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Executive Summary

LeClair/Riverton Valley Irrigation Storage Project, Level II Study

Professional Services No. 0451

Prepared for:
Wyoming Water Development Commission
Cheyenne, Wyoming

Prepared by:
States West Water Resources Corporation – Cheyenne, Wyoming

In Association with:
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1. Purpose

The purpose of this study was to develop conceptual designs with cost estimates and economic analyses, operational plans, and recommendations for the LeClair and Riverton Valley irrigation districts to assist with the determination of the feasibility of constructing re-regulation reservoir facilities within the two districts. The study was to evaluate and quantify the need for additional storage, identify all feasible storage locations, select the preferred alternative sites, conduct further investigations of the preferred alternative sites, and present detailed alternatives to the irrigation districts.

2. Problem Identification

There are typically four times per year when the two irrigation districts experience irrigation water supply shortages. These shortages usually occur in early May when the irrigation districts first begin operation for the season when pre-runoff flows in the Wind River are low, early July after the first cutting of hay, early August after the second cutting of hay, and lastly the two irrigation districts historically have late season shortages. When the farmers cut hay they shut down irrigation for approximately two weeks to allow their fields to dry out enough to gain access and cut hay. During these periods system demand decreases and excess water is wasted. The demand peaks and the irrigation districts experience shortages after each hay cutting when irrigation resumes. It would be beneficial to the irrigation districts to release water from storage during these four times of shortage. Several different reservoir configurations are presented in this study to help solve these water shortage problems.

3. Site Identification

Three types of sites were investigated in this study. The first type of site could be located in between the two canals and operate with an exchange between the two irrigation districts. LeClair irrigation district could divert a portion of Riverton Valley irrigation district’s water through their diversion and divert this water along with a match to storage. When supplemental supply is needed LeClair irrigation district could continue taking a portion of Riverton Valley irrigation district’s water. Riverton Valley irrigation district could release their supplemental supply from storage. This type of facility would be the most beneficial located near the upper portion of Riverton Valley irrigation district’s system and could benefit both irrigation districts. A second type of reservoir configuration investigated in this study could be located on each irrigation district’s canal and operated independently of the other irrigation district to supply supplemental water to the respective canal. This storage option could be supplied by and deliver water to the same canal. This type of storage would re-regulate flows in the canal to better meet irrigation district needs. The third type of reservoir configuration investigated in this study could be located to capture new sources of water available to the two irrigation districts.

Twelve areas were identified as possible reservoir sites. Most areas had several different storage configuration options. The potential reservoir sites studied can be seen on Figure 1.1.

4. Site Alternatives Selection

The potential reservoir sites were studied and screened using input from the project sponsors and a weighted comparison with a variety of inputs. Table 1.1 gives pertinent data and allows for
comparison of each potential site. The sites were evaluated using the following design criteria: 1) store 1,800 ac-ft of supplemental water, 2) storage shall be located and operated to serve maximum benefit to both irrigation districts, 3) benefit land owner, 4) impact less than one tenth of an acre of wetland, 5) benefits outweigh the costs, 6) technically sound, and 7) compliance with the State of Wyoming’s Dam Safety Laws. Each site was ranked using a weighted comparison. Sites 8, 7A, 11A, and 7B are the four top ranked potential sites and Sites 11 and 4 tie for fifth ranking. These site rankings compliment the irrigation district’s preferred sites list. The LeClair and Riverton Valley Irrigation Districts held a joint board meeting on November 29, 2005 to discuss reservoir site alternatives. Reservoir Sites 7A, 7B, 8, 11, 4, and 2 were determined to be the preferred alternative reservoir sites, and the irrigation districts were in agreement to pursue further investigation on these sites. Through thorough investigation of these potential reservoir sites, Sites 7B, 4 and 2 were dropped from the list of preferred alternatives. The storage volume in Site 7B would be limited by the presence of a bedrock knob in the middle of the pool area resulting in an inefficient site. The bedrock knob was determined to be costly to remove and economical construction of this site would not be feasible. Sites 4 and 2 have several geotechnical concerns and it was determined that the economical construction of a safe dam at these sites would not be feasible. Sites 7A, 8, 11, 4, and 2 are discussed briefly in this summary. The report contains a complete description of this study.

