

Sediment Issues for the Tuckasegee Project

Based on information in the First Stage Consultation Report (FSCR), the Technical Leadership Team (TLT), identified sediment accumulation in the main-stem reservoirs as a major area of concern. The TLT also recommended the development of a sediment management plan for the Tuckasegee Project. The present plan contains information about sediment accumulation in the reservoir, particle size analysis in different areas of the reservoir, cleaning trash racks, downstream bank stability and a review of bathymetric mapping results for 1999 and 2001.

The Tuckasegee Project only generates electricity when there is sufficient flow in the river. In this case a minimum of 130 cfs is required for one unit operation and flows in excess of 326 cfs are spilled. There is negligible useable storage for electric generation and, consequently, there is no need nor are there plans for dredging sediments from the reservoir. The only maintenance activity in the reservoir is trash and debris removal from the trash racks.

Bathymetric Surveys

Bathymetric surveys were started in June and completed August 2001. Measurements were taken along transects used to produce the 1999 maps. An aluminum boat equipped with an outboard motor and an electric trolling motor was used to obtain depth readings using a depth finder with an accuracy of +/- 0.5 ft. The shoreline points used in the 1999 survey were used to establish transects for the 2001 survey. For each transect a GPS point, using a Trimble model AgGPS 132, with sub-meter differential accuracy (correction factors from Omnistar Satellite service) was established as close to the right-hand bank (facing downstream) as possible and another GPS point was established as close as possible to the left-hand bank. At some locations the GPS points were established a considerable distance from the shore due to a lack of signal because of overhanging trees. Here the GPS points were located on the map (for instance transect 5 in Figure 5.3.7-1) and depths recorded along regular intervals to the shore. At other

locations the GPS point was recorded at an area where the water depth was less than 2 feet and not accessible by boat. A field estimate was made as to the distance to the bank; a more accurate distance measure was made using the Arc-View (version 3.2a) measuring tool on the aerial imagery. The image was geo-referenced and has a 3 foot resolution. The bathymetric map was produced by transferring the GPS points, transects, and depth data to the aerial image.

Sediment samples were collected from transects established at points 1/5th, 2/5th, 3/5th, and 4/5th along the midline of the impoundment from the dam to the headwater area. At each transect, PONAR grab samples were taken at 4 equidistant points across the impoundment. Particle sizing was done according to ASTM D422 method using standard sieve sizes (number in parenthesis is sieve opening in mm) of: # 4 (4.750 mm), #10 (2.000 mm), #20 (0.850 mm), #40 (0.425 mm), #60 (0.250 mm), #80 (0.180 mm), #100 (0.150 mm), #120 (0.125 mm), #200 (0.075 mm), #270 (0.053 mm). Sediment particle size analysis was done by Standard Laboratories, Inc. of Jacksboro, Tennessee.

Results

The results of the June and August 2001 re-run of the 1999 depth profiles reveal no major changes. Comparisons of the maps yield little information regarding changes in the storage volume of the reservoir and give no useable information about the rate of sediment accumulation.

There are several reasons why detailed comparisons can not be made. The accuracy of the 2001 and 1999 depth measurements is roughly comparable (+/- 0.5 ft). Though the 1999 transects were re-run in 2001, the intervals where depth measurements were taken are not the same. The 1999 survey relied on taking depth readings at timed intervals along a transect (the accuracy of the distance measured for this was not available) or, where the reservoir was narrow enough, a calibrated chain was used (the original data were not available). In 2001, depth readings were taken at given distances based on distances measured using a hip chain (a device where a thin thread-line runs across a calibrated wheel; accurate to +/- 0.5 ft per 100 ft).

Due to the difference in the measuring methods, the distances from shore the depth measurements were not taken at the same points. The 1999 depth and distance results were plotted on an enlargement of a topographic map and the depth contours drawn by hand. The resulting maps had no horizontal scale so distances could not be measured on the 1999 bathymetric maps. The 2001 depth and distance data were plotted on a geo-registered digital photo with GPS points used to locate the contour lines. Cross sections of the reservoir could be measured to +/- 3 feet using the ArcView (version 3.2a) GIS software. Placement of the contour lines is an important variable in determining volumes of the reservoir. Selection of the 1999 contour intervals, the distance from shore and the actual depth interval, determined the accuracy of the comparisons that could be made regarding loss of reservoir volume. The depth intervals were also too great for the amount of sedimentation that might have actually occurred between the two measurement periods.

Furthermore, as discussed below, it appears that filling of the reservoir has reached a balance in which either deposition or scouring is predominant depending on river flows.

