EXECUTIVE SUMMARY
FOR
KIRBY IRRIGATION DISTRICT CONSERVATION
PROGRAM, LEVEL II STUDY

Prepared For:

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002

Prepared By:

Anderson Consulting Engineers, Inc.
375 E. Horsetooth Road, Bldg 5
Fort Collins, CO 80525

August 15, 2010
EXECUTIVE SUMMARY
for
KIRBY DITCH CONSERVATION PROGRAM
LEVEL II

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(ACE Project No. WYWDC28)

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TABLE OF CONTENTS

I. INTRODUCTION ................................................................................................................... 1

II. STRUCTURE INVENTORY AND EVALUATION ................................................................. 1

III. SEEPAGE LOSSES ............................................................................................................. 3

IV. OPERATION AND IRRIGATION EFFICIENCY .................................................................... 3

V. SYSTEM AUTOMATION .................................................................................................... 4

VI. STORAGE/RE-REGULATION RESERVOIRS ..................................................................... 5

VII. GIS MAPPING .................................................................................................................. 5

VIII. REHABILITATION MASTER PLAN ................................................................................. 5

IX. IMPLEMENTATION PLANNING ......................................................................................... 6

X. FUNDING STRATEGY AND ECONOMIC ANALYSIS ...................................................... 6

XI. RECOMMENDATIONS ...................................................................................................... 9

LIST OF FIGURES

Figure 1. Kirby Ditch Vicinity Map......................................................................................... 2

LIST OF TABLES

Table 1. Total Implementation Phase I Project Costs............................................................. 7
Table 2. Total Implementation Phase II Project Costs............................................................. 7
Table 3. Results of Economic Evaluation ............................................................................... 9
I. **INTRODUCTION**

On June 7, 2007 Anderson Consulting Engineers, Inc. (ACE) entered into a contract with the Wyoming Water Development Commission (WWDC) to provide professional services in support of the Kirby Irrigation District Conservation Program, Level II Study. The Kirby Irrigation District (KID) requested the study to determine potential conservation opportunities through the enhancement of water conveyance facilities and operations. In their request to the WWDC, the KID specifically identified that the study address or evaluate the items indicated below:

- potential for delivery system and on-farm conservation opportunities;
- current operation including water appropriation, water rights, and a determination of conveyance losses;
- inventory of existing structures associated with the delivery system;
- potential to automate structures within the delivery system;
- potential re-regulation storage alternatives;
- development of a comprehensive management and rehabilitation plan; and
- development of a Geographical Information System (GIS) reflecting the main delivery canal, laterals, and structures within the delivery system.

This work culminated in the development of an implementation plan and an economic evaluation associated with implementation of the plan of improvements. Formulation of the initial implementation plan assumed an ongoing construction effort to minimize the financial burden to the KID water users. A location map of the KID is presented in Figure 1.

II. **STRUCTURE INVENTORY AND EVALUATION**

One hundred and seven (107) structures (including farm headgates/turnout structures) were inventoried during the completion of the project. This includes an assessment of the condition of 49 major conveyance structures (river headgate, check structures, culvert crossings, concrete liners, siphons and wasteways) along the delivery canal. The inventory also included 57 farm turnout structures and one (1) location where the delivery canal required rehabilitation due to erosion. The results of the structure inventory provide a snapshot of the overall condition of the irrigation structures within the KID in 2007 and 2008. Of the 49 major conveyance structures assessed during the inventory, only 11 were found to be in poor condition with none considered to be in failing condition. Following the completion of the inventory, the river headgate structure experienced failure of the downstream wingwall in the delivery canal. A temporary rehabilitation measure was installed to allow the continued operation of the headgate structure.
Figure 1. Kirby Ditch Vicinity Map.
III. SEEPAGE LOSSES

A seepage study was conducted to identify and evaluate areas of significant water loss, thereby flagging those locations for potential improvement measures. Eight reaches were initially delineated to conduct the seepage measurements. Following a presentation to discuss the results of the draft report, an additional seepage investigation was conducted in the vicinity of Cochran Point. Results of the seepage studies provided the conclusions presented below.