4.1 Reservoir Site Number 7A

4.1.1 General
Site 7A is located between the LeClair and Riverton Valley canals, north of River View Road. This site is located in the south half of Section 25, Township 1 North, Range 3 East. Access to this site is from River View Road to the south. The reservoir and appurtenances would all be located on deeded land owned by two different landowners. Currently there is approximately 38 acres of hayfield in production at this site that would be inundated. An old homestead site would also be inundated along with a corral and a small cabin. Either the land would be purchased or easements would be obtained for the dams and reservoirs, pipelines, and other appurtenances.

4.1.2 Reservoir Capacity
The irregularly-shaped reservoir area of Site 7A would be impounded by several long embankment sections constructed between topographic high points along the south and west margins of the reservoir area. For purposes of describing the site characteristics and preliminary dam layouts, the site is segmented into two areas: 7A West and 7A East, separated by a north-south oriented bedrock ridge. Six storage volume scenarios and the resulting costs were analyzed for this potential reservoir site. The six storage configurations are 7A East, 7A West, and 7A East and West combined each with and without over excavation. Each storage configuration was evaluated with and without over excavation of the sandy silty material in the pool area to increase storage volume in the reservoir. Over excavation and spoil appears to be a cost effective method of increasing storage volume. The combined reservoirs would impound approximately 1090 acre-feet with no reservoir stripping, and approximately 1290 acre-feet with 12 feet (average) of additional excavation in the reservoir areas to provide additional, below-grade storage volume.

4.1.3 Reservoir Embankment
The reservoir embankments could be constructed utilizing a homogeneous earth fill embankment design. The sandy silty material excavated from the pool area appears to be suitable for use in this type of dam construction. Detailed conceptual designs are given in the final report. The embankment design incorporates a chimney and blanket filter/drain along with a plastic concrete core
wall on several sections of the embankments. The maximum section for Site 7A West incorporates a cobble toe berm. Riprap slope protection would be required and is imported for the upstream slope and locally barrowed for the downstream slope. The embankment foundation requires excavation to bedrock and re-compaction of the loose sandy silty alluvial deposits. Dewatering for these excavations is anticipated. Main dam embankments have 3H:1V upstream slopes and 2.5H:1V downstream slopes; maximum heights above final grade of about 58 feet (west dam) and 35 feet (east dam); and 20 feet crest widths at elevation 5125 feet. The east dam is approximately 1400 feet long, and the west dam, main section is approximately 1100 feet long. The closure section of the west dam is approximately 1200 feet long and consists of flatter upstream and downstream slopes and wider crest width.

4.1.4 Reservoir Supply
Site 7A would be supplied with a diversion and pipeline from the LeClair canal. The diversion point from the LeClair canal would be east of the adjacent tribal land boundary. Water would first be stored in Site 7A East and would spill over into Site 7A West. Water would have to fill to an elevation of 5115’ in Site 7A East before water would begin to flow over the saddle and into Site 7A West. An alternative pipeline route would supply water directly to Site 7A West if Site 7A East were not built.

4.1.5 Outlet Works
The Site 7A East and West outlet works would each consist of an intake structure, a concrete gate tower incorporating two 36’’ sluice gates located within the embankment, and a 36’’ outlet pipeline connecting between the two reservoirs and running to an impact basin outlet structure in the Riverton Valley canal. The maximum capacity of these primary outlet works would be approximately 110 cfs.

4.1.6 Emergency Spillway
Sites 7A and 7A East require an emergency spillway. It was anticipated that during an extreme flood event the LeClair canal could potentially breach and inundate these sites. The emergency spillway capacity was designed using the Probable Maximum Flood (PMF) inflow design flood in addition to the LeClair canal breech. It was anticipated that the emergency spillway would be an unlined channel cut into bedrock adjacent to the left abutment of Site 7A East. Site 7A West does not require an emergency spillway because it could store the PMF and a LeClair canal breech would not inundate this site.

