WALL RESERVOIR REHABILITATION
AUSTIN AND WALL CANALS LEVEL II STUDY

EXECUTIVE SUMMARY

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Prepared for
Wyoming Water Development Commission
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1.0 INTRODUCTION

A Level II study was authorized by the Wyoming Water Development Commission (WWDC) in July 2013. The Level II study was completed by Sunrise Engineering, Inc. (Sunrise) and HDR Engineering, Inc. (HDR) in September 2011. HDR’s 2011 “Technical Memorandum, Conceptual Design, Wall Reservoir Rehabilitation, Austin and Wall Canals Level II Study” (TM) was included within the final report as Appendix B.

HDR completed this Level II, Phase 2 study as the prime consultant responsible for overall project management. The consulting team included Ground Engineering Consultants, Sunrise Engineering, Inc. (Sunrise), Cultural Resource Consulting, and Eco Bear Lake, LLC. The Austin and Wall Irrigation District (District) is the project sponsor.

The Wall Reservoir is located in a small tributary basin to the Blacks Fork River near the Town of Fort Bridger. The Blacks Fork River receives water from the Uinta Mountains south of Wall Reservoir. The Blacks Fork River is tributary to the Green River.

The main purposes of this phase 2 study are to: 1) perform further review of the proposed remedial measures for addressing the water seepage at Wall Reservoir, 2) further assess the dam safety deficiencies, and 3) to evaluate potential non-agricultural benefits and the permitting and mitigation requirements for rehabilitation of the reservoir.

2.0 PROJECT MEETINGS

Four project meetings have been conducted for this project. A project scoping or kick-off meeting was held in Lyman on July 23, 2013. A second project meeting was held October 29, 2013 to discuss the Uinta County Road 221 and Wall Reservoir. The third project meeting occurred on March 22, 2014. A final project meeting was held on April 20, 2015. A copy of the final meeting minutes for each meeting is within Appendix F of the final report.

3.0 GEOLOGY AND SURVEY

The regional geology is thoroughly discussed in HDR’s 2011 TM. The geology of the region around the reservoir and dam site is shown on Plates 10 and 11 of the TM and are presented in Appendix C of the final report. The bedrock of the site is largely underlain by Eocene age siltstone and sandstone (ST) of the Bridger Formation.

Subsequent Quaternary erosion and deposition during the past 1 million years have formed the pediment surfaces, terraces and floodplains that surround the site. Quaternary age colluvial soils (C(sw)m-g) consisting largely of silts and clays that have weathered out of the Bridger formation cover much of the site.

During this phase of the investigation, an onsite survey was conducted by HDR in August 2013. The surveyor performed a topographic survey of Wall Reservoir from the existing water level within the dead pool below the reservoir outlet invert elevation up to the bank elevation of the Austin Canal and the county road to the west and south, respectively. In addition, a topographic survey was performed along cross-sections of the primary (service) spillway, emergency spillway, and at the primary spillway outlet features. The horizontal datum for this survey was NAD83. (2011) Wyoming West State Plane Coordinate System, and the vertical survey datum was NAVD88. The accuracy level of the control for this site is ±0.1 feet providing topography for the dam embankment features and footprint of the reservoir with ±0.1-foot accuracy at each
survey data point. The topographic surface created for the reservoir footprint between the data points is accurate to ±1 foot. Results of the survey are shown on Figure 3 of the final report. The active storage capacity of the reservoir estimated from the survey is 646 acre-feet to the existing emergency spillway crest as summarized on Figure 4 of the final report.

4.0 SUBSURFACE INVESTIGATIONS

Five borings were drilled at the dam site in the fall of 2010 as part of HDR’s initial subsurface investigation program. Piezometers were installed in each boring in order to establish and monitor water levels within the dam and foundation. In addition to the five borings, seven test pits were excavated in order to identify potential borrow sources for dam remediation. The results of these investigations are presented in HDR’s 2011 TM. The results of the 2010 investigations were used to design the most appropriate site investigations for this phase of the project.

An HDR representative, Mr. John Charlton, performed an inspection of the downstream toe of the dam and downstream toe of the right abutment on September 7, 2013. Bedrock was exposed at numerous locations within this dry portion of the reservoir outlet channel. The bedrock is siltstone that exhibits sub-horizontal fractures along bedding planes as well as vertical fractures. Bedding plane fractures are very continuous (greater than 100 feet), and the continuity of vertical fractures could not be assessed due to limited outcrop extent.

