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EXECUTIVE SUMMARY

WYOMING WATER DEVELOPMENT COMMISSION

CODY CANAL IRRIGATION DISTRICT REHABILITATION AND HYDROPOWER LEVEL II STUDY

May 2006

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EXECUTIVE SUMMARY

CODY CANAL IRRIGATION DISTRICT
REHABILITATION AND HYDROPOWER
LEVEL II STUDY

Prepared for:

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Cheyenne, WY 82002

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With Subconsultants:

May 2006
EXECUTIVE SUMMARY

This Level II study was initially requested to review the District’s existing facilities and develop recommendations and preliminary designs for improvements. The potential failure of key structures such as the Sulphur Creek Flume was the driving force behind initiating this project. Failure of one of several flumes could result in a complete disruption of the canal system deliveries until repairs could be performed. The District believes the Sulphur Creek Flume is in fact the most critical structure in the entire system.

The project focus is on existing system inventory and conceptual designs. However, the study entails a number of equally important tasks:

- Existing system inventory and mapping – problem identification
- Creation of a GIS based database and maps
- Prioritization of structural improvements
- Conceptual designs
- Modernization opportunities and SCADA potential
- Hydropower analysis for three potential sites
- Permitting and environmental analysis
- Water quality sampling and analysis
- Operating plans including emergency preparedness, lateral organization, overall system operations and maintenance plan, and urban development plan
- Cost estimates and economic analysis

Conceptualizing a strategy and plan for the District to strive towards in the next 20 to 30 years means looking beyond the structural issues that are at-hand. Out-of-the-box thinking and brainstorming beyond the status quo was a main goal of the project team. Improving local relationships, redefining services, strategizing new operating plans, conceptualizing new revenue sources, visualizing a modernized canal system, and exploring new added-value services such as pressurized dual systems are ideas presented in this study. All of these discussions are presented as a means for the Cody Canal Irrigation District to better manage their existing water supply and continue the successful delivery of irrigation water for many years to come.

A. PROJECT BACKGROUND

The Cody Canal Irrigation District (CCID, District) is located in and around Cody, Wyoming which is in Park County. The Cody Canal diversion headgates are located approximately 2 miles upstream of Buffalo Bill Reservoir. Cody Canal has water rights dating back to 1895, making this District the most senior diverter on the South Fork of the Shoshone River. The District was formed in 1911 and serves approximately 11,433 acres of land. The main canal is approximately 15 miles long and runs east from the headgate, serving the area south and east of the City of Cody. There are 14 lateral ditches and 322 farm turnouts throughout the system.

The maximum diversion right is approximately 360 cfs and the average diversions in June and July are approximately 235 cfs. There is usually about 5 to 10 cfs spilling at the end of the system. Supplies have been tight in July and August during the past five years. Otherwise, the water supply is reasonable due to the District’s senior water rights. The system has had numerous enlargements and rehabilitation efforts over the years.
There are 1,982 water users in the system based on the County Assessor’s tax roll from 2005. The minimum assessment is equal to the assessment due on five acres, regardless of the property size. The CCID customer base is increasingly urban as residential developments continue to emerge within the District’s service area.

Much of the District’s original infrastructure, dating to the early 1900’s, is still in place and much of it is in need of extensive repair, rehabilitation or replacement. The system runs off of direct flow decrees only. There are no storage rights associated with CCID decrees.

B. EXISTING SYSTEM INVENTORY

Structures within the Cody Canal Irrigation District conveyance system include headgates, checks, pumps, drops, spillways, measurement structures, and flumes. Additionally, there are many piped drainage inlets into the canals, crossings over the canals, and piped sections of the canals. Proper operation of an irrigation district is highly dependent upon the structural components within the system. Deteriorated, outdated, unstable, or unsafe structures do not permit ideal operation and limit delivery consistency. To fully understand the state of the District’s canals and structures, a complete field inventory was conducted.

The inventory was conducted by the project team during the summer of 2005. The process for collecting data was to follow each canal or lateral from head to tail, recording information at each structure. Assistance from CCID staff, including the manager and ditchriders, was crucial to the identification of all structures in the system. The data collected included photos of the structure, a Global Positioning System (GPS) data point for location, measurements of critical structural dimensions, relevant information about the structure: structure name, structure description and function, improvement ideas including SCADA opportunities, dimensions, and structure condition and improvement priority rankings. The following summarizes the ranking options:

**Structure Condition**
1. Not Functional: structure is not working and needs to be completely removed.
2. Major Repairs: major repairs needed or structure needs to be replaced.
4. Adequate: structure is adequate but needs improvements/repairs in the long term.
5. Excellent: structure is fairly new, fully functioning, and does not require repair.