4.1.7 Operation
This potential reservoir site, located between the LeClair and Riverton Valley canal, could serve both canals through a water exchange between the two irrigation districts. This reservoir site could store water in the spring and when irrigation demand is less than irrigation supply as long as the Wind River is not in regulation. Water could be released during periods of high demand on the canal systems. It is anticipated that this site could be filled twice per season. Costs associated with this site would be split between both irrigation districts based on acres served.

4.2 Reservoir Site Number 8

4.2.1 General
Site 8 is located north and west of the LeClair Canal. This site is situated in a small, natural drainage feature that drains towards the east-southeast. Remnants of a small, breached embankment dam are evident on the same alignment as the proposed new dam alignment. The breach is located at the
deepest part of the drainage near the toe of the left abutment. It is unknown whether the breach was intentional or occurred as a result of overtopping or failure of the dam. This site is located in the SE ¼ of the NE ¼ of Section 20, Township 1 North, Range 4 East. Access to this site is from the LeClair canal bank road. The reservoir and appurtenances would be located on deeded land. The land is currently used as pasture. It is anticipated that the land needed for the reservoir, pipelines, and appurtenances would either be purchased and owned by LeClair ID or easements would be obtained.

4.2.2 Reservoir Supply
An existing lateral used to supply irrigation water to several fields above the LeClair canal was replaced in the summer of 2005 with 24” PVC irrigation pipe. The reservoir would be supplied through this existing 24” PVC piped lateral. The supply capacity of the existing lateral could fill the reservoir in approximately six days.

4.2.3 Reservoir Capacity
Site 8 could store approximately 120 ac-ft of water to a high-water line of 5159’ with a 32-feet high, 680-feet long dam. This storage elevation, however, would inundate approximately 0.8 acres of tribal land to the west. A high-water line of 5154’ would limit the storage volume to 77 ac-ft, but would not inundate the tribal land boundary.

4.2.4 Reservoir Embankment
The reservoir embankment utilizes a zoned embankment design consisting of a central clay core protected by a chimney filter/drain which ties into a blanket drain and an outer shell consisting of locally barrowed sandy silt and gravelly sand. It is anticipated that there is an adequate amount of locally available clay material for use in the clay core and core trench. Clay and loose material should be stripped from the dam foundation. The stripping depth in the valley bottom may be limited to the top of the conglomerate layer which should provide a strong foundation. Shallow loose soil materials on the abutment slopes should be stripped to bedrock. The upstream slope requires slope protection. Preliminary riprap sizing analyses indicate that nearby sources of oversize alluvial cobbles and boulders would be suitable as a potential riprap source for this site’s moderate erosion protection requirements. As an alternative, soil cement plating could be considered for this site. The embankment has a maximum height of 32 feet, with 15 feet crest width, 3H:1V upstream slope and 2.5H:1V downstream slope. Dam crest elevation is at elevation 5164 and normal pool (spillway crest) is at elevation 5159.

4.2.5 Outlet Works
The Site 8 outlet works include an inverted slide gate on a 24” steel outlet pipe and an 18” pipeline to the LeClair canal. The design of the outlet works was developed to allow a supply of 15 cfs to be delivered to the LeClair canal with minimal depth in the reservoir. The 18” canal supply pipeline would be aligned along the south side of the draw to avoid the wetlands and riparian areas located below the reservoir in the bottom of the draw and to maintain a grade on the pipeline to the outfall. Water not delivered to the LeClair canal could be released below the toe of the embankment and conveyed down the draw to the existing underdrain structure which passes flows in the draw under the LeClair canal. The maximum capacity of the primary outlet works with discharge to the draw is approximately 56 cfs.

4.2.6 Emergency Spillway
Site 8 requires an emergency spillway. The emergency spillway capacity was designed using the Probable Maximum Flood (PMF) as the inflow design flood. It was anticipated that the emergency spillway would be an unlined channel cut into bedrock adjacent to the right abutment and discharge into the drainage below the toe of the dam.

4.2.7 Operation
This potential reservoir site would be located above the LeClair canal near the mid point of the canal system. This site would serve the LeClair canal only. This site could help to regulate flows in the canal and reduce waste by storing water any time irrigation demand is less than irrigation supply assuming the Wind River is not in regulation. It is anticipated that this site could be filled two or three times per season depending on the amount of runoff, frequency of summer rainfall, and system operation. This site could store approximately 120 ac-ft of water per fill allowing this site to yield approximately 240 to 360 ac-ft per season.

