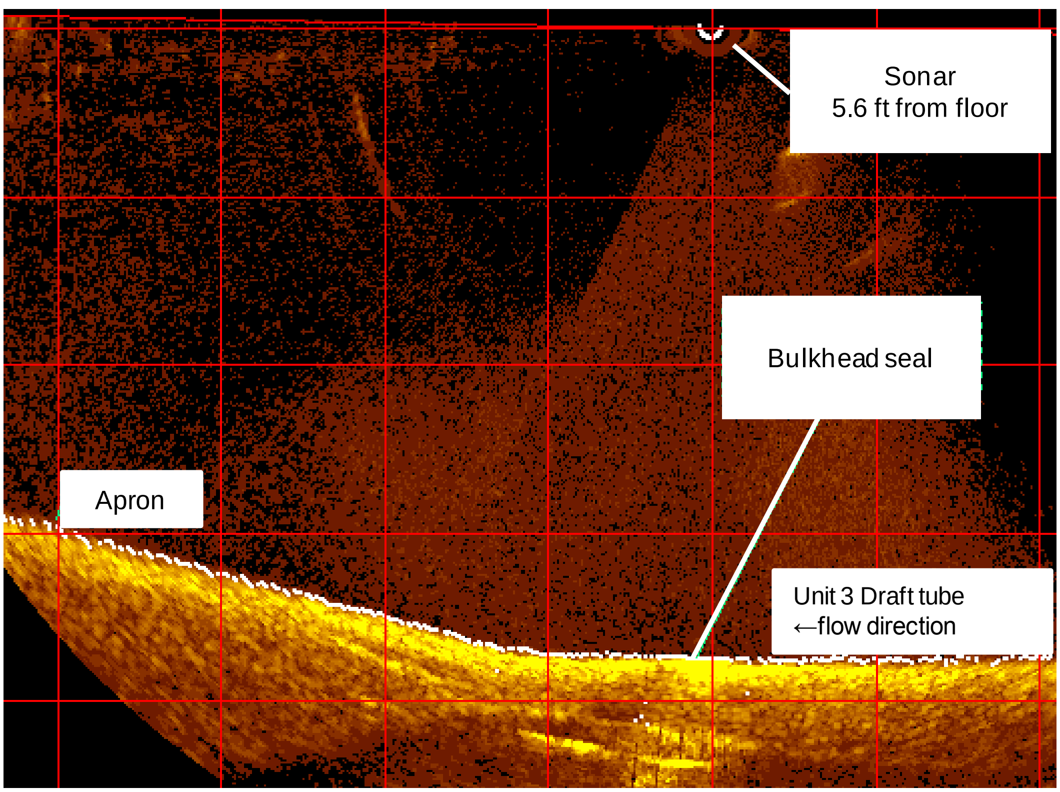


Figure 14. Sonar profile collected 8 ft from the right (west) wall of the unit 3 draft tube. Other than some surface roughness or loose rocks, no erosion holes were imaged at this station. The grid spacing is 1.5 ft/division and the scanning range is 7.5 ft.

Sonar Images of Power Plant Draft Tubes and Tailrace

Several sonar images of the power plant draft tubes and tailrace were collected using the sonar mounted to a tripod. The tripod was positioned along each unit's centerline at several locations on the concrete apron. Unfortunately, the sonar was located too high above the apron to image the bulkhead seat plate and the sloping concrete surface. When set on the apron's 4:1 slope, the orientation of acoustic fan beam was parallel to the concrete apron, so there were no acoustic reflections from the apron surface to generate an image. In an effort to image the apron, sections from the tripod legs were removed and a scan with the sonar placed a few inches above the concrete apron resulted in an improved image of the bottom gate seat and the concrete joint. However, the image still did not fully encompass the erosion damage, but it did reveal the damage along the power plant-apron concrete joint.

The following figures present the sonar images and brief annotations of the important features. It is important to note that sonar images of the draft tube features are not photographs and are open to interpretation.

Figure 15 shows a typical image of the unit 3 draft tube collected with the sonar located 12 ft from the power plant. The sonar image (a plan view) clearly shows the east and west bulkhead guides and the upper bulkhead gate seat (El. 5048.06 ft) and surrounding concrete. The acoustic target was also clearly visible from this location. The scan range was 30 ft which allowed imaging of rocks on the apron sill and along the Shoshone River bed.