- The most significant losses are located along the reach extending from the end of Liner No. 2 to a distance of approximately 500 feet downstream of Liner No.3.
- Over a period of three years, the annual losses in this reach ranged from 1,200 acre-feet to over 1,800 acre-feet.

Several improvements were identified to mitigate the seepage and included the following:

- Sealing of the cracks and deteriorated concrete in the two existing concrete liners near Cochran Point.
- Installation of a concrete liner in the earthen ditch located between the two existing concrete liners.
- Extending the last concrete liner for a distance of approximately 450 feet.

IV. OPERATION AND IRRIGATION EFFICIENCY

The operation and management of the water delivery to the users was evaluated during the project. This work consisted of an evaluation of: (a) operational waste, (b) potential on-farm improvements, (c) conveyance efficiency associated with existing facilities, and (d) existing maintenance and methods for the management and delivery of water. The results of this work provided the following conclusions:

(a) Measurements of operational waste indicated a loss of over 3,500 acre-feet during the 2008 water year.

(b) Diversions from the river of approximately 6.8 acre-feet per acre of irrigated land are required to meet the present needs of the KID. Improvement in irrigation application efficiency may reduce the diversion requirements significantly. Conversion to more sprinklers (~60% of irrigated acres) and gated pipe (25% of irrigated acres) will reduce the diversion requirements to 5.6 acre-feet per acre or a reduction of approximately 20%.
(c) At several locations within the delivery canal, existing facilities tend to constrict the flow of water thereby increasing water surface elevations, decreasing water velocity, and promoting the growth of algae. Recommendations were provided to improve the conveyance efficiency. These improvements included:

- Reshaping the 4,900 feet of the irrigation ditch
- Replacement/enlargement of three (3) crossing structures
- Removal of five (5) check structures
- Lowering/replacement of the existing concrete liners (3); or alternatively reshaping the irrigation ditch upstream of the liners

(d) Existing operation, maintenance and management procedures should be reviewed and consideration given to the following items:

- Orders for water should be routinely placed with the ditch rider and recorded.
- Farm turnout gates and associated check structures should be adjusted by the ditch rider to promote the delivery of water to the individual users. Adjustments to the farm turnouts/check structure should be the sole responsibility of the ditch rider.
- Measurement facilities should be considered at every farm turnout structure. Installation of these measurement devices would ensure equitable distribution of water to all users. Records of the delivery to each turnout structure should be maintained and assessments made in accordance with the water deliveries.
- Maintenance activities involving ditch excavation/dredging should be closely monitored to preclude excessive lowering of the ditch invert.
- Future maintenance projects should involve reshaping the ditch section including raising the ditch invert along with establishment of a bottom width ranging from 6 to 10 feet and sideslopes of 2H:1V. This effort may preclude the requirement to lower the existing concrete liners specified above.

V. SYSTEM AUTOMATION

The automation study focused on the improvements that would reduce operational waste and improve the management and delivery of irrigation diversions. Results of the investigation identified six sites for automation by the KID. Three (3) sites involve the automation of existing slide gates along with monitoring the water levels. These sites include the canal headgate, Wasteway No. 3 near the Kirby Creek Siphon, and the Tail End Wasteway. Three (3) sites were identified for monitoring the water surface elevation in the irrigation ditch and included the following locations: (a) WSEO gage, (b) Wasteway No. 1, and (c) Wasteway No. 2. A mobile base station is also included in the automation system.
VI. STORAGE/RE-REGULATION RESERVOIRS

Six storage/re-regulation reservoirs were identified and evaluated as a means to better manage irrigation deliveries and operation waste, along with the opportunity to store surface water during the non-irrigation season. Based on the relatively high total project cost associated with construction of the reservoirs, combined with the annual cost of pumping (4 alternatives included pumping for storage or evacuation), no reservoir alternatives were recommended for implementation.