4.3 Reservoir Site Number 11

4.3.1 General
Site 11 is located in the E ½ of the NW ¼ of Section 28, Township 2 North, Range 5 East. Access to this site is from the Riverton Valley canal bank road. The reservoir and appurtenances would be located on deeded land. A portion of the property inundated by the reservoir pool is in the process of being sold and subdivided. The developer was contacted and was favorable to the idea of having an irrigation storage reservoir inundate a portion of the development. Attached in Appendix D of the final report is a letter dated April 13, 2006 to Robert Olson with BC Development that indicates the intent of Riverton Valley ID. Further coordination and written agreement with the developer would need to occur in order to pursue this storage option. It is anticipated that the land needed for the reservoir and appurtenances would either be purchased and owned by Riverton Valley ID or easements would be obtained.

4.3.2 Reservoir Supply
The supply for Site 11 would be the flow in the drainage. The drainage flows water year round, however, the flow is influenced by agriculture. The drainage flows more water during the irrigation season by conveying return flows from the LeClair ID. The concept would be to utilize these flows in the drainage. Two options were considered at this location. A small storage reservoir could store and release the flows to the Riverton Valley canal. The estimated supply flow rate could fill the reservoir in one to two days. The second option is to install a diversion structure to divert the flows in the drainage into the Riverton Valley canal. No testing has been completed on the quality of this water.

4.3.3 Reservoir Sizing
The reservoir option could store water to a high-water line of 4890’ and impound approximately 12 ac-ft of water. The diversion structure option would check the water level up to elevation 4882’ and create a small pool backing water approximately 380’ upstream.

4.3.4 Reservoir Embankment
Detailed storage option typical dam sections were not developed for this site. The absence of competent bedrock in the abutments and their susceptibility to both surface erosion and internal seepage erosion or piping make the economic construction of a safe dam at this site likely not feasible.
4.3.5 Outlet Works

4.3.5.1 Storage Reservoir Option
The primary outlet works for this site would include a concrete inlet box, a 20 foot concrete gate tower, a 24” steel outlet pipe, an 18” steel pipeline to connect with the Riverton Valley canal, and an impact basin. Water delivered to the Riverton Valley canal via the 18” pipeline would tie-in to the existing 36” steel piped canal. Water not delivered to the Riverton Valley canal would be released through the impact basin and conveyed down the draw. The capacity of the 24” primary outlet works is approximately 38 cfs at normal reservoir head.

4.3.5.2 Diversion Structure Option
Flow diverted with the diversion structure option would be piped with an 18” pipeline to the Riverton Valley canal. Flow in the drainage is checked up to a sufficient elevation with the use of the sheet pile weir to generate the required head to transmit the flows to the Riverton Valley canal.

4.3.6 Operation
Site 11 is located near the end of the Riverton Valley canal. This site would serve the Riverton Valley canal only. The flow in the drainage is a new source of water and there appears to be sufficient flow in the drainage to supply the irrigated lands on the Riverton Valley canal downstream from this site which could free up some water for diversion by irrigators located higher up on the canal.

4.4 Reservoir Site Number 4

4.4.1 General
Site 4 is situated in a relatively large, southward-draining, natural channel that is deeply incised through thick alluvial sediments. This site is the location of an existing small embankment dam. Site 4 is located in the E ½ of the SW ¼ of Section 26, Township 1 North, Range 3 East. This site is located north of the Riverton Valley canal and south of River View Road near the Riverton Valley diversion. This site was considered as a potential small storage site that would require a 26-feet high, 400 feet long dam to impound approximately 90 acre feet. This site could store water to a high-water line of 5069’. Access to this site is a private road off of River View Road. The reservoir and appurtenances would all be located on deeded land. It is anticipated that the land needed for the reservoir and appurtenances would either be purchased and owned by the LeClair and Riverton Valley ID or easements would be obtained.