The 2013 drilling program included drilling, sampling, and testing of an additional 8 boring in the dam and right abutment areas. This program was completed from September 10 through September 20, 2013 using a buggy mounted auger rig. Ground Engineering from Casper, Wyoming performed the drilling, sampling, and testing operations. Samples of soil materials were retrieved with a split spoon sampler in accordance with standard penetration (SPT) (ASTM D-1586). Thin wall Shelby Tube samples were collected at specific depths in order to get some undisturbed samples.

Soil and rock samples were logged, labelled, and preserved by Ground Engineering personnel. Each boring was advanced through soil using 6 inch diameter augers until refusal on bedrock. Bedrock was drilled and sampled using NQ wireline tooling. The locations of these along with the original borings from the 2010 investigation program are shown on Figures 5 and 6 in the final report.

Hydraulic conductivity of the rock mass was assessed using water pressure tests with 7 borings. Soil and partially weathered rock samples collected with the split spoon sampler during the drilling and sampling program were transported to the Ground Engineering Laboratory for analysis. A total of 18 samples were analyzed for moisture content, dry density, gradation, and Atterberg Limits. In addition to the split spoon sample testing, four Shelby tube samples were tested for hydraulic conductivity in the laboratory.

5.0 ENGINEERING EVALUATIONS

The water pressure test data from the exploration program were used to estimate Lugeon values, which is a unit of measure typically used in the evaluation, design and construction of foundation grouting programs for dams.
Based on the data presented in Table 5.2 in the final report, there appears to be a correlation between depth into the rock mass and hydraulic conductivity. With the exception of the test interval of two borings, hydraulic conductivity decreases with depth into the rock mass. This type of correlation is common in rock due to a greater degree of weathering, strength reduction, and fracturing in the upper portion of the rock just below completely weathered rock and soil and stresses within the rock mass.

The most important conclusion is the there is a high permeability zone (as high as 10\(^{-3}\) cm/sec) that extends under the dam. The hydraulic conductivity indicates that the upper 10 to perhaps 20 feet of bedrock has a hydraulic conductivity sufficient to allow significant seepage underneath the dam in the vicinity of the right abutment and throughout the right abutment. Further, the estimated Lugeon values from the testing program also indicate that grouting can likely be performed with an expected favorable outcome to reduce the hydraulic conductivity of the foundation bedrock with a corresponding reduction in seepage losses from the reservoir.

5.1 SEEPAGE CONTROL MEASURES

In order to mitigate the seepage through the dam foundation near the right abutment and through the right abutment at the Wall Reservoir the hydraulic conductivity of the upper 10-20 feet of bedrock will have to be reduced. Based on the geologic characterization models and engineering analyses complete for the site, we believe that there are two different approaches that can be used to achieve a significant reduction in hydraulic conductivity of the foundation bedrock and the corresponding seepage from the reservoir. These approaches include:

1) excavation of a cutoff trench and backfilling of the trench with a low permeability cement/bentonite backfill, and

2) grouting with a properly designed balanced and stable grout.

Each of these foundation treatment approaches would be combined with installation of a low permeability compacted clay liner over the upstream face of the dam and upstream right abutment area. Based on our experience and the results of our seepage analyses, we believe that these systems would achieve a seepage reduction ranging from 60 to 90 percent through the areas selected for treatment.

Overall, if properly designed and constructed, we would expect both approaches to work well at reducing seepage with the cutoff wall achieving the highest level of seepage reduction. An alternative evaluation should consider both effectiveness and costs in selecting the preferred approach to the foundation seepage issues.

6.0 SALINITY PROGRAM FUNDING

The Colorado River Basin Salinity Control Act was enacted in 1974, and was later amended into the program as it now stands. The objective of the Colorado River Basin Salinity Control Program (CRBSCP) is to minimize the salt loading in the Colorado River system for uses within the United States and Mexico.

Sunrise Engineering performed a water balance study to evaluate Austin/Wall Irrigation District seepage loss at the Wall Reservoir to assist in quantifying seepage losses for a funding application. Beginning on May 22, 2014, Sunrise Engineering assembled evaporation,
precipitation, temperature, and humidity measurement devices adjacent to the Wall Reservoir. Baseline readings were collected for evaporation, reservoir inflow and outflow and reservoir elevation on that date.

