EXECUTIVE SUMMARY

WYOMING WATER DEVELOPMENT COMMISSION

WILLWOOD IRRIGATION DISTRICT
MASTER PLAN
LEVEL I STUDY

May 2006
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Prepared for:

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EXECUTIVE SUMMARY

This Level I study was initially requested to review existing facilities and develop recommendations for improvements in order to upgrade the Willwood Irrigation District’s system. The District’s goals were to develop projects that will help them improve water supply management and water conservation abilities.

The project focus is on the preliminary design of flow measurement devices that will assist the District in managing the water supply better and potentially conserve water or improve water deliveries. Three flow measurement structure designs were incorporated into the project: one that will be used in the main canal in multiple locations, one that will be used off-channel in multiple laterals, and one that will be used in existing lined ditch delivery laterals.

In addition to the flow measurement focus, the study included the preliminary design of two pump stations that would transfer irrigation return flow water from drainage ways into adjacent laterals thereby creating what is sometimes called a pump-back system. These transfers would allow reduction in diverted water at the head of the lateral by supplying irrigation return flow water from the drainage way to tail end users, thus improving delivery consistency and overall operation efficiency for the District.

The Level I project includes recommendations for improvements, creation of a District GIS map and database, preliminary design of flow measurement structures and pump stations, cost estimates, economic analysis, environmental analysis and water quality testing results, and system operations recommendations.

The goal of this study is to provide Willwood Irrigation District with a plan to proceed with project recommendations. Recommendations range from conducting additional studies, performing field tests and flow monitoring, and constructing flow measurement structures.

A. PROJECT BACKGROUND

The Willwood Irrigation District is located in Willwood, Wyoming which is immediately south of Powell, Wyoming. The District is primarily in Park County and extends east into Big Horn County, just east of Highway 32. The Shoshone River borders the District to the north. Figure 1.1 below shows the project site in relation to the State of Wyoming.

The Willwood Irrigation District (also referred to herein as the District and WWID) is responsible for the operation and maintenance of irrigation facilities within the Willwood Division of the Shoshone Project, which is part of the Great Plains Region, U.S. Department of the Interior Bureau of Reclamation. Water is diverted from the Shoshone River at the Willwood Diversion Dam into the main canal. The main canal is approximately 25 miles long and runs generally east from the dam. There are about 53 miles of distribution laterals. The District has 54 miles of open drains and 19 miles of closed drains, most of which discharge back to the Shoshone River.

The District serves approximately 11,426 acres. There are 152 water users in the District boundaries and 231 farm turnouts throughout the system. According to the District, the system was designed for 320 cubic feet per second (cfs) peak delivery but in practice
they can deliver flows as high as 400 cfs. The system has both river and reservoir rights based on the “state allotment”. There is very little irrigation tail water left at the end of the canal.

B. EXISTING SYSTEM INVENTORY

The Existing System Inventory task included collected data at each of the proposed flow measurement locations and the proposed pump station locations. Three locations on the main canal were selected by the District as the priority locations for flow measurement:

- Main at Loepper Siphon (just downstream of the siphon)
- Main at Lateral 70 (just downstream of the Lateral 70 headgate)
- Main at Lane 14 (just upstream of the bridge for Road 14)

Four laterals were identified as preferred flow measurement locations:

- Lateral 40
- Lateral 57
- Lateral 70
- Lateral 84

Two potential pump station sites were identified and elevation and dimensional data was collected at each site. The two locations identified and developed in the preliminary design of the pump stations were:

- Lateral 57 pump station (immediately north of Hwy 295 where Willwood Draw crosses the Highway)
- Lateral 84 pump station (approximately 1 mile north of Highway 295 on Road 5).

Photos were taken and site maps were compiled for the flow measurement and pump station locations. The report includes a map that shows the proposed flow measurement and pump station sites.