**Improvement Priority:**
1. Immediate: structure is in poor condition and needs improvement soon.
2. Short Term: improvements are not needed immediately, but definitely in short term.
3. Long Term: improvements are not a big concern, but will be in the long term future.
4. Not a Concern: no discernable improvements are identified for this structure.

The purpose of this ranking was to identify, in a subjective manner, which structures were more of an improvement priority or structural concern for the District.
A total of 1,004 structures were included in the inventory of the Cody Canal Irrigation District. Table E.1 lists the structure types and the number of structures found during this project.

### Table E.1  Structure Summary

<table>
<thead>
<tr>
<th>Naming Convention</th>
<th>Type of Structure</th>
<th>Inventory Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>Check</td>
<td>96</td>
</tr>
<tr>
<td>CR</td>
<td>Crossing</td>
<td>256</td>
</tr>
<tr>
<td>DP</td>
<td>Drop</td>
<td>34</td>
</tr>
<tr>
<td>DR</td>
<td>Drain Inlet</td>
<td>29</td>
</tr>
<tr>
<td>FL</td>
<td>Flume</td>
<td>4</td>
</tr>
<tr>
<td>HG</td>
<td>Headgate</td>
<td>322</td>
</tr>
<tr>
<td>MS</td>
<td>Measurement Structure</td>
<td>10</td>
</tr>
<tr>
<td>PE</td>
<td>Pipe Section End</td>
<td>7</td>
</tr>
<tr>
<td>PM</td>
<td>Pump</td>
<td>216</td>
</tr>
<tr>
<td>PS</td>
<td>Pipe Section Start</td>
<td>11</td>
</tr>
<tr>
<td>SP</td>
<td>Spillway</td>
<td>19</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>1004</strong></td>
</tr>
</tbody>
</table>

A Geographic Information System (GIS) base map was developed from the field inventory data collected and from spatial data developed by others. A total of thirty-four individual 11x17 plots were created to show the structural inventory of the Cody Canal system. Each map shows a segment of a lateral or main canal, with the associated GPS points collected in the field.

### C. SYSTEM REVIEW AND CONCEPT DESIGN

#### Prioritization

Following the system field inventory, a system of prioritizing improvements was developed. The recommendations are based on a combination of the two ranking factors: structure condition and improvement priority. By combining the total number of pairings between the two ranking categories, a total of 19 possible priority levels can be developed and are defined in the report (there are four Priority Categories, and four or five Priority Levels within each Priority Category).

Each Priority Category corresponds to a recommended time frame for completing the replacement of the structure. The immediate improvements in Category #1 should be completed in the next five years, followed by improvements in Category #2 in years 6 through 10. Long term improvements in Category #3 are defined as years 11 through 20 and Category #4 improvements should be considered for future replacement beyond 20 years. Within each Priority Category, the recommended improvements should be completed from the first through the fifth priority level.

There are a total of 14 structures in the Priority #1 Category (including four priority levels), 102 structures in the Priority #2 Category (including five priority levels), 224 structures in the Priority #3 Category (including five priority levels) and 212 structures in the Priority #4 Category (including five priority levels). Additionally, 456 structures were listed as “NA” for the improvement priority, meaning that an improvement priority has no meaning to the canal operations or that structure.
Conceptual Structural Designs
Several types of structures were identified as needing preliminary designs. The “typical” structures are described in the report along with preliminary design details. Typical designs included check structure, headgate, pump system intake, spillway, drop structure, and long-throated flume.

Five preliminary designs for the check structure were developed to provide the District with several alternatives. The District may select one, or several, of the designs as their standard structure for implementation throughout the canal system. The five preliminary designs included a standard concrete pier check (similar to existing structures in the system), a steel removal pier check (similar to the USBR check already in the system), a duck-billed weir check, a single manual overshot gate check, and a multiple manual or automated overshot gate check. Three headgate preliminary designs were developed to provide some variation and selection for the District.

Several structures required more detailed preliminary design considerations as part of this study. The Glory Hole Drop was evaluated and a new concept design was developed for its eventual replacement. The design included a 12 ft wide by 4 ft deep concrete chute. The beginning of the chute would begin approximately 15 ft upstream of the drop, immediately downstream of the Zinn Lateral headgate. The new chute design would incorporate a new check structure as well. Concrete floor blocks at the outlet would help minimize turbulence at the bottom of the chute.

