Executive Summary
for the
Shell Valley Storage
Level II Study

Prepared for
Wyoming Water Development Commission

Prepared by
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I. Introduction

In June, 2010, the Wyoming Water Development Commission contracted with the team led by States West Water Resources to perform the Shell Valley Storage Project, Level II Study. This study was performed on behalf of the Shell Valley Watershed Improvement District. Team members included RJH Consultants, Inc., Leonard Rice Engineers, Inc., Western EcoSystems Technology, Inc., Watts and Associates, Inc., and the Office of the Wyoming State Archaeologist. This report presents the findings of the Level II Study.

The general project area consists of the Shell Creek watershed. The highest reaches of the basin are in the Big Horn mountains. Major tributaries include Beaver Creek, Horse Creek, Trapper Creek, White Creek, Willett Creek, Cedar Creek, and Adelaide Creek. The basin terminates at the confluence of Shell Creek and the Greybull River near the town of Greybull.

The overall purpose of this Level II study is to find and evaluate new and existing potential water storage alternatives, refine the hydrologic data to determine how much water can be stored and how much shortage relief would be attained, determine purpose and need, determine permitting mitigation requirements, conduct an ability to pay analysis, and complete conceptual design and cost estimates for the preferred alternatives.

II. Basin Hydrology

Introduction

Leonard Rice Engineers, Inc. (LRE) has developed a historic consumptive use (CU) analysis for the Shell Creek Basin (i.e. Shell Valley Watershed). This consumptive use analysis is based on actual ditch diversions from 2003 through 2009. The analysis estimates crop demands from 1951 through 2009 and provides estimates of crop shortages in different areas of the basin for the study period. In addition to the CU analysis, LRE also conducted a hydrologic analysis to estimate available flows above potential storage project locations.

Estimating Shortages

To estimate shortages for diversions with diversion records, StateCU, the consumptive use analysis tool developed by the State of Colorado used during this study, compared actual diversions for a structure to the monthly crop irrigation water requirement (CIR) calculated for that same structure, taking into account delivery losses and application efficiencies as specified in the model input files.

Available Flows Analysis

Available flows for potential storage locations were determined for two locations in the basin. The Shell Creek Basin drainage above the Forest Service Boundary is approximately 90,000 acres with an average elevation of just over 7,200 feet. USGS stream gauge SHELL CREEK NR SHELL, WY (06278500) is located less than a mile below the bottom of this drainage and has a fairly complete record for the 1951-2009 study period. The Beaver Creek Basin drainage above the North and South Beaver Creek confluence is approximately 17,030 acres with an average elevation of just over
7,500 feet. There is no permanent gauging on Beaver Creek at this time. Some spot-measurements have been taken in the past at various locations along Beaver Creek (Level I Study) and a temporary stream gauge was monitored in 2010 from May to October year the North/South Beaver Creek confluence.

III. Site Identification and Screening

Site Identification

The identification of reservoir sites to be analyzed in this study was compiled from previous studies, input from the Project Sponsor, and map and field reconnaissance. The potential storage sites analyzed for this study are shown in Figure III-1.

Screening

The screening of potential storage sites was facilitated by the use of a matrix that incorporated the important factors for reservoir feasibility. These factors are weighted to reflect the relative importance of the factors. Each reservoir site is then relatively rated for each factor on a scale from zero to ten. This screening also identified any “fatal flaws” that would make the site either impractical or impossible. Sites with a fatal flaw in one of the factors received a zero score for that factor. The totaling of the ratings and weights results in a total score that allows for comparison of the overall suitability of the potential reservoir sites. This matrix is included as Table III-1.

The factors considered and the weights for screening were ability to meet needs, access, multiple use potential, geotechnical feasibility, land ownership, cultural resources, environmental impacts, ability to permit, and cost.

Conclusions

Based upon the initial screening, it was determined that preliminary designs and cost estimates should be developed for the Upper Leavitt, Douglas Draw, and Shell Canal Tunnel sites.

IV. Preliminary Design and Cost Estimates

Preliminary designs and cost estimates were prepared for the Upper Leavitt site, the Shell Canal Tunnel site, and the Douglas Draw site. These designs were based on the recommendations presented in the geological/geotechnical report found in the report Appendices. These designs are preliminary and site-specific investigation would be required for final designs.