The District’s most important single structure is the Willwood Diversion Dam. The dam was built across the Shoshone River and diverts water into the Willwood Main Canal. This structure is 81 years old. A study completed in 1989 outlined many recommendations for improvements at the dam. Several of these improvements have been made, and several have not. In particular, the District overhauled the canal gates with new seals around 1995 and the canal outlet works and tunnel are inspected annually and reported to be in good shape. Through our observations of the dam, review of previous reports, and discussions with the District, we have the following comments and recommendations to make regarding this 81-year-old concrete, gravity, ogee weir dam:

- Deteriorated concrete abutments and bank erosion behind the concrete need to be rehabilitated.
- Two of three sluice gates not functional and should be repaired or replaced.
- Siltation upstream and downstream of dam must be removed. Dredging the areas upstream and downstream of the dam will be important to create a “fresh start” along with improvements to the gates.
• River control during construction and dredging may be a significant undertaking and should be carefully considered as part of a rehabilitation plan.
• Turbidity test sites and permanent facilities may be beneficial and should be investigated. Automated water quality sampling is one option to consider.
• The single lane road over the dam is a safety concern. The District should continue to coordinate with other governing authorities (USBR, County, etc.) to resolve concerns or close the road to through traffic.
• A Level II Study is recommended to address the issues described in this report.

The Willwood Irrigation District conveyance system includes several structures that were originally constructed during the period of 1924 to 1927. Many of the current structures on the system are the original construction and display signs of aging and deterioration. The report includes descriptions and photos for a few examples of the major components in the conveyance system that should be further assessed in detail as part of a Level II study.

A Geographical Information System (GIS) was developed from the field inventory data collected by the project team as well as from spatial data developed by others. GIS is used to analyze, store, and manipulate data that is tied to a spatial display on a map. The electronic files were submitted with the final report so the District can build upon the base map and database to suit their needs in the future.

C. SYSTEM REVIEW AND CONCEPT DESIGN

Regardless of the approach, flow measurement is essential to successful and equitable operation of a canal system. It is important to understand flows at the river diversion and at varying locations throughout the canal system.

Flow measurement options were discussed and compared in detail in the report. Specifically, the Parshall flume, the long-throated flume, and sharp crested weirs were evaluated.

**Conceptual Designs of Long-throated Flumes**

Flow measurement is vital to many aspects of the Willwood Irrigation District conveyance and management systems. Based on discussions with the District and site visits to the desired flow measurement locations, it is recommended that the District use long-throated flumes as a standard measurement structure. Of various flow measurement devices considered, the long-throated flume will effectively and accurately measure the flow required for the main canal, laterals, and farm laterals.

Using the design criteria for the District’s canals and laterals, three typical long-throated flumes were designed that would meet the requirements of all three sites along the main canal, all four lateral sites, and a typical farm lateral. WinFlume is the computer program developed by the U.S. Bureau of Reclamation, the Agricultural Research Service, and the International Institute of Land that was used for these designs. The software aids in the design of long-throated flumes based on parameters provided to the program and calculations using pure hydraulic theory. Based on the parameters discussed in the report, three standard long-throated flumes were designed that would accurately
measure the flows at each location. Preliminary details were developed and are included in the report appendix.

**Conceptual Retrofit Designs at Existing Lateral Structures**

Another flow measurement alternative was discussed with the District: the possibility of using the existing lateral concrete structures as flow measurement devices. The current structures are concrete and built so as to become Cipolletti contracted weirs. Field data was collected at the sites of the existing structures immediately downstream of each lateral headgate. For Laterals 40, 57, and 84 it is possible to measure the flow using a Cipolletti weir plate placed on the existing concrete structures. Preliminary designs for retrofitting the existing concrete structures with new Cipolletti weirs were developed and are included in the report appendix.

**Conceptual Designs for Transfer Pump Stations**

The Willwood Irrigation District requested the preliminary design and evaluation of two pump stations with this project. The pump stations would be strategically located to capture irrigation return flows from existing drainage ways. The pumps would then transfer the water from the drainage way into the nearby lateral. The supplemental water entering the lateral would either provide additional water to benefit downstream users on the lateral, or it would allow a reduced diversion at the headgate of the lateral which might benefit other users on other laterals within the District.

This pumped-back water would be saved and reused within the District’s boundary and before the water leaves the District’s dominion and control. The District should verify with the Wyoming State Engineer that the proposed pumping plan is allowable from a water rights perspective prior to continuing to a Level II study.