4.4.2 Recommendations
Adverse geologic and other site conditions encountered at Site 4 are considered to represent fatal flaws for economic construction of a safe dam and reservoir at this site. These adverse conditions are summarized as follows:

- Absence of competent bedrock or dense impervious soil on which to found the dam in either abutment;
- Presence of loose, highly erodible silt and silty fine sand in the upper abutments;
- Presence of highly pervious sand and gravel layers in the lower abutments;
- Significant potential for rapid sedimentation (infilling) of the reservoir impoundment area;
- Poor soil conditions in both abutments prohibit economic construction of an emergency spillway, which would be required due to the relatively large drainage basin area.
It is the recommendation of the project team that Site 4 be eliminated from further consideration for dam and reservoir construction.

4.5 Reservoir Site Number 2

4.5.1 General
Site 2 was initially considered as a potential site for a small re-regulating reservoir. The water storage capacity at this site was anticipated to be less than 90 acre-feet. The primary function of this structure would be to facilitate water delivery from the Site 7A storage reservoir into the Riverton Valley canal.

4.5.2 Site Conditions and Geologic/Geotechnical Concerns
Site 2 is situated immediately north of the Riverton Valley Canal in a small, southward-draining, natural channel that is incised through alluvial sediments. Geologic reconnaissance of the site indicates the drainage is incised into relatively homogeneous, unconsolidated, very fine-grained sand and silty sand deposits. Well-established wetland vegetation covers the bottom of the drainage at the location of the proposed structure.

The fine silty and sandy materials at this site, which are also prevalent along the upstream drainage channel approaching the site, are highly vulnerable to erosion. These materials are problematic with regard to both surface erosion and internal erosion or piping caused by seepage forces through and under a dam at this location. Special design measures such as seepage cutoffs and internal filters and drains would be required to protect against seepage-erosion failure modes. In addition, the upstream channel would probably require slope protection or lining to avoid excessive scour and accumulation of sediment behind the structure under the higher stream flows that would be expected under system operation.

4.5.3 Recommendations
Based on the unfavorable foundation and abutment conditions regarding seepage and piping potential, high probability for erosion and scour in the channel, and the presence of high-quality wetlands at the site, it is recommended that a re-regulating structure not be constructed at this location. The recommended alternative is to convey water directly from Site 7A to the canal via an extended outlet pipeline.

5. Cost Estimates and Economic Analysis

A summary of costs for these irrigation projects is presented below. The costs include construction costs, construction engineering, preparation of final design plans and specifications, permitting and mitigation, legal fees and acquisition of access and rights-of-way. These tables present the annual repayment required by the two irrigation districts based on the WWDC funding of 67% grant and 33% loan at 4% interest for 50 years.

The following tables contain information about the economic benefits of these irrigation projects and the sponsor’s ability to pay.
Table 1.2 Direct Irrigation Benefit

<table>
<thead>
<tr>
<th>Project/Configuration</th>
<th>Cost ($Millions)</th>
<th>One Fill (AF)</th>
<th>Releases (AF)</th>
<th>Crop ET (AF)</th>
<th>Annual Irrigation Benefit ($)</th>
<th>Benefit-Cost Ratio</th>
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Table 1.3 Total Irrigation Benefit

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Table 1.4 Sponsor’s Ability to Pay Summary (30 percent of direct benefits)

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<td>7A West w/ Over Excavation</td>
<td>5.85</td>
<td>1.93</td>
<td>89,900</td>
<td>37,100</td>
<td>13.6</td>
</tr>
<tr>
<td>7A Comb</td>
<td>8.48</td>
<td>2.80</td>
<td>130,300</td>
<td>46,600</td>
<td>11.8</td>
</tr>
<tr>
<td>7A Comb w/ Over Excavation</td>
<td>9.39</td>
<td>3.10</td>
<td>144,400</td>
<td>55,100</td>
<td>12.6</td>
</tr>
<tr>
<td>Site 8</td>
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<td>0.26</td>
<td>12,300</td>
<td>6,900</td>
<td>18.5</td>
</tr>
<tr>
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<td>0.40</td>
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<td>2,400</td>
<td>43.0</td>
</tr>
<tr>
<td>Site 11 Reservoir</td>
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<td>0.15</td>
<td>6,900</td>
<td>2,400</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Table 1.5 Sponsor’s Ability to Pay Summary (50 percent of direct benefits)