Upper Leavitt Reservoir Enlargement

General

A preliminary design and cost estimate were developed for a total reservoir capacity of 5,915 AF. The reservoir high water level would require that the existing county road be raised in two locations. Most of the reservoir enlargement and dam embankment would be on BLM lands. The enlargement would inundate approximately 200 acres of BLM lands and 21 acres of private land.
FIGURE III–1 POTENTIAL RESERVOIR SITES LOCATION MAP
<table>
<thead>
<tr>
<th>Reservoir Site</th>
<th>Ability to Meet Needs</th>
<th>Ability to Permit</th>
<th>Land Ownership</th>
<th>Cultural Resources</th>
<th>Environmental Impacts</th>
<th>Geotechnical Feasibility</th>
<th>Multiple Use Potential</th>
<th>Access</th>
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| Maximum Total Possible=          | 1500                  |                   |                 |                   |                      |                         |                         |        |                 |                             |                                               |

| Factor Weight as % of Total:    | 20.0%                 | 6.7%              | 13.3%          | 6.7%              | 6.7%                 | 6.7%                    | 13.3%                    | 13.3%  | 13.3%           |                                               |                                               |
**Dam Embankment**

The embankment is approximately 1600 ft. long with a maximum height of 85 ft. The crest width would be 22 ft.

**Outlet Works**

The primary components of the outlet works would be a gated inlet structure, a 36-inch pipe, a control building with valves to regulate the outflow of water, and a stilling pool for discharge to Davis Draw below the existing dam. Davis Draw flows into Beaver Creek less than one mile below the existing dam.

**Spillway**

The spillway would be a simple open channel excavated in a saddle located to the west of the proposed dam. It is highly likely that the material at this level would be bedrock. The overflow elevation would be set by the crest of the spillway and would be 5 ft. below the top of dam elevation.

**Supply System**

The Upper Leavitt Reservoir would be supplied by a 1.25 mile-long pipeline fed by a diversion on Beaver Creek. This pipeline would be completely located on private lands. The design of the diversion structure, headgate, and meter was not completed during this report phase as more information is needed on topography and required flows.

**Transfer Pipeline**

In order to serve more irrigated lands, a transfer pipeline from Beaver Creek could be incorporated into the Upper Leavitt Reservoir project. This pipeline could discharge reservoir flows to one or more points on Shell Creek, Whaley Ditch, and/or Shell Canal. This pipeline would be a pressure line.

**Wetlands**

The preliminary design of the Upper Leavitt Reservoir project includes construction of approximately 5.2 Ac of wetlands. The proposed Upper Leavitt reservoir would inundate roughly 20 acres of existing wetlands along the fringe of the existing reservoir. The proposed wetlands could help to mitigate this effect. The wetlands would have water supply from the reservoir.

Additional wetlands could be constructed at the upper reaches of the reservoir. If reservoir supply pipeline were to supply these wetlands, they could serve to remove sediment from the inflow, thereby resulting in "cleaner" water in the reservoir pool and discharge.

**Cost Estimate**

The total costs for the Upper Leavitt reservoir were determined to be $19.9M without the transfer pipeline and $24.9M with the transfer pipeline.

**Shell Canal Tunnel**

**General**

A preliminary design and cost estimate were developed for a total reservoir capacity of 225 AF. The entire dam and reservoir would be located on BLM lands.
This site would not be expected to help alleviate any significant water shortages. It was developed as a way to utilize material that would be created should the Shell Canal Tunnel be excavated to be an open channel and to replace the existing aging canal drop structure crossing the drainage.

**Dam Embankment**

The embankment would be approximately 325 ft. long with a maximum height of approximately 50 ft. The dam crest would be a total of 42 ft. wide and would incorporate a concrete-lined open channel for the Shell Canal.

**Outlet Works and Spillway**

Due to the presence of the Shell Canal and topography, design of a typical open channel spillway would not be practical. Additionally, with a drainage area of only 0.59 sq.mi., only a minimal spillway would be needed. Therefore, the preliminary design utilizes a combined outlet works and spillway.

The main components of outlet works and spillway would be a gated inlet structure for the outlet, an 18-inch outlet pipe, an uncontrolled spillway inlet tower, and a 36-inch combined outlet/spillway pipe. Because this reservoir would not be operated to supply irrigation water, other than the upstream outlet slide gate, no additional controls would be needed.