- The data collection period was from May 22nd to June 10th, 2014. Data was collected at the beginning and ending dates as well as intermediate dates of May 27th, 29th, June 3rd and June 6th.

- During the 19-day period, 30% of the inflow was lost through the outlet and embankment subsurface seepage, 19% evaporated, 29% was stored in the reservoir and 22% was unaccounted seepage.

- The outlet and subsurface seepage intercepted by the reservoir outlet ditch can be as high as approximately 28 acre-feet per week when the reservoir is full. The unaccounted subsurface seepage is estimated to be approximately 20 acre-feet per week when the reservoir is nearly full.

Salt load reduction estimates for agricultural areas can only be provided in areas where salinity studies have been performed. The Wall Reservoir area is located within a salinity study area. A draft Wall Reservoir funding application can be found in Appendix H of the final report. Applications are reviewed by the USBOR and awarded based on the cost per ton of salt saved or reduced. Projects that are able to reduce the most tonnage of salt at the lowest cost receive higher rankings for CRBSCP funding.

The verbal communications with the USBOR staff indicate that a reservoir rehabilitation project may reduce the salt load credit applied to future canal piping projects for the District which would have a negative effect on the selection review of future canal piping grant requests from the District.

7.0 RESERVOIR ENLARGEMENT/OPERATING PLAN CONSIDERATIONS

HDR performed a preliminary review of the reservoir enlargement considerations. The focus of this study has been to update the conceptual designs for the seepage control analysis as well as studying reservoir deficiencies. Any substantial increase in the reservoir water levels without the installation of effective seepage controls would worsen the current seepage conditions that exist at Wall Reservoir. HDR does not recommend proceeding with a reservoir enlargement at this time.

The Wall Reservoir secondary supply water rights include 2,550.80 acres under the canal system. The Wall Canal serves a total of 2,717.98 adjudicated acres of adjudicated direct flow water rights. Both the Austin and Wall Canals are operated in the fall and winter months following the heavy use irrigation season. The canals divert small quantities of water from the Blacks Fork River for stock watering purposes and to maintain saturated conditions within the conveyance systems. The Austin Canal diverts and carries water in the winter months for the purpose of filling Wall Reservoir.

Due to the relative junior priorities of the District’s direct flow water rights and the variability of available natural flows in Blacks Fork River, the water supply is inadequate to serve the irrigation demands for the entire irrigation season. When demands exceed the natural flows, the stored water released from Meeks Cabin Reservoir allows the District members to continue
to irrigate during the summer and fall months. The reliance on Wall Reservoir releases can directly benefit the Wall Canal members in addition to serving as a source of replacement water for conveyance losses associated with Meeks Cabin Reservoir storage.

Following the implementation of the proposed rehabilitation project, the average estimated cumulative release quantity of Wall Reservoir storage to serve Wall Canal irrigators is 492 acre feet. Based on this total quantity, the potential release rates within an operational plan are listed below.

- Constant release rates of 4 cfs in month of July,
- 2 cfs in August, and
- 2 cfs in September.

Of course the District would need to vary actual daily releases in response to water orders and other conditions; such as dry out periods for crop cultivation and harvesting, and natural precipitation events, etc.

8.0 SPILLWAY HYDROLOGY AND ROUTING

The previously developed hydrologic model of the contributing watershed to the Wall Reservoir was relied upon to simulate the Probable Maximum Precipitation (PMP) storm and Probable Maximum Flood (PMF) runoff conditions, and to assess the capacity performance of the existing and proposed spillways for the reservoir during a 100-year and PMF event.

The proposed regulations of the Wyoming State Engineer's Office (WSEO) Dam Safety program require that the PMF event be analyzed as the inflow design storm (IDS) when proposing changes to any high or significant hazard dam within the state.\(^1\) According to the Dam Safety Program, a high hazard dam is classified as Class I and a significant hazard dam is classified as Class II. The Natural Resources Conservation Service Technical Release No. 60 Earth Dams and Reservoirs, 210-VI-TR60, July 2005 (TR-60) provides guidance on developing the hydrograph to be used in designing the principal and auxiliary spillways for a dam being proposed or modified.

The State of Wyoming Water Development Commission with supplemental funding from USDA Natural Resources Conservation Service (NRCS) has developed a geographically-based tool that can easily calculate PMP storm events for individual subbasins. Experience in other states of this region indicates that, spillways in higher elevation regions may be sized 20 to 40 percent too large when HMRs alone are relied upon. Within this Phase II Study HDR has relied upon the PMP storm developed using the geographically-based tool rather than using HMR-49.