The Newton Avenue Drop was one of three locations considered for a potential hydropower plant. Because it did not meet the screening requirements for hydropower generation, a new concrete chute preliminary design was developed. The design includes a new concrete inlet, outlet, and 2.5 ft wide by 1.5 ft deep concrete chute. Engineered and compacted fill below the chute will be necessary. The side slope of the hill will need to be regarded. The inlet design considered controlling the depth of the water in the chute to reduce the erosion in the upstream natural channel. Repair of the upstream bridge wing walls and rip rap in the channel are additional alternatives that would enhance this section of the ditch.

Diamond Creek Flume and Sulphur Creek Flume were surveyed as part of this study in order to develop fairly detailed preliminary designs for alternative replacement options. For each flume, one option included backfilling the creek and installing a concrete lined ditch above the creek. For these options, culverts would be placed in the creek and soil backfilled to the required elevation to build the concrete ditch. A second option for each flume was to construct a siphon. Both alternatives are described in the report along with advantages and disadvantages for both. Additionally, for the Diamond Creek Flume, a polyurea coating is presented in the report as another option.

For Diamond Creek, approximately 2,300 cubic yards of fill would be required for the concrete lining alternative. For Sulphur Creek, approximately 35,200 cubic yards of fill would be required. The Diamond Creek siphon would be a single 66-inch diameter RCP pipe; or two parallel 48-inch diameter RCP pipes. The Sulphur Creek siphon would be a single 60-inch diameter RCP pipe. A trash grate at the inlet and manhole at the bottom are recommended for both siphons. A siphon is self-cleaning when designed properly. By constructing a concrete inlet and concrete outlet, siphon velocities can be as high as 10 fps. The minimum required cleaning velocity is approximately 3 fps. High velocities
keep the sediment suspended so it can continue through the siphon and pass the concrete outlet.

**Re-regulating Reservoirs**

Re-regulating reservoirs are discussed in the report as a possible additional structure and management tool within the Cody Canal Irrigation District. Capturing excess canal flows and releasing them as needed can assist the District in overall management and delivering consistent flows. Five potential sites were reviewed.

**SCADA Potential**

Supervisory Control and Data Acquisition (SCADA) operations and opportunities are discussed in the report. There are multiple levels at which SCADA can be implemented. Beginning with monitoring only, and then expanding the initial system to other sites and adding capability and features to sites is quite appropriate. Each level results in increasing capability within the SCADA system, but each level costs more. The additional cost is largely at the remote sites, not at the central workstation. The central workstation becomes a fixed cost except for human-machine interface (HMI) upgrades and the inevitable computer hardware upgrades or replacement over time.

First phase implementation a SCADA system for the District would cost approximately $39,500 for the central computer hardware and software as the backbone of the system. The cost for remote sites would range from approximately $5,295 to $11,000. The lower end of the site cost projection assumes monitoring of water surface levels and the higher end considers actuated gates with an actuator that may cost $5,000 or more depending on the requirements. It should be noted that there would be an economy of scale to be realized with any implementation phase that approaches or exceeds $100,000.

**Hydropower**

Three sites on the Cody Canal system were identified for investigation for hydropower feasibility. These three sites were the Purvis Drop, Sulphur Creek Drop, and Newton Avenue Drop. The purpose of portion of the study was to screen the sites to those that were promising enough to perform more detailed preliminary design, cost estimates and financing. Available head and flow were determined or estimated for each site in order to conduct necessary calculations for the evaluation.

The feasibility investigation of the Purvis Drop, Sulphur Creek Drop, and Newton Drop indicated that only the Purvis Drop would justify further analysis. The power price and revenue needed to make the Sulphur Creek and Newton Avenue Drops feasible is beyond that currently available.

The Purvis Drop was advanced to preliminary design to develop more accurate cost estimates. The potential hydropower revenues were investigated to maximize revenues. Funding scenarios were investigated to determine if the Purvis Drop could be financially feasible. The diversion structure from the existing canal to the pipeline must be designed to transition the flow without creating a constriction. This structure would be a concrete structure. The hydropower unit would have a maximum 1,660 kw output. The head and flow conditions indicate that a Francis-type turbine would be appropriate.
Dual Systems
As Cody Canal Irrigation District continues to see urbanization pressure within the service area, the District should keep an open mind to how to best serve these new urban customers while maintaining and improving historic operations. Development of pressurized raw water systems can occur in several ways, and the ownership, management, and ultimate replacement strategy are important factors in project success. Win-win scenarios can be achieved with dual systems because the potable water purveyor, the housing developer, the irrigation district, and the residential land owner each benefit.