Figure 16 is an image collected with sonar lowered to just above the apron floor at a distance of 10.6 ft from the unit 2 draft tube exit. The primary linear feature is the upper bulkhead seat, but a weaker linear feature appears to be the eroded face of the concrete joint between the draft tube and apron at unit 2. This damaged area was measured to be about 34.8 inches long which is consistent with the width of erosion area 4 in Figure 4. The scan also shows what appears to be the exposed edge of the bottom bulkhead seat located about 12 inches from the damaged construction joint.

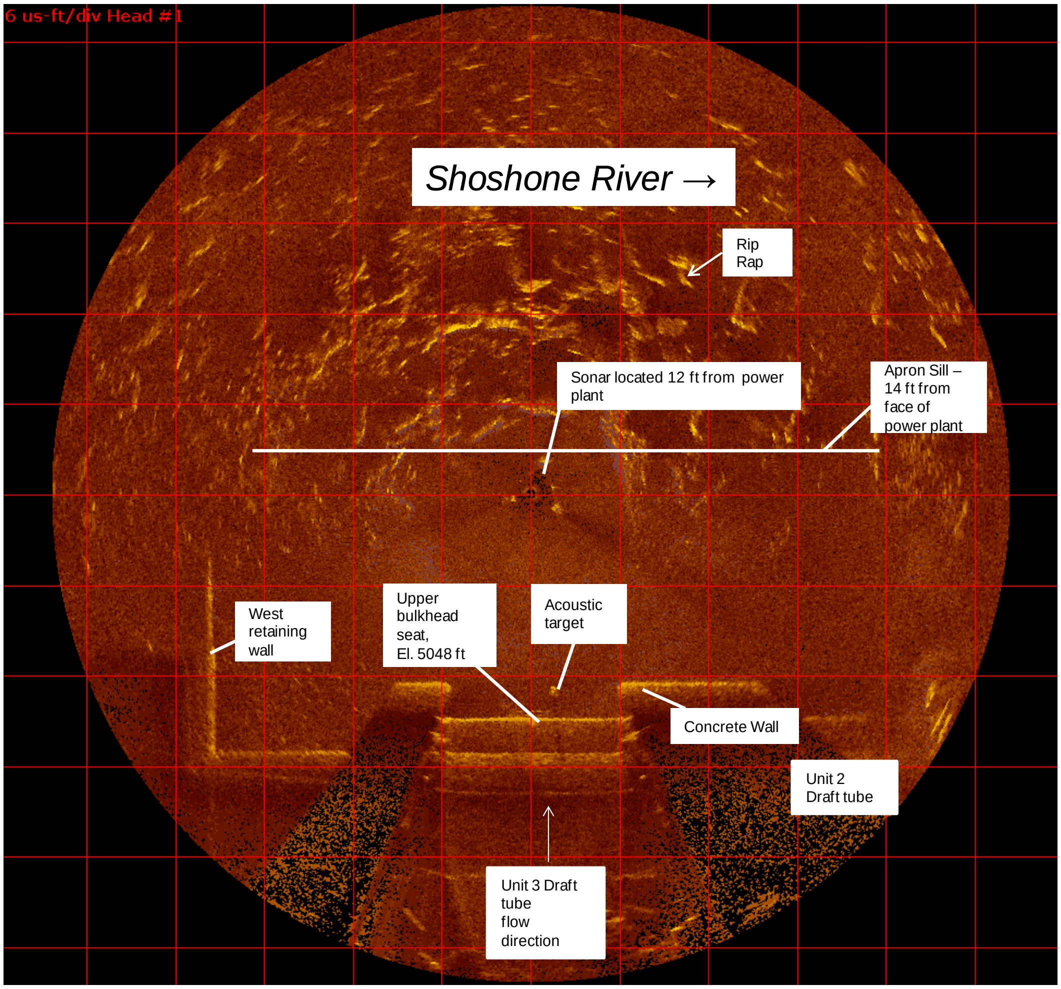


Figure 15. Sonar image of the draft tube face collected along the unit 3 centerline. The sonar was located 12 ft from the power plant face and the scan range was 30 ft. The grid spacing is 6.0 ft/division.