Pump station design requires two primary design criteria: flow and pressure. Based on these two design criteria, the pump station (including the pumps, pipes, and valves) can be sized to meet the demands of the situation.

The seasonal drainage way flow is the key design criteria in the design and operation of the proposed pump stations. Without records of flow data, it is impossible to know the normal flow rate, the minimum and maximum flow rates, and the frequency of each of those threshold flow rates. Using information collected during site visits, the normal flow rates have been roughly estimated and are the basis for the preliminary design.

The pump station sizes, recommended system approaches, inlet structures, and outlet structures are all included in the preliminary designs of the report.

**SCADA Possibilities**

As many canals are modernized, an appropriate technology for consideration is Supervisory Control and Data Acquisition (SCADA) to provide either monitoring or both monitoring and control (gate actuation, pump operation) of canal operations from a centralized location. Data and information such as canal flows and reservoir storage level data can be easily obtained and monitored for both management personnel and water user access.
The current cost of SCADA implementation has decreased in recent years to a price point where SCADA is affordable and useful to irrigation districts. SCADA can provide a lot of cost effective features which result in significantly improved canal operations, improved deliveries to irrigators, and reduced liabilities.

We recommend that the District implement a server based and internet accessed SCADA capability. First phase implementation of such a system would cost approximately $39,200 for the central computer hardware and software and approximately $5,300 to $12,000 for each actuated and monitored site. The higher end of the site cost is driven by the cost of an actuator to be added to an existing canal gate. We have estimated the cost of the actuator at approximately $6,000 based on the experience of other districts.

If this approach were of interest, it is recommended that central computer hardware and software be budgeted at $18,000 and individual monitored sites (the new long-throated flumes conceptualized in the report, for example) could be added at a budgetary cost of approximately $3,750 each.

D. PERMITTING AND ENVIRONMENTAL OVERVIEWS

Permitting Overview

Several of the specific projects listed in the report may warrant special permitting consideration prior to implementation and construction. An overview of potential permitting requirements was provided for the following sites:

- Lateral 57 Pump Station
- Lateral 84 Pump Station

The following agencies were contacted about permitting issues:

- Wyoming Department of Transportation
- Park County
- Wyoming State Engineer’s Office
- Wyoming Department of Environmental Quality
- US Army Corps of Engineers
- Wyoming State Historic Preservation Office

Although the report provides considerable detail on permitting issues related to these study sites, much of the material presented will likely apply to other projects the District proposes in the future. A general overview of each permitting issue was presented.

Easements, water right permits, storm water discharge permits, US Army Corps of Engineer’s 404 Section permits, and cultural resources permits were reviewed as part of the report.
Environmental Overview

In addition to special permitting considerations, several of the projects identified may also have specific environmental concerns associated with implementation and construction. An overview of potential environmental issues was provided.

Although the report provides details on the environmental issues related to specific sites, much of the material presented will likely apply to other projects the Willwood Irrigation District proposes in the future. A general overview of each issue was presented.

The environmental elements reviewed for this study included fish and wildlife, wetlands, and National Environmental Policy Act (NEPA).

E. WATER QUALITY ANALYSIS

The primary purpose for the water quality testing and analysis in this study was to establish a base water quality profile for the District. Water quality samples were collected at three locations in the District two separate times during 2005 irrigation season. An analysis of the results examined the significance of each water quality constituent as they relate specifically to the suitability of the water for irrigated agriculture. The constituents tested and analyzed included: chloride, nitrogen, sodium ion, sodium and calcium ratio, electrical conductivity / total dissolved solids, and pH.

All test results were within or below guidelines for irrigated agriculture; however, there was a notable trend. Almost all water quality parameters tested are higher in concentration at the end of the Willwood Canal system in the drainage water and towards the end of the irrigation season. The most likely reason for this trend has to do with the location of irrigation return flows and total flow volume.

The District should consider continued monitoring of the water quality into the future, at least several times before, during, and after the irrigation season. This will help to better understand trends and evaluate potential lasting impacts.

F. OPERATING PLANS

The operating plans presented in this report included elements of a System Operations and Maintenance Plan, GIS Map Tool, Flow measurement structure, pump stations, and SCADA system.