It should be noted that Quarry Creek drainage does not directly contribute to Wall Reservoir during extreme events. A canal diversion and a county road bridge structure directs flow from Quarry Creek to Wall Reservoir during typical low flows. During extreme events, it is anticipated

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\(^1\) A sunny day breach analysis performed in the initial phase of this study confirmed that Wall Reservoir may be classified as a high hazard dam (Class I). See Appendix D for the prior Dam Hazard Classification and Spillway Analyses within HDR's 2011 TM.
that some Quarry Creek runoff will follow its natural flowpath to Black Fork RIver, and some flow will enter Wall Reservoir.

The HDR analysis assumed either 100% or no contribution of PMF flows from the Quarry Creek drainage. A more refined analysis would need to be performed to quantify the amount of Quarry Creek runoff that could be expected to bypass the Austin Canal and move on downslope and into the Blacks Fork River drainage. Doing so will likely reduce the volume and peak flow rate of the PMF routed through Wall Reservoir under Condition no. 1, which represented the combined runoff of the Scoop Shovel and Quarry Creek drainages.

The 100-year proposed conditions modeling indicates conceptual primary spillway and auxiliary (emergency) spillway are sufficient to convey the 100-year event with an acceptable minimum freeboard within the reservoir at the maximum water surface elevation for runoff from the Scoop Shovel Draw which is modelled under Condition no. 2.

9.0 NON-AGRICULTURAL BENEFITS, PERMITTING & MITIGATION

HDR performed a screening level evaluation of potential non-agricultural benefits, cooperative public access opportunities, and mitigation measures for the project. The intent of this investigation was to identify measures which could potential qualify for grant programs made available by State, Federal, or private organizations as well as provide on-site compensatory mitigation to offset potential impacts to existing resources that may occur as part of project construction. The initial screening level investigation revealed the following potential opportunities:

- Recreational fishery,
- Installation of fish protection screens on the Blacks Fork River,
- Recreational waterfowl hunting,
- Wetland and waterfowl habitat development, and
- Passive recreational wildlife viewing.

The Wall Reservoir could be managed to maintain a year-round trout fishery if adequate inflows or diversions from the Blacks Fork River to maintain water depths and water quality can be provided during the May through August irrigation season. In this review, it is not known if adequate inflow can be provided during that time frame to maintain water depth and temperatures for trout during the irrigation season.

HDR contacted Wyoming Game and Fish Department (WGFD) officials about the potential for the reservoir serving as a public recreation facility for water fowl viewing and hunting. The initial minimum pool deliberations serving fishery needs would be much more disruptive to the District operations at the Wall Reservoir than compared with a conservation pool to serve water fowl habitat needs.

Cultural Resources Consulting completed a Class III Cultural Resources Inventory Report for the proposed Wall Reservoir rehabilitation. Because the Class III Cultural Resources Inventory Report divulges information about NRHP archeological sites that are protected under 43 CFR 7, the report can not be released to the public. The report was sent to the BLM Kemmerer Field Office but no comments were received.
On October 5, 2013, the area of proposed impact of rehabilitation was visited to determine if there were any potential jurisdictional wetlands. The reservoir was almost dry and there was no water being released. Observations of the reservoir outlet site revealed small ditches that went into the Austin/Wall irrigation system. Following a field visit, Eco Bear Lake, LLC completed a short memorandum that reviewed the potential impact to jurisdictional wetlands.

The simplified approach and analysis was sent to Mr. Thomas Johnson with the USACE Area Office on October 25, 2013. Mr. Johnson’s initial e-mail review indicated that the proposed maintenance on the dam does not apply as an exempt maintenance activity under 33 CFS 323.4(a)(2). However, Mr. Johnson said the maintenance activity for Wall Reservoir may be authorized under Nationwide Permit 3 under paragraph (a).

In response to Mr. Johnson’s comments, Eco Bear Lake, LLC (EBL) performed a second field visit on April 10, 2014. The data collection was focused on the seepage areas at the toe of the Dam which would be disturbed by the proposed toe drain rehabilitation activities.