D. PERMITTING AND ENVIRONMENTAL OVERVIEWS

Permitting Overview
Several of the specific projects listed in Chapter 7 warrant special permitting consideration prior to implementation and construction. The purpose of this Chapter is to provide an overview of potential permitting requirements for the following sites:

- Sulphur Creek Flume (2 alternatives)
- Diamond Creek Flume (2 alternatives)
- Six re-regulating reservoir sites (See Chapter 4, Figure 4.20)

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. Specific hydropower permitting issues were also discussed.

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 Cody Canal 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 two locations in the District, two times during the 2005 irrigation season. This section examines the significance of these results as they relate specifically to the suitability of the water for irrigated agriculture. 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.

Overall, the test results for both sites and both sampling times are within or below guidelines for irrigated agriculture. However, there is a notable trend. Almost all water quality parameters tested are higher in concentration at the end of the Cody Canal system 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. These changes in water quality should not warrant major concern on the part of the District. The District should continue to monitor water quality into the future, at least several times before, during, and after the irrigation season. This will help to better understand trends and any lasting impacts.

F. OPERATING PLANS

The report describes a series of Operating Plans to be implemented by the Cody Canal Irrigation District. These include: System Operations and Maintenance Plan, Emergency Preparedness Plan, Urban Development Plan, GIS/Information Management Plan, and a Hydropower Generation Plan. The purpose of these operating plans is to detail a methodical approach to resolving various management issues confronting the District. A background of some District operational issues is presented, including: Board of Directors, landowner participation, District staff, revenues and expenditures, and lateral ditch systems.

Approximately 10% of the District’s assessment revenue comes from water user accounts in the name of the City of Cody. The City uses its District water to supply a pressurized raw water distribution system. Staff at the City of Cody tell us that the City “is highly dependent on a functioning Cody Canal system.” This interdependence of the City and the District warrants in-depth discussion and analysis which is included in the report.

We propose a System Operations and Maintenance Plan as a coordinated and organized effort to maintain and improve the District’s infrastructure. Topics discussed in the report include: job descriptions, succession planning, maintenance practices, staff training, structure rehabilitation schedule, and easement defense. Drought response and equipment upkeep and purchase are also briefly reviewed.

While the District is not responsible for any high-hazard infrastructure (such as a dam), the possibility still exists for infrastructure failure that would threaten property and lives. In the event of a significant failure, the District should have a planned response that
includes notification of all appropriate authorities. A sample emergency procedure card is included in the appendix of the report.

Urban growth is contributing to a host of management and operational issues for the Cody Canal Irrigation District. Along with the shrinking lot sizes and increasing disturbances of the canal and its easements, urbanization also brings a changing demographic to the District landowners. As the District enters into its second century of operation, District water is used less for agricultural irrigation and more for irrigation of landscaped areas in residential subdivisions. In fact, fully 85% of the District landowners are paying minimum assessments – i.e., they own 5 acres of land or less. These landowners are less likely to depend on District water for their livelihood, and as a result are less likely to have a vested interest in the inner workings of the District’s management and daily operations. To help cope with urbanizing pressures, we are proposing a series of action items for the District’s consideration. The following action items are discussed at length in the report:

- **Goal 1: Increasing Landowner Participation**
  - Review the District’s eligibility requirements for Commissioner candidates.
  - Increase Annual Meeting Participation.

- **Goal 2: Improving Institutional Relationship with the City of Cody**
  - Provide for the City’s formal participation in District affairs.
  - Work toward resolution of easement conflicts.
  - Assess the degree to which sediment has accumulated in Beck Reservoir and prepare a plan of response.
  - Inventory the chronic maintenance problems on the laterals within the City limits.

- **Goal 3: Modifying the Relationship Between CCID and its Private Laterals**
  - Initiate lateral organization where none exists.
  - Explore Takeover of Lateral Systems.
  - Explore Abandonment of Deteriorating Laterals.
  - Institute Maintenance Agreements with Lateral Associations.

- **Goal 4: Advancing the Development of Secondary Supply Deliveries**
  - Pump Permits.
  - Phase II WWDC Study: Converting laterals to pipelines.