**Cost Estimate**

The total project costs for a Shell Canal reservoir are estimated to be $1.6M.

**Douglas Draw Reservoir**

**General**

A preliminary design and cost estimate were developed for a total reservoir capacity of 5,240 AF. The reservoir and dam embankment would be on BLM lands.

**Dam Embankment**

The main embankment would be approximately 1575 ft. long with a maximum height of 100 ft. The crest width would be 26 ft. A smaller embankment 275 ft. long with a maximum height of 45 ft. would be constructed in a saddle to the east of the main embankment. This embankment would have a crest width of 14 ft.

**Outlet Works**

The primary components of the outlet works would be a gated inlet structure, a 48-inch pipe, a control building with valves to regulate the outflow of water, and a discharge pipeline to Shell Creek or Shell Canal.

**Spillway**

The spillway would be a simple open channel excavated in a saddle located to the west of the proposed dam. It is highly likely that the material at this level would be bedrock. The spillway would discharge into a natural swale that flows into Red Gulch less one-half mile from the spillway. The overflow elevation would be set by the crest of the spillway and would be 5 ft. below the top of dam elevation.
Supply System

Two options for supplying the Douglas Draw Reservoir were investigated. Both options include diversions from Shell Creek and a two-way pipeline to discharge to either Shell Creek or Shell Canal. Both pipeline options would also connect to the reservoir’s outlet works. Both pipeline options would also be entirely on private lands with the exception of the 100 yards closest to the reservoir.

The first option would be a diversion from Shell Creek just downstream of the existing USGS gaging station. This diversion would divert water into a 5¾-mile long 48” PVC or HDPE pipeline. A portion of the supply pipeline would also serve as the discharge pipeline to discharge reservoir water to Shell Creek just above Shell Canal. While this option would require less with respect to future power expenditures, the initial construction cost would be much higher.

The second option would be a diversion from Shell Creek approximately one-half mile west of the Shell cemetery. This option would require a 3000HP pump station and would divert water into a one-mile long 48” PVC or HDPE pipeline. The entire supply pipeline would also serve as the discharge pipeline to return reservoir water to Shell Creek at the diversion point. While this option would require significant power expenditures in the future, the initial construction cost would be considerably lower.

Cost Estimate

The total costs for the Douglas Draw reservoir were determined to be $33.3M with the gravity-fed pipeline and $25.4M with the pump station and pressure pipeline.

V. Economic Analysis

Project Benefits

Introduction

This section describes the direct and indirect economic benefits that would accrue to area residents, the regional economy, and the State of Wyoming from additional storage in the project study area. The analysis in this section was performed by Watts and Associates and concentrates on two sites, the Upper Leavitt Reservoir site and the Douglas Draw site, as representing the best alternatives for multipurpose projects that would provide irrigation and recreation benefits.

Total Benefits

The total benefits of the Upper Leavitt Reservoir were found to be $2,363,000 per year with a present value of $51.3M. The total benefits of the Douglas Draw Reservoir were found to be $2,932,000 per year with a present value of $63.8M.

Costs – Upper Leavitt

The estimated construction costs for the reservoir and associated supply pipeline would be $19.9 million. A transfer pipeline from Beaver Creek to Shell Creek, Whaley Ditch, and/or Shell Canal would add an additional $5 million for a total of $24.9 million.

Operation and maintenance can be expected to cost $25,000 per year.
**Costs – Douglas Draw**

The estimated construction costs for the reservoir and associated gravity supply pipeline diverting water from Shell Creek near the USGS gage would be $33.3 million. The estimated construction costs for the reservoir and associated supply pipeline with a pump station diverting water from Shell Creek near the Shell cemetery would be $25.4 million.

Operation and maintenance can be expected to cost $25,000 per year for both supply/discharge options.

Power costs for the gravity supply pipeline will be very minimal and, therefore, not included in this analysis. Power costs for the pump station option could average $37,050 per year.

**Benefit-Cost Ratio**

The estimated present value of direct and indirect irrigation benefits and flat-water recreation benefits would be $51.3 million for the Upper Leavitt site. When compared to an estimated construction cost of $19.9 million for the reservoir alone and $24.9 million for the reservoir plus transfer pipeline, the benefit-cost ratio for the project would be 2.58 and 2.06, respectively.