Mr. Johnson responded with a letter dated May 15, 2014 within Appendix G of the final report. Mr. Johnson stated that the investigation was not adequate and did not properly evaluate the project area. Mr. Johnson stated that the proposed rehabilitation of the reservoir embankment with fill material on the upstream face and the downstream toe deviates from the original fill design of the embankment structure and therefore, does not qualify as an exempt maintenance activity under 33 CFR 323.4(a)(2). The maintenance activity can be authorized by the Nationwide Permit 3.

Further wetlands investigation and classification/delineation study is needed on all areas that could be impacted by the reservoir rehabilitation. In addition to the proposed fill at the toe of the dam embankment, the conceptual design of the proposed auxiliary spillway will need to be reviewed to address potential impacts to existing wetlands. The proposed investigation would identify the acreage and the qualities of wetlands impacted by the proposed project and propose a mitigation plan to minimize the adverse impact.

A portion of the reservoir embankment is located on U.S. Bureau of Land Management (BLM) lands and will require a clearance and authorization from the BLM prior to rehabilitation. The proposed alternatives for addressing dam safety deficiencies for passing an inflow design flood may need to be considered during a BLM NEPA review process. The outflow from the existing and proposed auxiliary spillway is routed through BLM lands.

The cultural resource investigation and coordination with WGFD and USACE officials completed under the current study helps the District and State understand the permitting requirements and clearances for implementation of the proposed Wall Reservoir rehabilitation project.

10.0 CONCEPTUAL DESIGN UPDATES

HDR’s previous 2011 TM proposed the following remedial measures for addressing the Wall Reservoir dam deficiencies:

- Construction of an upstream cutoff trench
- Foundation grouting
• Construction of a downstream toe drain
• Removal and replacement of the existing outlet works
• Removal of existing trees/vegetation

As an alternative to foundation grouting, an approach was considered in the current evaluation that included the excavation and backfilling of a cutoff trench. The trench would be filled with a cement/bentonite backfill material. An advantage of this method is more complete cutoff of seepage through the bedrock over what may be achieved with grouting methods.

An additional 300 linear feet of cutoff trench (Zone 1) and the foundation cutoff trench or grout curtain measures for addressing the existing seepage in the right abutment bedrock are recommended.

At this time, we have assumed that seepage reduction measures are needed for the entire 1,800-foot length of the dam and right abutment. It may be appropriate and cost effective to reduce the length of seepage reduction measure to 1,500 feet or less based on additional exploration borings performed during a subsequent phase of work.

The removal of the existing trees and vegetation along the dam embankment and the construction of a downstream toe drain continue to be recommended rehabilitation measures. Depending upon the success of the cutoff trench and foundation treatment measures, the toe drain and buttress may not be needed.

The existing arch CMP culvert and earthen road emergency spillways are undersized for passing 100-year and PMF runoff event. In addition the existing primary outlet is undersized and leaks.

The proposed rehabilitation of the primary outlet and auxiliary spillway include:

• removal of the existing culvert under the county roadway,
• filling the existing spillway control section on the county roadway to the top of the dam elevation,
• replacement of the primary spillway conduit with a 30 inch reinforced concrete pressure pipe with an inclined sluice gate to allow water level control,
• constructing a reinforced concrete riser at the primary spillway conduit, and
• constructing an auxiliary (earthen) emergency spillway and outlet channel.

11.0 PROJECT FINANCING

HDR’s amended preliminary opinions of probable cost are approximately $3.49 million for 1,800 feet of seepage control measures versus $3.14 million for 1,500 feet of seepage controls for the foundation grouting alternative. The opinions of probable cost for the foundation cutoff trench alternative are $3.73 million for 1,800 feet versus $3.35 million for 1,500 feet of seepage controls is within Table 10.2. Based on the preliminary review of costs the foundation cutoff trench alternative represents about a 7% percent increase in cost versus the foundation grouting. If seepage control measures are not needed to the northwest at left abutment, the potential estimated cost savings based on HDR’s preliminary opinion of probable costs is approximately $350,000 for the foundation grouting alternative and $385,000 for the foundation cutoff trench alternative.
An annual per-acre assessment of the District members would address payroll needs to pay part-time District employees and could fund other expenses of current operations as well as meeting any future payments for debt obligations. The Members agreed to a $200,000 loan obligation during the first phase of funding for the WWDC Level III canal rehabilitation project. The Members have expressed reluctance to incur any additional debt. While available sources of loan financing have been described below, it is unlikely that the District could encumber significant debt obligations.