The System Operations and Maintenance Plan proposed ideas for improved administrative management, best management practices, structure rehabilitation schedules, and drought response planning.

We recommend the District invest in the procurement of GIS software and a computer suitable to running GIS. A base GIS map and database have been created as part of this project. The Willwood Irrigation District can easily expand GIS into a working tool. The District may want to consider the potential use of the GIS system including: Structure Maintenance and Improvement Plans, Water Rights and Assessment Base, and Water Delivery Accounting. The capabilities of GIS for better canal management are virtually endless. If a GIS system is desirable for the District, the most important thing to consider is the ultimate goal and desired future management capability of the District.
Operations and annual maintenance of the proposed long-throated flumes and retrofit Cipolletti weirs are included in the report. These recommendations are intended to assist the District in maintaining the structures in order to achieve accurate flow measurements and to increase the longevity of the structures.

A description of the proposed operation for the transfer pump stations is provided. Additionally, an estimated annual electrical cost range has been completed based on varying operational hours. Depending on the volume of water pumped and the frequency of operations, the anticipated annual electrical costs could range from $1,775 to $30,810.

G. COST ESTIMATES / ECONOMIC ANALYSES

Implementation of the recommendations presented in the report will help improve water delivery, system operations, and overall efficiency for the District’s water users. The costs of a particular improvement may determine whether or not the District pursues that recommendation.

Cost estimates for each preliminary design are shown in Table 9.1 of the report. The table presents a “shopping list” of all preliminary designs included in the report. The District can review and pick the most desirable structures to implement individually. This table also shows the anticipated total loan from WWDC, the annual loan repayment, annual cost per acre, and total cost per acre. The calculations are based on the total service area of Willwood Irrigation District, which is approximated at 11,426 acres.

If the District pursues the recommendations stated in this report, they may continue to receive assistance from the Wyoming Water Development Commission (WWDC). The District should request a Level II study through WWDC to further define the options and costs associated with the Willwood Diversion Dam, pump stations, and the other structures discussed in this Level I Study. Regarding the flow measurement recommendations, the District should proceed with application to WWDC for Level III, final design and construction.

Construction funding is available from WWDC as a 33/67 loan to grant split. WWDC will provide the District with a grant of at least 67% for construction improvements of the existing main canal system. The remaining 33% of the construction cost can be a concessionary-rate loan from WWDC. Current terms for these loans are 20 years at an annual interest rate of 4%.

H. RECOMMENDATIONS

The goal of this study was to provide Willwood Irrigation District with recommendations and a plan to proceed. Recommendations range from performing field tests and flow monitoring, constructing flow measurement structures, and conducting additional studies.

Specific recommendations resulting from this Level I study follow:

1. Maintain the ArcView GIS map and utilize GIS in the future as a maintenance and planning tool.
2. Request a Level II Study from the Wyoming Water Development Commission (WWDC) to include an in-depth review and preliminary designs of improvements at the Willwood Diversion Dam.

3. Begin working with all entities with interests in the Willwood Diversion Dam in preparation of funding and cooperation for improvements resulting from a Level II study.

4. Request a Level II Study from the WWDC to include an in-depth review and preliminary designs of improvements for several of the major infrastructure components on the main Willwood Canal as described in this report.

5. Install the long-throated flumes recommended in this report, beginning with the flumes on the main canal. Final design (including detailed survey and analysis of upstream water level) for specific sites is necessary and should be included in the Level III project, requested from the WWDC, along with construction funding.

6. Determine the preferred flow measurement device at Laterals 40, 57, and 84: long-throated flume or retrofit Cipolletti weirs. Complete final designs for specific sites and begin installation of the selected device in the laterals.

7. Start installing farm lateral long-throated flumes as opportunities arise.

8. Monitor the flow rates and frequencies in the drainage ways adjacent to the proposed pump stations. Further investigate the pump-back concepts described in the report and determine the value of a pump-back system to the District based on the available water for pumping.

9. Consider implementing a SCADA system with a central computer and hardware and software interface at the District’s office. Include SCADA at future individual sites such as the future long-throated flumes.

10. Continue monitoring the water quality within the District as outlined in this report or at other locations to develop a database.

11. Implement operational plans that are appropriate for the District and which are not already be in place.