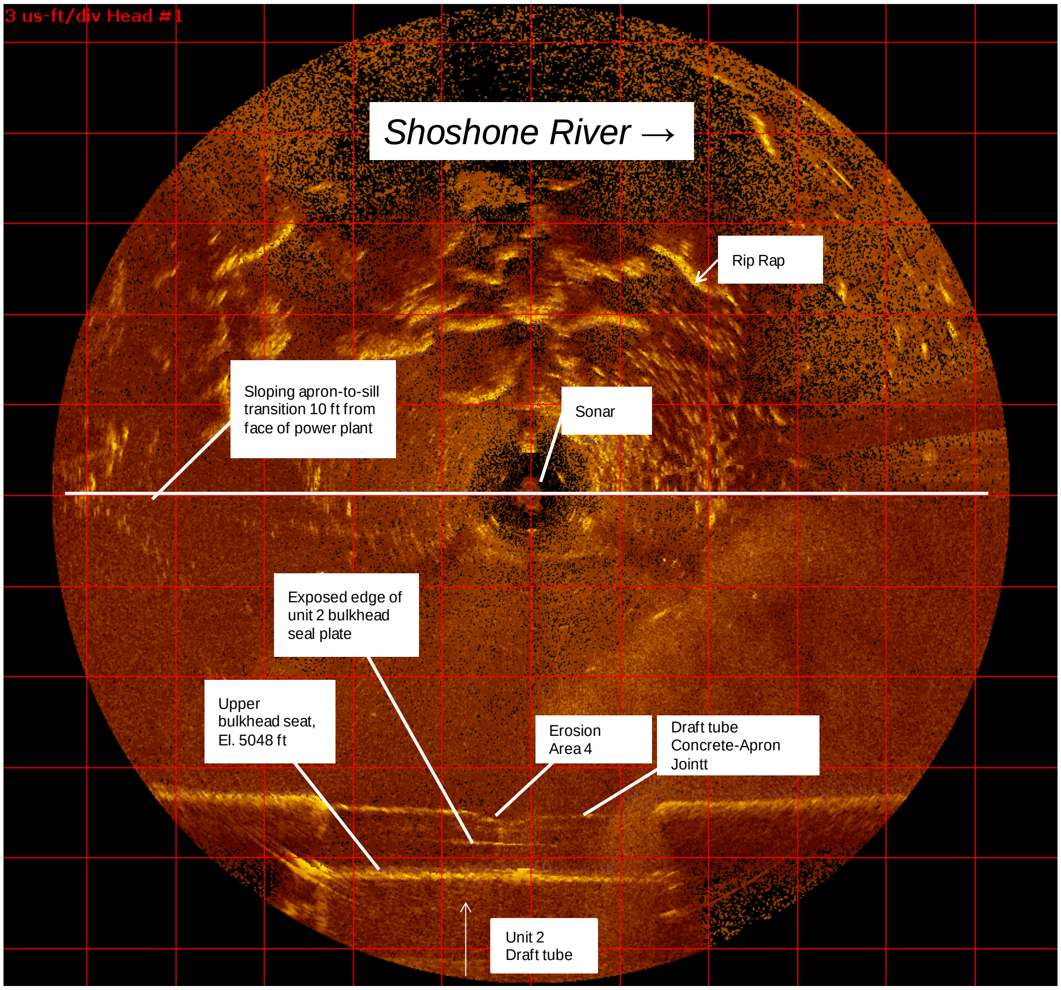


Figure 16. Image collected with sonar lowered to the apron floor in front of unit 2. This sonar scan detected the eroded face of the concrete joint between the draft tube and sloping apron. The thin line about 18 inches behind the joint is the exposed edge of the bulkhead seat. This damaged area was measured to be about 2.89 ft (34.7 in.) wide which is larger than the width of erosion area 4 in Figure 4 (W=31 in.). The grid spacing is 3.0 ft/division

River Flow Conditions near Power Plant Tailrace

Observations of river and power plant flow interactions during this field visit helped to formulate a hypothesis on how sediment is transported into the tailrace and draft tubes. For high flowrates through the power plant, water flows upslope and causes large surface boils which extend across the river channel. This increased water level deflects the Shoshone River flow toward the bay upstream from unit 3 (Figure 17). When outlet works releases from Buffalo Bill Dam are sufficient to mobilize river bed material, this flow condition appears to be capable of moving sediment into the tailrace where it is available to cause concrete erosion damage. Another source for rocks may be the tailrace protection dike located immediately upstream from the power plant (Figure 18). Once the material reaches the concrete apron the 4:1 slope facilitates the sediment movement toward the powerplant structure.

