BIGHORN LAKE
SEDIMENT MANAGEMENT RECONNAISSANCE STUDY SCOPE

April 2012

Introduction

Bighorn Lake was created when the Bureau of Reclamation constructed Yellowtail Dam across the Bighorn River in the 1960s. The reservoir, at full pool, impounds approximately 1.32 million acre-feet of water, covers approximately 17,200 acres, and is approximately 71 miles long. The reservoir is operated as a multi-use facility for the purposes of flood control, hydro power, recreation, and water supply. Approximately half of the basin is controlled by the Boysen, Anchor and Buffalo Bill Dams. The contributing portion of the basin is arid, steep and sparsely vegetated, which tends to yield relatively large amounts of sediment. Yellowtail Dam is operated to fill during the spring runoff period which is also the highest sediment producing period. Since dam closure, sediments have accumulated within the pool area and are impacting lake resources.

In April 2007, Reclamation initiated the Bighorn River System Long Term Issues Working Group to begin a collaborative process with parties across Montana and Wyoming to address public concerns and develop long term proposals and procedures to improve all of the benefits of the Yellowtail Unit. One of the specific concerns was the deposition of sediment in Bighorn Lake and how deposits are affecting the Bighorn Canyon National Recreation Area.

The primary recreational opportunities are located in the southern portion of the reservoir before the lake enters the reservoir canyon areas. The Groups particular area of sedimentation concern is at Horseshoe Bend (HSB), which is located immediately upstream of the canyon entrance. HSB is a remnant oxbow of the natural river, which provides an overly wide flood plain. Due to the narrow canyon downstream of HSB, public access at this location is an important recreation feature. The HSB area acts as an efficient stilling basin that traps sediments before it can enter the canyon. Deposition at HSB has exceeded 50 feet in several areas and can prevent access to the reservoir when the pool falls below the safe boat launch elevation identified by the National Park Service.

Previous Study

The *Bighorn Lake Sediment Management Study* (Reclamation, 2009) was an initial assessment conducted to evaluate several sediment management alternatives. The technical focus study used existing cross section, hydrologic, and sediment data for the reservoir as input to a one-dimensional sediment transport model. The sediment model was used to assess alternative scenario sediment conditions compared to existing conditions. Six different alternatives were investigated with the sediment analysis. The alternatives consisted of:

a. Maintain Higher Reservoir Levels During the Recreation Season.
b. Trap Sediment in the Pool Upstream of the Lovell Hwy 20 Causeway.
c. Flush Sediment Through the Horseshoe Bend Area.

d. Manage Sediment at Horseshoe Bend with a Separation Berm.
e. Manage Watershed Sediments.
f. Dredge Horseshoe Bend Sediments.

The study determined that all alternatives impact the distribution of future sediment deposits within the pool and at HSB. Some of the alternatives had negative impacts due to future sediment deposition location. Implementation costs were also excessive. An alternative that could be successfully implemented at a reasonable cost was not identified.

Reconnaissance Study Proposal

Since the conclusion of the sediment management study (Reclamation, 2009), the Bighorn River System Long Term Issues Working Group formed a sediment committee to evaluate study conclusions and further research sediment alternatives. A major challenge to an implementable sediment alternative is the annual sediment volume. The committee identified an area industry sediment use with Bentonite mining operations that require sediment to meet soil and vegetation cover needs as part of the mine closure process. Repetitive sediment removal by area industry reduces operation costs and could result in a feasible alternative. Therefore, further investigation of an alternative to combine the potential industry sediment use with the alternative to trap sediments upstream of the Lovell Hwy 20 causeway is proposed.

Study Methodology

A new two-dimensional model (SRH-2D or similar) of the area upstream of the Hwy 20 causeway will be constructed to evaluate the feasibility of constructing flow barrier structures with the goal of sediment deposition. The existing condition and three alternative sediment deposition dike configurations will be evaluated. The structure configuration details and modeling scenarios will be developed during the study with input to the modeling team from Reclamation and the Bighorn River System Long Term Issues Working Group. The study will use existing data including digital elevation model, cross section surveys, reservoir area capacity study results, and USGS gage data for the Bighorn and Shoshone Rivers.

Study Tasks

Primary study tasks consist of the following:

1) Review available studies, assembly all study data
2) Construct a new two-dimensional model of the sediment deposition zone upstream of the Lovell Hwy 20 causeway
3) Model Existing and 3 alternatives for sediment retention structures
4) Design Flow Barrier Dike Features
5) Interview area Bentonite mining companies to determine likely sediment use levels
6) Estimate construction, maintenance, and sediment removal costs for the selected plan
7) Prepare a technical report

Task 1 - Review Studies and Assembly Data

This task consists of reviewing all available previous studies and collection available sediment samples, measured flows, measured suspended data, the best available DEM data for the sediment retention zone.

Note: Rangeline sections in this area were not collected in the 2007 survey. No new surveys or data collection are proposed for this study.