The estimated present value of direct and indirect irrigation benefits and flat-water recreation benefits would be $63.8 million for the Douglas Draw site. When compared to an estimated construction cost of $33.3 million for the gravity supply line option and $25.4 million for the pump station option, the benefit-cost ratio for the project would be 1.91 and 2.51, respectively.

**Ability to Pay – Upper Leavitt**

The Wyoming Water Development Commission offers several grant-loan funding ratios. A common ratio is 67% grant with the remaining 33% costs being funded by a 50-year loan at 4% interest. Assuming a net of 2,700 AF of diversions and no transfer pipeline, the cost per acre-foot of delivered water would vary from $123 at 67% grant to $9 at 100% grant. With the transfer pipeline, the cost per acre-foot would increase to $152 at 67% grant. There would be no change to the 100% grant cost.

**Ability to Pay – Douglas Draw**

The Wyoming Water Development Commission offers several grant-loan funding ratios. A common ratio is 67% grant with the remaining 33% costs being funded by a 50-year loan at 4% interest. Assuming a net of 3,500 AF of diversions and the gravity supply pipeline option, the cost per acre-foot of delivered water would vary from $153 at 67% grant to $7 at 100% grant. With the pump station option, the cost with a 67% grant would decrease to $129 and the cost with a 100% grant would increase to $18.

**Conclusions**

These projects would have relatively high benefit-cost ratios of 2.58 (Upper Leavitt reservoir alone), 2.06 (Upper Leavitt reservoir with transfer pipeline), 1.91 (Douglas Draw gravity supply pipeline), and 2.51 (Douglas Draw pump station option).
VI. Permitting

In the current regulation environment, permitting can become a complex and expensive process. Following is a list of the permitting that would likely be required of any of the storage sites studied.

► Federal Permitting Requirements
  ● U.S. Army Corps of Engineers Section 404 Permitting
  ● United States Fish and Wildlife Service (USFWS)
  ● U.S. Department of Interior – Advisory Council on Historic Preservation (Section 106)

► State Of Wyoming Permitting
  ● Wyoming State Engineer’s Office (WSEO) Surface Water Storage Permits
  ● Wyoming State Department of Environmental Quality (WDEQ) Permitting
  ● Wyoming Historic Preservation Office (SHPO) Archaeological Clearance

VII. Summary and Recommendations

Summary of Results

This report presents the results of the Shell Valley Storage Level II Study. The primary tasks of this study were the hydrologic analysis, site screening, preliminary designs and cost estimates of the most viable sites, an economic analysis of the preferred site, and initial formulation of the Purpose and Need statement.

The hydrologic analysis indicates significant shortages during an “average” year. Communications with irrigators in the basin suggest that shortages during drier years are more considerable. The hydrologic analysis also indicates that water available for storage does exist in multiple locations in the basin.

The site screening evaluated seventeen potential storage sites. The screening resulted in the determination to prepare preliminary designs and cost estimates for the site at Upper Leavitt, Douglas Draw, and Shell Canal Tunnel.

The preliminary designs were based on the recommendations of the geotechnical/geological report. This report uses reconnaissance-level information. More extensive study would be required for more precise designs and estimates.

The preferred site was determined to be Upper Leavitt. An economic analysis that included calculation of potential benefits, both direct and indirect, and costs was completed for this site. The analysis indicated a favorable benefit to cost ratio.

Finally, the purpose and need for a project in the Shell Creek drainage was preliminarily evaluated. While many secondary benefits could be achieved by a reservoir project in the area, the primary purpose would be for storage of irrigation water. The hydrologic analysis indicates a need for such a project.

Recommendations

It is the recommendation of the States West team to further study the Upper Leavitt site. Specifically, the following items are recommended:

● Creation of a complete StateMod model in conjunction with stream gaging to establish firm numbers regarding shortages and the effectiveness of an Upper Leavitt reservoir as well as to determine the optimum reservoir size;
• Completion of a full wetlands delineation at the site to determine the extent of potential wetland mitigation requirements;
• Implementation of a subsurface geotechnical program at the site to reveal conditions affecting design of a dam and reservoir;
• Completion of a full topographic and property ownership survey to assist in design of a dam and reservoir; and
• Creation of more accurate preliminary design and cost estimates for the site based upon the geotechnical program and topographic survey.