Figure 18 shows the tailrace protection dike at low flows. This dike could be a source of rock material entering the tailrace. It is difficult to tell if the length or elevation of the dike has changed since construction. Therefore, a survey of the dike should be conducted to document any loss or movement of rip rap.

According to the diver's inspection report, erosion damage decreases in the downstream direction, which indicates releases from units 1 and 2 may flush the sediment back into the river channel. However, rocks can be captured in the scour holes in front of units 2 and 3 where they will exacerbate the concrete erosion process.

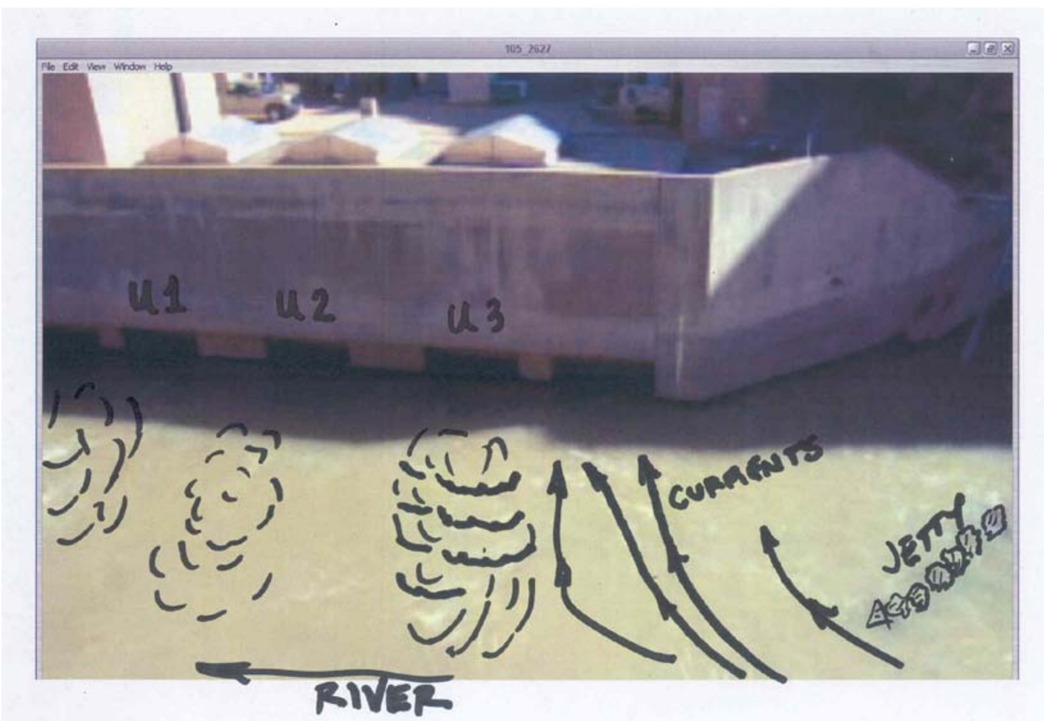


Figure 17. Photograph of tailrace looking from the access road opposite the power plant. All 3 units were operating which resulted in upwelling that deflected Shoshone River flow toward the power plant. High flows released from Buffalo Bill Dam and power plant combine to create a flow pattern that is likely responsible for moving sediment into the tailrace and draft tubes.

Figure 18. View of the Buffalo Bill Power Plant tailrace area, looking upstream along the Shoshone River. Photograph was taken from the January 19, 2011 dive inspection report.

Conclusions

It is important to note that sonar images of the draft tube/tailrace features are not photographs and are open to interpretation. However, careful review of the sonar images, diver observations, and design drawings provided a high level of verification of erosion damage and sediment accumulation.

Flow conditions in the Shoshone River during the spring and summer of 2011 produced sediment movement into the Buffalo Bill Power Plant tailrace. Sonar images revealed that erosion holes in the tailrace concrete that were cleaned out in January 2011 have accumulated new rocks and sediment during 2011 high flows.

Sonar images were used to estimate size of erosion damage areas and there appears to be a small increase in the horizontal extents of erosion damage since the January 2011 underwater inspection. In addition, there appears to be new erosion damage which could be undermining the unit 2 seal plate. It is recommended that this damage be confirmed by divers.