Task 2 – Construct New Two-Dimensional Model

This task will consist of constructing a two-dimensional model for the reservoir pool reach upstream of the Hwy 20 Lovell causeway. The model will be constructed from the best available DEM data (3 meter) with supplemental information from other survey sources. The model will cover the area approximately shown in Figure 1 as the potential sediment basin area. The flow barrier dike locations shown in Figure 1 are for demonstration purposes only. Approximate size of the area to be modeled is 2000 to 2500 acres with a floodplain length upstream of the causeway of about 4 miles.

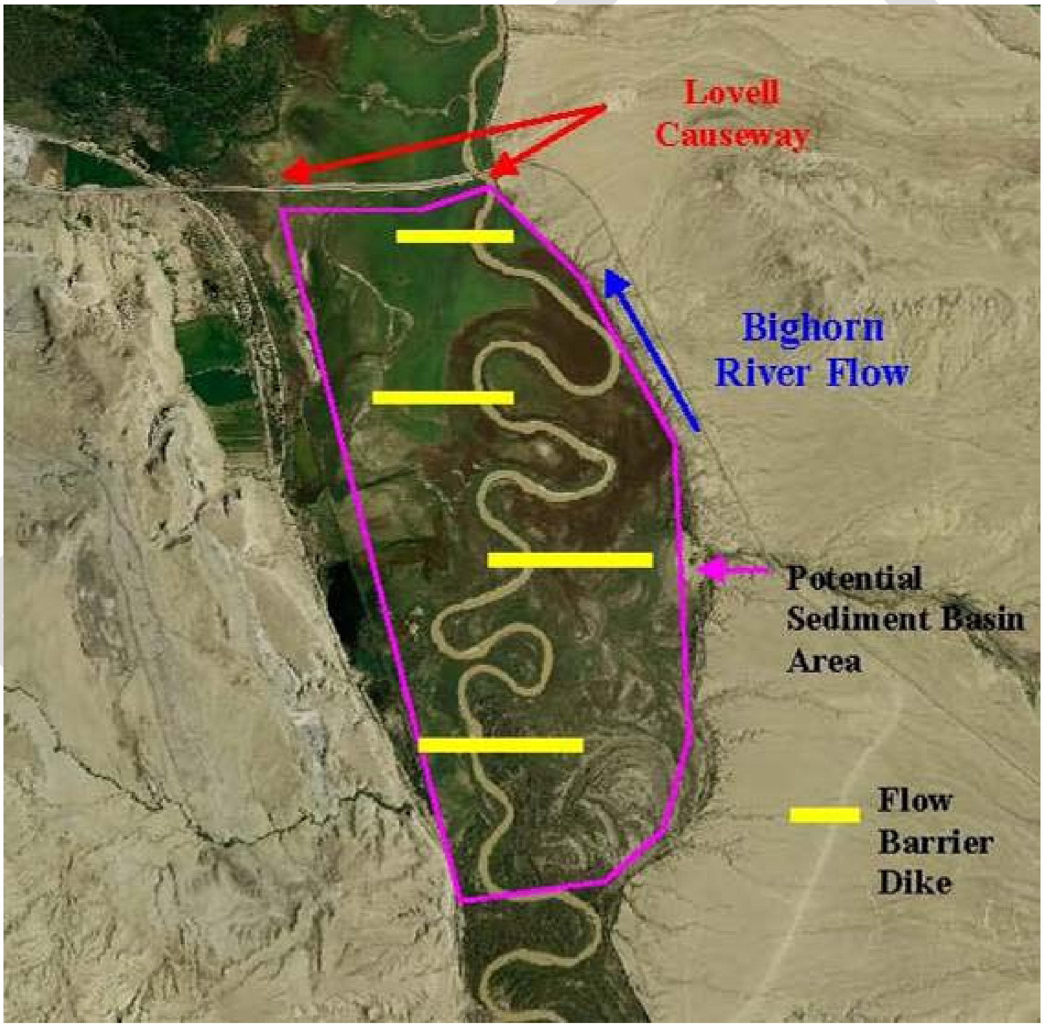

Figure 1. Potential Sediment Basin Area

Upstream Boundary – The model upstream boundary will consist of the Bighorn River inflow and sediment concentration. This data will be derived from available USGS gage data. A daily routing model for the entire period is not feasible. Therefore, a high, normal, and low inflow hydrograph will be derived. Daily flows will be assembled for a modeling duration of 60 to 90 days to represent the normal spring inflow period. NOTE: The initial assumption is that model runs will be for the entire flow hydrograph period. If this is not feasible, then the model will be switched to use a series of steady flows.

Downstream Boundary - The model downstream boundary will consist of the Yellowtail pool level. NOTE: Although the Shoshone River enters on the downstream side of the causeway, the Shoshone River will not be included in the model geometry but considered to be part of the pool record. Sediment detention and removal areas on the Shoshone River are not a part of this analysis. The amount of sediment entering the lake from the Shoshone River will be reviewed and updated from the previous study.

Model Startup and Calibration - Initial runs with the constructed model will be performed and model output reviewed. Although no calibration data is available, the base condition model should be stable and show reasonable deposition trends, flow depths, and flow velocities. To address the lack of calibration data, a series of sensitivity analysis will be performed on critical parameters including sediment input and roughness to assess model response and assist with setting base model values.