VII. GIS MAPPING

During the completion of this study, GIS mapping and a project database was developed to facilitate the planning process, document the inventory of structures, and provide data to promote the operation and management of water deliveries as well as the implementation of planned improvements. The GIS was developed within the ArcView 9.2 environment which allow viewing/editing of the data along with integration of customized navigation and search tools. To facilitate viewing of the database by the KID, the project GIS was also modified to be compatible with ArcExplorer.

VIII. REHABILITATION MASTER PLAN

The rehabilitation master plan was formulated to identify practical and economic improvements associated with structure rehabilitation or replacement including canal lining; operation and irrigation efficiency as well as management/maintenance operations, and automation of structures. Through the completion of this project along with input received from the KID landowners and board members, 20 improvements to existing structures within the KID have been identified and prioritized for replacement or rehabilitation. Two (2) additional projects have been included to mitigate potential seepage in the vicinity of Cochran Point (Lined Reaches 2 and 3). Of these 22 projects, 10 were included in the master plan and prioritized for replacement or rehabilitation. The total project costs to rehabilitation/replacement these structures is estimated to exceed $359,300. Rehabilitation of these structures increases the longevity of the irrigation delivery system, and reduces the risk of loss and associated economic hardship for all water users.

The rehabilitation plan also included improvements associated with operational and irrigation efficiency, automation of existing facilities, and re-regulation storage. These improvements are itemized below.

- Eleven (11) projects are earmarked to improve operation and irrigation efficiency. Total project costs for implementation of these improvements were estimated to be $464,345.
- Six (6) sites were identified for automation. The total cost for installation of these sites, including a mobile base station, was estimated to be $242,900.
One re-regulation reservoir was included in the rehabilitation plan, Kirby Ditch Re-regulation Reservoir #2, with a total project cost estimated to be $530,000. As indicated previously, no reservoir storage projects were identified in the implementation plan due to relative magnitude of the total project costs along with annual costs related to pumping.

IX. IMPLEMENTATION PLANNING

The total cost of the construction projects identified in the rehabilitation master plan is estimated to be approximately $1.61 Million. Given the total cost associated with these improvement projects, development of an implementation plan focused on those projects assigned as high priority (priority 1) and included consideration of the following factors:

(a) reducing the risk of failure of existing structures and subsequent loss of income related to the inability to deliver irrigation water;
(b) benefits related to potential conservation of water, including the increase in potential crop production and income to the KID water users; and
(c) the ability of the water users to pay for construction of the proposed improvements.

In recognition of these considerations, an implementation plan for construction of the improvements identified as a high priority in the master plan was developed. The plan consists of two phases of construction. The first phase involves seven (7) structure rehabilitation/replacement projects. The second phase includes a conveyance efficiency project and four automation projects. A summary of the two implementation planning phases is provided in Tables 1 and 2.

X. FUNDING STRATEGY AND ECONOMIC ANALYSIS

The economic analysis focused on identification of alternative funding sources and funding strategy. Alternative funding sources are largely related to federal and state programs. Federal programs include those related to the BOR, USDA/NRCS, and USCOE. Potential funding opportunities exist from these federal sources. However, limitations associated with funding levels, competition for funds, availability of funds and the timeframe to obtain these funds, prevents consideration for immediate availability in a funding strategy.

Several state programs may be applicable to fund improvements identified in the rehabilitation plan. Funding sources include the Wyoming Department of Environmental Quality (DEQ), WWDC, Office of State Lands and Investments (SLIB), and Wyoming Business Council. DEQ funding is considered limited and typically focuses on water quality issues. The Wyoming Business Council through the Community Development Block Grant Program also offers limited funding. The SLIB program lends itself more readily to construction of on-farm
Table 1. Total Implementation Phase I Project Costs.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Plan Component</th>
<th>Component Project Number</th>
<th>GIS Identifier</th>
<th>Structure Type</th>
<th>Station (feet from headgate)</th>
<th>Cost of Project Components</th>
<th>Engineering (10%)</th>
<th>Subtotal</th>
<th>Contingency (15%)</th>
<th>Total Construction Costs</th>
<th>Final Plans/Specifications</th>
<th>Permitting and Mitigation</th>
<th>Legal Fees</th>
<th>Access and Right-of-Way</th>
<th>Total Project Cost</th>
<th>33% Loan</th>
<th>Annual Payment(1)</th>
<th>Assessment(2)</th>
<th>(Cost/Acre)</th>
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<tbody>
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<td>Ditch Headgate</td>
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<td>Lined Reach 5</td>
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<td>Lined Reach 2</td>
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<td>KID-UI-005 to KID-UI-006</td>
<td>Lined Reach 3</td>
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<td>$0</td>
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</table>