Acoustic profiles taken in unit 2 and 3 draft tubes showed the holes are partially filled with rocks. If the rocks are not removed, they will likely create additional concrete damage during power plant operations. Given that unit 3 has significantly more damage than units 1 and 2, it is recommended that unit 3 be used sparingly until rocks can be removed from the tailrace erosion holes.

If measurement of 2011 tailrace damage is desired, a follow up sonar survey can be conducted after the rocks have been removed by divers. These measurements would document the damage which occurred during 2011 spring runoff.

Releases from Buffalo Bill Power Plant and the sloping tailrace apron create strong upwelling that re-directs Shoshone River flows toward the upstream end of the power plant. This hydraulic condition is likely responsible for moving sediment into the tailrace only when river flows are high enough to mobilize bed material (i.e. during large bypass flows from Buffalo Bill Dam). The rock jetty (dike) upstream from the power plant may have eroded during previous flood events; thereby reducing its effectiveness. It is recommended that the existing rock dike be extended to train the Shoshone River flows toward the north canyon wall. The length of the dike should be extended further downstream to prevent the river from flowing toward the power plant.

A survey of the tailrace protection dike should be conducted to document any loss of rip rap in the years since it was built.

Appendix 1

Specification Sheet

1071-Series Sonar – Geared Fan/Cone Sonar Head

3000 m “High Resolution” Geared Fan/Cone Sonar Head Digital Telemetry

KONGSBERG

P/N 974-23050000

This version of the 1071-Series Sonar has been specifically designed to produce the highest resolution scanning sonar images possible with 675 kHz. Its design is targeted at bottom clearance, body recovery, underwater construction, pipeline inspection, cable route survey, bridge/pier inspection and applications where data clarity supercedes any other requirement.

This sonar head should also be considered in conditions where the in-water temperatures are lower than 4° C, or higher than 20° C. Domed, oil-filled heads may acoustically defocus beyond these temperature ranges. This sonar head incorporates the electronic advantages of increased sampling rates, wider receiver bandwidth, increased power output, and a very narrow horizontal beam pattern with the fan transducer. The telemetry is RS 485 and RS 232 compatible, and is automatically sensed and configured. The transducer is of a bare-shaft design, but the motor-end is oil compensated to prevent water ingress into the main electronic stack via the transducer shaft.

The sonar head is compatible with the MS1000 and MS900D Surface Processors. To take full advantage of the advanced features and high resolution this head has to be operated with the MS1000 processor.

Operating Frequency	675 kHz
Beam Width	0.9° X 30° Fan/1.7 X 1.7° Cone (nominal)
Range	0.5 - 100 Metres typical; 150 Metres obtainable
Range Resolution	≥ 19 mm (@ 1500m/sec speed of sound, 25 µs transmit pulse)
Sampling Resolution	≥ 2.5 mm
Scan Angle	360° continuous
Mechanical Step Size	≥ 0.225°
Scan Speed	nom 11 sec/360° @ 10 m and 1.8° step size (@ 230 kbits/sec.) nom 36 sec/360° @ 100m and 1.8° step size (@ 230 kbits/sec.)
Transmit Pulse Lengths	25 - 2500 µs
Transmit Power	OFF, 50 W nom, 500 W nom
Receiver Bandwidth	12/100 kHz
TVG Control	-20 to +100 dB
Telemetry	RS 485/RS 232 auto switching asynchronous serial data
Telemetry Rates	Downlink: 9600 Baud Uplink selectable: 230K, 115K, 57K, 38K, 19K, 9600 bits/sec automatic (to suit cable telemetry)
Power Requirements	33W, 22 - 60VDC
Temperature Ranges	-10 to +40° C operating -30 to +40° storage
Operating Depth	3000 meters
Connector	Seacon RMG-4-BCL (optional connectors; inquire to factory)
Materials	Aluminum 6061-T6, 300-Series SS
Dimensions	Diameter 3.5"/89 mm Length 22.4"/569 mm Transducer width 5.5"/140 mm
Weight	In air 13.5 lbs/6.1 kg, In water 6.5 lbs/2.9 kg
Options:	-7801 Built-In Security Key

Specifications subject to change without notice
P/N 974-23057901 Iss 1.5
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