Task 3 – Model Base and 3 Alternative Conditions

The constructed model will be used to model the existing and 3 alternative project conditions.

Base Condition – The base condition model will be used to evaluate current flow conditions. Base condition model output will provide the comparison level for depth, velocity, sediment deposition, and upstream impacts.

Alternative Condition, Flow Barrier Dikes Modeling - Three alternative conditions will be modeled to assess the impact of different flow barrier dike locations. The structure configuration details and modeling scenarios will be developed during the study. The alternative condition will be compared to the base condition to assess deposition location, deposition rate, sediment trap efficiency, and upstream impacts. One or more of the alternatives may include restrictions at the Hwy 20 opening. Discussions will be held with Wyoming DOT to determine possible restrictions on Hwy 20 construction. The extent of upstream impacts will be compared to existing real estate. Flow barrier dike location may require adjustment to limit upstream impacts.

Task 4 – Design Flow Barrier Dike Features

Features of the flow barrier dikes will be designed to meet project goals. Design will be performed at a reconnaissance level consistent with the entire study. The flow dike cross typical section and materials will be evaluated and construction quantities determined. Dike stability features will also be determined to assess pool impact on the dike, design any recommendations for dike protection materials, and assess long term O&M needs.

Task 5 – Define Mining and Other Potential Soil Use

The potential sediment uses will be defined by contacting area mining companies. Other potential sediment uses will also be evaluated. The identified sediment uses will be factored into the project cost estimate.

NOTE: These tasks would be performed by Reclamation, Montana Area Office, using local points of contact.

Task 6 – Estimate Construction, Maintenance, and Sediment Removal Costs

The selected flow barrier design and information determined regarding sediment deposition and the required removal rates will be used to develop a cost estimate for initial construction, sediment removal, and maintenance requirements.
NOTE: Project quantities will be provided to Reclamation – Montana Area Office who will perform the cost estimate.

Task 7 – Technical Report

A technical report of the project will be prepared. A draft report will be provided and review comments incorporated. The report will provide modeling results, compare the various dike alignments, present cost estimates, and provide recommendations.

Task 8 – Meetings, Coordination, Review

During the project, coordination will be conducted with the Reclamation Montana Area Office and other stakeholders as needed. Two meetings in Billings, MT, or Lovell, WY, are assumed with 3 days allocated for each meeting based on 2 days travel and another day for the meeting. Peer review will be performed.
NOTE: This task does not include an independent technical review.

Study Products

The Corps will produce an engineering technical report that compares the various alternatives with respect to management of the sediments with in the reservoir, with a recommendation as to how to proceed. All electronic modeling files will also be provided.

Schedule and Budget

Schedule and budget estimates are provided in Table 1.

Table 1.

Bighorn Lake
Sediment Management Reconnaissance Study
April 2012 Cost Estimate

		Individual Task Labor		Task Subtotal	
Task	Task/Sub Task	Days	Cost ($)	Days	Cost ($)
1	**Review Studies and Assemble Data**			**7**	**$6,300**
	Review Studies and Reports	2	$1,800		
	Assemble hydrologic and sediment data	3	$2,700		
	DEM and best available data for model	2	$1,800		
2	**Construct New Two-Dimensional Model**			**30**	**$27,000**
	Model Building and Debug	15	$13,500		
	Construct Boundary Conditions	4	$3,600		
	Initial Runs-Model Depth, Velocity, Sediment Transport	8	$7,200		
	Sensitivity Analysis	3	$2,700		
3	**Model Base and 3 Alternatives**			**28**	**$25,200**
	Base Condition Modeling	8	$7,200		
	Three Alternatives	20	$18,000		
4	**Design Flow Barrier Dike Features**			**15**	**$13,500**
	Dike Layout, Section, Quantities	9	$8,100		
	Dike Stability Evaluation and Design	6	$5,400		
5	**Define Mining and Other Potential Soil Uses**			**6**	**$5,400**
	Contact mining companies and explore other possible uses	6	$5,400		
6	**Estimate Construction , Maintenance, and Sediment Removal Costs**			**5**	**$4,500**
	Develop Input Required to Reclamation Cost Estimator	4	$3,600		
	Review Results and Summarize Data	1	$900		
7	**Technical Reports**			**18**	**$16,200**
	Draft Engineering Report	12	$10,800		
	Review of Draft Report	1	$900		
	Final Engineering Report	5	$4,500		
8	**Meetings / Coordination / Review**			**20.8**	**$18,720**
	Meetings and Coordination (assume two trips to Billings, each trip requires 2 travel days and 1 day meeting)	9	$8,100		
	Peer Review, Supervision and Administration	11.8	$10,620		
	Labor Total	**129.8**	**$116,820**		
	Non-labor Costs				
	Airfare (two roundtrip tickets)		$3,000		
	Per diem and miscellaneous travel costs		$1,110		
	Study Total		**$120,930**		

Note: Task 5 is included in the study total cost although this task will be performed by the Montana Area Office.