Sediment carried into the reservoir is highly mobile and composed of suspended sands and silts which are deposited on the falling limb of the hydrograph in backwater areas, but easily re-suspended and moved during high flow events. Based on the bathymetric maps, the general form of the channel bed upstream of the dam remained unchanged. Material deposited behind the dam is very fine grained (generally less than 1 mm) and is of such a composition that it is easily re-suspended during high flows. There is little change in particle size from upstream to downstream near the dam, which would have indicated coarse particles aggrading due to backwater effects of the dam. Particle sizes along the length of the reservoir indicate that deeper areas have 1 mm particles, and shallower areas have essentially very fine, suspendable particles less than 0.1 mm (see A through D Figure 5.3.7-1 and Table 5.3.7-1). During high flows, observations upstream and downstream of the dam indicated the presence of large amounts of suspended

materials; as flows dropped, this material was not stored in the main channel except for in backwaters and deep pools.

The elevation of the trash rack opening will ultimately determine the depth of sediment accumulation at the dam. There is no delta formation downstream of Tuckasegee dam since the flow velocities in the river channel are sufficient to carry the sediment load downstream (US Army Corps of Engineers 1997).

Trash Rack Maintenance

Based on a review of hydro operations at Tuckasegee, it was determined that the main operational problems were related to debris accumulation on the trash racks. Sediment accumulation in the reservoirs had little direct effect on unit operation. The trash racks are designed to keep large debris from blocking or entering the hydro unit and causing damage. The racks also accumulate small debris, such as leaves. This small debris is continuously removed using a leaf rake to keep the rack open so that the debris does not accumulate to such an extent that the flow into the tunnel would be reduced or stopped. However, the leaf rakes do not keep the racks completely clean and small debris and leaves accumulate in front of the racks. This process is repeated until the debris has accumulated to such an extent that it interferes with unit operation and it must be cleaned to provide sufficient water flow to the unit. Compounding the problem of routine cleaning is the presence of large objects, such as trees, which can lodge against the rack and interfere with the rake cleaning. Eventually the debris obstruction must be removed in order to provide sufficient water depth and flow for the unit.

Historical Review of Maintenance Activities

The review of operational maintenance activities indicates that no major cleaning of the trash racks was ever required at Tuckasegee. There was only instance when divers were

employed to remove some rocks from in front of the racks but no other special cleaning was done.

Proposed debris/sediment management plan

Routine trash rack cleaning is done using leaf rakes on a day-to-day basis. Major cleaning using other equipment will be done when operations become affected by debris build-up. The major debris removal can be done at any time of year and under different flow regimes since no flow will take place through the turbines during this time. It is difficult to provide a more precise estimate for scheduling cleaning of the racks since the rate of debris accumulation is dependent on the amount of debris transported from the area upstream of the project. There are no permit requirements for trash rack maintenance and Duke Power plans to continue routine maintenance program.

Major debris removal process

In the event there is ever a need, present plans call for cleaning the racks under a wide range of flow conditions. Prior to cleaning the generating unit is shut off and the water is allowed to spill over the dam so that currents in the debris removal area are minimized. The impoundment will be kept at full pond during the entire debris removal operation. The debris is removed using large equipment (clam shell or track hoes) and the debris is then disposed of properly. In the area affected by debris removal (approximately 50 feet upstream of the trash rack), once debris removal ceases, the sediments that became suspended will either settle out or will be carried away over the dam and dispersed by the downstream currents. Once the debris removal is completed and the heavy equipment removed, the generating unit is ready for operation. The reservoir is kept at full pond the entire time so there is never a time when the pond is drained. The entire operation may take two to three days. Continuous minimum flow into the West Fork Tuckasegee River will not be interrupted.

Required Drawdowns for Planned or Emergency Work

The Licensee shall notify the North Carolina Department of Environment and Natural Resources (NCDENR), the North Carolina Wildlife Resources Commission (NCWRC), and the United States Fish and Wildlife Service (USF&WS) at least 15 days prior to planned major debris removal activities or planned drawdowns for maintenance or inspection purposes that will require a temporary modification of the reservoir elevation limits. The licensee shall notify the NCDENR, the NCWRC, and the USF&WS as soon as practical, but no later than ten days after any temporary modification of the reservoir elevation limits required by an operating emergency beyond the control of the Licensee.

Drawdown Procedure

The trash gate and flashboard will be used to release water during normal or emergency drawdowns at the Tuckasegee Project. The Tuckasegee Project consists of a 254 ft long

and 61 ft high concrete arch dam with the crest of the dam acting as the spillway (Nantahala Power and Light 2001). The crest of the dam is lined with 3 ft high breaking link flash boards, one 3 ft high, hand-controlled flashboard, and one hand controlled trash gate. Drawdowns can only be done by opening the trash gate and/or one section of hand controlled flash board but this will only result in lowering the reservoir elevation by three feet to the top of the concrete crest of the dam. A sand gate at the base of the dam is not operable because the control cable has corroded away so complete draining of the reservoir is not possible.