<table>
<thead>
<tr>
<th>Project/Configuration</th>
<th>Project Cost ($Millions)</th>
<th>Sponsor’s Cost ($Millions)</th>
<th>Sponsor’s Annual Payment ($)</th>
<th>Sponsor’s Annual Ability to Pay ($)</th>
<th>Sponsor’s Percentage Ability to Pay (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7A East</td>
<td>4.37</td>
<td>1.44</td>
<td>67,200</td>
<td>22,600</td>
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<td>1.60</td>
<td>74,500</td>
<td>29,900</td>
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</tr>
<tr>
<td>7A West</td>
<td>5.41</td>
<td>1.79</td>
<td>83,300</td>
<td>55,100</td>
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</tr>
<tr>
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<td>89,900</td>
<td>61,900</td>
<td>22.7</td>
</tr>
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<td>2.79</td>
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<td>77,700</td>
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<td>91,800</td>
<td>21.0</td>
</tr>
<tr>
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<td>0.26</td>
<td>12,300</td>
<td>11,500</td>
<td>30.8</td>
</tr>
<tr>
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<td>3,900</td>
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<td>0.15</td>
<td>6,900</td>
<td>3,900</td>
<td>19.2</td>
</tr>
</tbody>
</table>
6. Recommendations

6.1 Site Number 7A
As shown in Table 1.2 Site 7A West with over excavation has the highest benefit to cost ratio, however, the direct benefits to the irrigators do not outweigh the costs. Site 7A Combined with over excavation has an even lower benefit to cost ratio but would allow for an increased storage volume. When indirect benefits to the regional economy are considered, as shown in Table 1.3, the total irrigation benefit to cost ratio is greater than one for all site configurations considered except Site 7A East with and without over excavation. The sponsor’s ability to pay for these irrigation projects is evaluated with two scenarios. Table 1.4 presents ability to pay estimates if 30 percent of the direct income generated from the irrigation project went toward repayment of the project, and Table 1.5 presents ability to pay estimates based upon an assumed ability to pay of 50 percent of direct project benefits. These results indicate a limited ability for project sponsors to repay estimated project costs without state assistance in the form of a higher than average grant or a state sponsored project. These site configurations appear to be technically feasible, however, economically they are probably not feasible with the current funding package and economic environment.

6.2 Site Number 8
Site 8 is assumed to have a long-term average fill rate of 2.5 times per season, and an average annual irrigation benefit of $23,000. The present value of this stream of benefits over a 50-year time frame using a 3 percent real discount rate is $591,800. Dividing this number by an estimated construction cost of $801,000 yields a direct benefit to cost ratio of 0.74. After incorporating indirect benefits to the regional economy the total benefit to cost ratio is 1.85. The sponsor’s ability to pay estimate based on an assumed ability to pay of 30 percent of direct project benefits is $6,900 annually or 18.5 percent of the total project cost financed for 50 years at 4 percent interest. The scenario improves with an assumed ability to pay of 50 percent of direct project benefits, however, the sponsor’s ability to pay is $11,500 annually or 30.8 percent of the total project cost as a loan. This is less than the current funding package of 33% loan and 67% grant from the WWDC. This site appears to be technically feasible, however, economically it is probably not feasible with the current funding package and economic environment.

6.3 Site Number 11
The Site 11 Diversion option has a direct benefit to cost ratio of 1.65 which means the present value of the direct benefits outweigh the costs. The Site 11 Storage option has a direct benefit to cost ratio less than one. It is only when indirect benefits are considered that the storage option has a favorable benefit to cost ratio. The sponsor’s ability to pay for these irrigation projects is $2,400 and $3,900 annually for an assumed ability to pay of 30 percent and 50 percent of direct project benefits respectively. This ability to pay makes the diversion option easily affordable with the current WWDC funding package. The sponsor’s ability to pay percentage for the storage option is less than the current WWDC funding package. The storage option at this site is technically questionable and financially not feasible, however, economic and technical feasibility of the diversion option appears to be favorable.