(1) Annual payment based on 33% loan, 4% interest, term of 20 years.
(2) Assessment based on assess acreage of 3,196 acres

Total Phase I Cost $300,316 $99,145 $7,295 $2.28

Table 2. Total Implementation Phase II Project Costs.

<table>
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<tr>
<th>Priority</th>
<th>Plan Component</th>
<th>Component Project Number</th>
<th>GIS Identifier</th>
<th>Structure Type</th>
<th>Station (feet from headgate)</th>
<th>Cost of Project Components</th>
<th>Engineering (10%)</th>
<th>Subtotal</th>
<th>Contingency (15%)</th>
<th>Total Construction Costs</th>
<th>Final Plans/Specifications</th>
<th>Permitting and Mitigation</th>
<th>Legal Fees</th>
<th>Access and Right-of-Way</th>
<th>Total Project Cost</th>
<th>33% Loan</th>
<th>Annual Payment(1)</th>
<th>Assessment(2)</th>
<th>(Cost/Acre)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Conveyance Efficiency</td>
<td>NA</td>
<td>Reconfigure Ditch</td>
<td>0+00 to 49+14</td>
<td>$55,000</td>
<td>$5,500</td>
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<td>$9,075</td>
<td>$69,575</td>
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<td>KID-MD-001</td>
<td>Canal Headgate</td>
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<td>KID-MD-011</td>
<td>WSEO Gage</td>
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<td>$200</td>
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<td>Automation</td>
<td>KID-WW-004</td>
<td>Tail End Wasteway</td>
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<td>$44,200</td>
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<td>Mobile Base Station / Software</td>
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(1) Annual payment based on 33% loan, 4% interest, term of 20 years.
(2) Assessment based on assess acreage of 3,196 acres

Total Phase I Cost $221,775 $72,186 $5,385 $1.68
improvements, individual loans are limited and the terms of the loan are less attractive than those offered through the WWDC. The WWDC through its Level III Development and Rehabilitation Program offers the most attractive funding opportunities involving 67% in grant money with 33% in loans. In addition, funding available through the Small Water Projects program offers an opportunity to partner with other funding sources on small projects with more immediate implementation.

The funding capability of the KID must also be considered for the implementation plan to move forward. Financial contribution from the KID largely reflects raising existing assessments to undertake debt retirement from funding obtained through sources such as the WWDC. The KID has indicated a willingness to consider raising assessments and the incurrence of debt.

Given the magnitude of the total project costs associated with Phase I and II of the implementation plan, an evaluation of the existing assessment along with the assessment associated with the implementation of the Phase I was conducted. The evaluation included the following scenarios:

- **Scenario 1**: ability of the existing assessment to satisfy the expenses associated with the operation and maintenance of the KID facilities.
- **Scenario 2**: assessment necessary to fund the implementation of Phase I of the implementation plan.

The existing assessment consists of an O&M assessment of $8.50. The KID also assesses users an additional $1.00 per acre and $0.50 per acre to service its two existing loans through the WWDC. Consequently, KID users currently pay a total assessment of $10.00 per acre. Based on an annualized evaluation of expenses versus revenues, a modest surplus of $5,310 presently exists within the KID.