Timing of Drawdown

Considering local weather patterns and inflow levels, summer and fall are the preferred times of year for planned drawdowns. The NCWRC and Duke fisheries biologists will be consulted as to the spawning periods for the species that inhabit the project reservoirs. Drawdowns during the spawning period will be avoided whenever possible to ensure that spawning beds will not be de-watered.

Rate of Drawdown

The current drawdown procedure for scheduled maintenance is to gradually drain the reservoir over a 24-hour period. The NCWRC and Duke fisheries biologists will be consulted as to the spawning periods for the species that inhabit the project reservoirs. Drawdowns during the spawning period will be avoided whenever possible to ensure that spawning beds will not be de-watered.

Rate of Refilling

Ideally the drawdowns would be conducted in the summer or fall during the natural low-flow period of the year to facilitate maintenance and repair activities. Refilling the reservoir will occur quickly due to releases from Thorpe Reservoir.

Agency Notification

The Licensee shall notify the NCDENR, the NCWRC, and the US Fish and Wildlife Service at least 15 days prior to commencing planned drawdowns for maintenance or inspection purposes that will require a temporary modification of the reservoir elevation limits or planned major debris removal activities. The licensee shall notify the NCDENR and the NCWRC of any temporary modification of the reservoir elevation limits required by an operating emergency beyond the control of the Licensee as soon as practical, either before, during, or immediately following such emergency, but no later than ten days after each such incident.

Downstream Bank Erosion

Visual surveys during aquatic macrobenthic collections revealed no evidence of downstream bank erosion caused by plant operation.

Literature Cited:

Nantahala Power and Light. 2000. FERC relicensing first stage consultation package. West Fork Hydroelectric Project. Nantahala Power and Light, Division of Duke Energy Corporation, Franklin, NC.

US Army Corps Engineers. 1997. Hydroelectric engineering requirements for reservoirs. EM 1110-2-1420.

Table 5.3.7-1. Tuckaseegee Project. Percentage of sediments passed through nested standard sieves. Locations designated by capital letters correspond to locations in Figure 5.3.7-1. Results are represented with RIGHT as the right-hand side facing the dam

Location	Sieve size (mm)	RIGHT				LEFT	Location	Sieve size (mm)	RIGHT				LEFT
		4P1	4P2	4P3	4P4				2P1	2P2	2P3	2P4	
Location A	4,75	100	100	100	100	Location C	4,75	100	85,82	99,98	100		
	2	99,73	99,88	99,93	99,96		2	99,32	74,19	97,32	99,91		
	0,85	96	98,28	98,44	99,28		0,85	93,18	49,54	66,86	98,66		
	0,425	93,61	95,54	96,73	97,66		0,425	84,94	33,48	34,71	96,75		
	0,25	89,27	86,04	89,82	88,67		0,25	76,59	23,56	18,87	93,53		
	0,18	84,02	69,9	81,31	80,3		0,18	67,93	18,59	13,63	87,6		
	0,15	76,07	54,1	76,82	74,43		0,15	64,85	15,72	11,09	85,85		
	0,125	69,08	38,65	69,52	66,67		0,125	56,9	11,64	8,09	77,33		
0,075	65,23	30,39	64,64	61,92	0,075	49,2	8,46	6,32	70,66				
0,053	58,14	25,61	57,83	57,35	0,053	44,85	6,28	5,21	61,43				
Location B	Sieve size (mm)	3P1	3P2	3P3	3P4	Location D	Sieve size (mm)	1P1	1P2	1P3	1P4		
	4,75	99,94	100	100	100		4,75	100	99,21	100	100		
	2	98,89	99,91	99,97	99,77		2	99,32	88,07	99,96	99,89		
	0,85	81,99	98,77	98,97	97,37		0,85	93,18	43,4	88,31	98,05		
	0,425	33,23	97,17	96,98	88,35		0,425	84,94	25,81	36,7	93,09		
	0,25	14,73	94,11	92,27	69,99		0,25	76,59	18,23	14,68	83,82		
	0,18	11,05	90,36	87,32	53,88		0,18	67,93	14,51	10,99	69,03		
	0,15	9,53	85,5	77,37	47,29		0,15	64,85	12,37	10,04	43,44		
0,125	7,57	78,27	68,29	38,17	0,125	56,9	9,64	8,74	29,65				
0,075	6,42	72,84	64,6	34,47	0,075	49,2	7,38	7,91	20,55				
0,053	5,44	64,54	57,51	31,58	0,053	44,85	5,66	7,22	16,95				