The project funding selection of the Colorado River Basin Salinity Control Program (CRBSCP) funding provides preference to projects that are the most cost effective at achieving the highest level of salt removed per dollar of cost. Based on the initial discussions, the USBOR would require a study completed by the USGS to help quantify the salinity savings before considering funding for a reservoir project. USBOR said that a reservoir rehabilitation project would reduce the salt load credit being applied to a future canal piping project for the District which may have a negative effect on the selection review of future canal piping grant requests from the District. One federal grant program that could potentially fund a portion of the rehabilitation is WaterSMART. This federal grant program limits the per project funding to $1 million.

Due to financial hardship and affordability considerations for District members under the Wall Canal, a funding mix of 67% WWDC grant and 33% District loan is not feasible. If the District is successful in obtaining a 29.9% federal grant, a funding alternative is presented in the final report that reduces the District loan obligation to 3.1% of total project costs. Under this funding mix alternative the estimated per acre annual assessment for Wall Canal District members is approximately $3.68 per acre for the cutoff trench foundation treatment alternative with 300 feet of the left abutment treatment removed.

12.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

The important finding of the site investigation is that the defects or fractures in the foundation are a primary cause of the seepage. Based on the analysis of seepage occurring in the vicinity of the right abutment, seepage controls need to be extended from the dam embankment around to the right abutment. Additional findings and recommendations of this Level II Study are:

- The outlet and subsurface seepage intercepted by the reservoir outlet ditch and the unaccounted for seepage can be as high as approximately 28 acre-feet per week when the reservoir is full.
- During the 19-day water balance study an estimated 52% of the reservoir inflows were lost to subsurface seepage.
- The existing arch CMP culvert and earthen road emergency spillways are significantly undersized for passing a PMF runoff event from the combined flows from both the Scoop Shovel Draw and Quarry Creek drainages.
- The Quarry Creek and Austin Canal confluence needs a refined analysis. The contribution of the Quarry Creek drainage during large storm events and the potential need for a water flow diversion structure at the confluence needs to be considered.
- A conceptual design of a new auxiliary (emergency) spillway to safely pass a PMF runoff event from the Scoop Shovel Draw has been prepared.
• The reservoir offers opportunities for a recreational fishery, recreational waterfowl hunting, wetland and waterfowl habitat development, and passive wildlife viewing.

• The public access and future opportunities for waterfowl hunting, wetland creation and waterfowl habitat and viewing appear to be much less onerous to the District and future operations of Wall Reservoir than a recreational fishery.

• The environmental consequences and mitigation requirements along with the District’s future irrigation practices relying on reservoir storage releases are important factors affecting the future operations of Wall Reservoir.

• A federally lead National Environmental Policy Act (NEPA) review process will require state agency reviews by WGFD for terrestrial and aquatic wildlife concerns.

• If WGFD approvals are required based on a selected funding alternative or proposed aquatic wildlife enhancements of the reclamation project, HDR recommends further coordination with WGFD in the design phase to refine the potential conservation pool requirements.

• Further wetlands investigation and classification/delineation study is needed on all areas that could be impacted by the reservoir rehabilitation.

• The proposed investigation would identify the acreage and the quality of wetlands impacted by the proposed project, and propose a mitigation plan to minimize the adverse impact.

• The initial responses from USBOR indicates that a reservoir reclamation project may not be eligible for funding under the CRSCRP and the funding of a reservoir project may have a negative effect on the ranking of future canal rehabilitation funding requests from Austin/Wall Irrigation District.

• The USBOR WaterSMART grant program is a potential federal program that is directly applicable to funding the water conservation and water savings proposed for this project.

• Additional geotechnical investigations are needed to understand the need for seepage controls along the left abutment of the reservoir embankment.

• HDR’s amended preliminary opinions of probable cost are approximately $3.49 million for 1,800 feet of seepage control measures versus $3.14 million for 1,500 feet of seepage controls for the foundation grouting alternative. The opinions of probable cost for the foundation cutoff trench alternative are $3.73 million for 1,800 feet versus $3.35 million for 1,500 feet of seepage controls.

• If seepage control measures are not needed to the northwest along the left abutment, the potential estimated cost savings based on HDR’s preliminary opinion of probable costs is approximately $350,000 for the foundation grouting alternative and $385,000 for the foundation cutoff trench alternative.