A financial planning model was developed and utilized as a tool to evaluate each scenario through balancing the annual expenses and revenues. The analysis was conducted for years extending from 2010 to 2040. During this time period, O&M expenses were assumed to increase an average of 2.0% per year to account for inflation. Given the modest surplus, an increase in assessment was identified as a means to balance future expenses and revenues for Scenario 1. The assessment increase included a first-acre assessment of $50 as indicated in Table 3. In addition, continuation of the loan assessments following retirement of each loan obligation was required to balance expenses and revenues. Consequently, in addition to the first acre assessment of $50, a per-acre assessment is necessary and ranges from $9.50 to $10 per acre.

Scenario 2, implementation of Phase I improvements assumed WWDC funding (67% grant/33% loan) for structure rehabilitation/replacement. Total assessment increases for Scenario 2 are also presented in Table 3. Balancing expenses and revenues for Scenario 2 requires a project assessment for structure rehabilitation/replacement projects of $1.50 beginning in 2012 and ending in 2032, thereby resulting in a per-acre assessment ranging from...
$10.00 to $11.50. In addition, the first-acre assessment of $50 is necessary in 2010 along with an increase of $25 in 2020.

Table 3. Results of Economic Evaluation.

<table>
<thead>
<tr>
<th>Year</th>
<th>First Acre Assessment</th>
<th>WWDC Loan Assessment</th>
<th>O&amp;M Assessment</th>
<th>Total Assessment ($)</th>
</tr>
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<tr>
<td>2009</td>
<td>$0</td>
<td>$0</td>
<td>$1.50</td>
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<tr>
<td>2010</td>
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<td>2015</td>
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<tr>
<td>2018</td>
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<td>2020</td>
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<td>2025</td>
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<tr>
<td>2040</td>
<td>$0</td>
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Scenario 2 - Phase I Implementation

<table>
<thead>
<tr>
<th>Year</th>
<th>First Acre Assessment</th>
<th>WWDC Loan Assessment</th>
<th>O&amp;M Assessment</th>
<th>Total Assessment ($)</th>
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<td>2009</td>
<td>$0</td>
<td>$0</td>
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<td>2010</td>
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XI. RECOMMENDATIONS

Based on the foregoing information, the following recommendations are provided for consideration.

- Existing expenses versus revenues should be balanced through an increase in the assessment.
Increase the existing assessment through a first-acre assessment and an increase in the O&M per-acre assessment in accordance with the information in Table 3.

Initiate the implementation of Phase I improvements as indicated for Scenario 2.

Irrigation water is presently delivered through cooperative management among all water users. Individual water users control their respective check structures and turnout headgates. Historic maintenance of the ditch has resulted in lowering of the ditch invert and hydraulically inefficient channel sections. During the completion of this project, it was noted that many of the problems presently experienced by the KID water users may be alleviated through revisions to the existing operation, maintenance and management procedures. Serious consideration should be given to the items previously discussed including the following:

- Orders for water should be routinely placed with the ditch rider and recorded.
- Adjustments to the farm turnouts/check structure should be the sole responsibility of the ditch rider.
- Measurement facilities should be considered at every farm turnout structure. Records of the delivery to each turnout structure should be maintained and assessments made in accordance with the water deliveries. The installation cost for these devices is estimated to be $65,550; funding for the materials may be obtained through the WWDC or other funding sources.
- Maintenance activities involving ditch excavation/dredging should be closely monitored to preclude excessive lowering of the ditch invert.
- Future maintenance projects should involve removal of flow obstructions, followed by reshaping the ditch section. This work will likely include raising the ditch invert along with establishment of a bottom width ranging from 6 to 10 feet and sideslopes of 2H:1V.

Revising the methods of water delivery will promote equitable distribution of irrigation water to all water users. In addition, monitoring of future ditch excavation, along with reshaping of the channel section, will improve the hydraulic efficiency of the conveyance facilities. It should be noted that potential increases in the water level may be created by the reshaping the ditch section; however, a reduction in water level afforded by construction associated with removal of flow obstructions may offset these increases. Should the existing diversion dam require rehabilitation due to potential increases in water level created by the recommended improvements, the height of the dam should be more fully evaluated and coordination conducted to ensure the maximum diversion of its water right under state water law as well as compliance with the 1969 court judgment.