- **Goal 5: Developing New Revenue Streams**
  - Pump Permits.
  - Recreational Trail Development.
  - Cost Recovery (crossing permits).
  - Hydropower.
  - Dual Systems Development.
  - Provision of Construction Water.
  - Lease to non-District customers.
  - Excess Water Surcharges.
  - Maintenance Fees.

**GIS**

A GIS Inventory or Map Tool can be used to better manage all aspects of an irrigation system: from tracking assessment revenue base to accounting for water delivery to users. It is crucial for an irrigation district to use an inventory system that matches their capabilities and intended uses. The irrigation district should be fully capable of using the inventory technology on a daily basis, without a significant amount of outside technology
support. We recommend the District invest in the procurement of GIS software and suitable hardware. The most time intensive component of developing a comprehensive GIS database system was completed by this study and the field inventory team. Now that each structure has been inventoried, including each individual pump and headgate, the CCID can easily expand GIS into a working tool. The report includes several options the CCID may want to consider while selecting the degree to which GIS may be used in their system.

**Hydropower**
The owner of the hydropower facility would be responsible for operation and maintenance of the installation. The facility does not need full-time personnel for operation. Adequate alarm and monitoring would allow periodic visitation. Normal operation and maintenance requires knowledge of mechanical equipment. Typically, operators of water treatment and sewage treatment plants can adequately run the facilities. Many owners have a maintenance contract with the hydropower manufacturer

**G. COST ESTIMATES / ECONOMIC ANALYSES**

Implementation of the recommendations presented in this report will help improve the District’s current infrastructure, resulting in improved water delivery, system operations, and overall efficiency for the District’s water users. We have attempted to present a “shopping list” of improvements and their associated costs so the District can evaluate each type of structure individually as well as viewing the overall “big picture” based on quantities recommended for the first two Priority Categories. Tables 11.1 and 11.2 in the report detail the cost estimated developed during this study.

Construction funding is available from WWDC as a 33 / 67 proportional loan to grant split. WWDC will provide the District with a grant of at least 67% for construction improvements of the existing 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%.

The cost estimates for the Purvis Drop were upgraded with consideration of the preliminary design. The hydropower station costs were estimated from generalized station costs related to head. The total estimated project costs for the Purvis Drop are $4,750,000. It should be noted that the WWDC does not offer a grant program for hydropower facility projects, only a loan program. However, items that could qualify for grants include the canal diversion, pipeline drop, and hydropower facility by-pass.

**H. RECOMMENDATIONS**

The Cody Canal Irrigation District is dedicated to improving water delivery consistency and canal operating efficiency within the District’s service area. A review of the existing facilities and our work directly with the District staff has led to recommendations that are presented in this report. Implementation of these recommendations will help the District add structures or strengthen operations that will assist in water deliveries. Specific recommendations resulting from this Level II study follow:

1. Maintain the ArcView GIS map and utilize GIS in the future as a maintenance and planning tool.
2. Request a Level III Project from the WWDC to finalize the design of the Diamond Creek and Sulphur Creek Flumes based on the selected alternative.

3. Determine the preferred alternatives for each structure presented and request a Level III Project from the WWDC to finalize the designs of several high priority structures that can become District standards.

4. Begin implementing construction projects to replace structures recommended.

5. Consider the District’s SCADA system options and further investigate the desired hardware and software bases. Begin implementing SCADA at individual sites such as spillways.

6. Discuss secondary supply opportunities within the District and determine how the District would like to move forward to implement ideas described in this report.

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

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

This study indicated that the Purvis Drop hydropower project could be financially feasible and potentially very beneficial to the Cody Canal Irrigation District. To advance the hydropower project, we recommend that the district apply to the WWDC for a Phase II, Level II Study. The following items should be included in the study:

1. Develop a detailed hydrological model to evaluate the water availability for season extension. The Big Horn Basin Study included a model which would be used as a resource.

2. Evaluate the environmental effects of the additional diversions. These effects could be primarily potential aquatic effects.

3. Contact PacifiCorp to begin negotiations for the sale of the hydropower. The power company will require a connection study to determine the manner and requirements for selling the power. The applicant has to pay for this connection study.

4. Develop preliminary designs and cost estimates for the project as finally formulated.

5. Contact the Federal Energy Regulatory Commission (FERC) and apply for a preliminary permit for the hydropower facility. Application for a facility license should be initiated when the project is advanced to pursue Level III funding. This will initiate the FERC process.

6. Negotiate with the WWDC for project financing. Important items are the potential for delay of payments and potential grants for portions of the project. Items that could qualify for grants include the canal diversion, pipeline drop, and hydropower facility by-pass.