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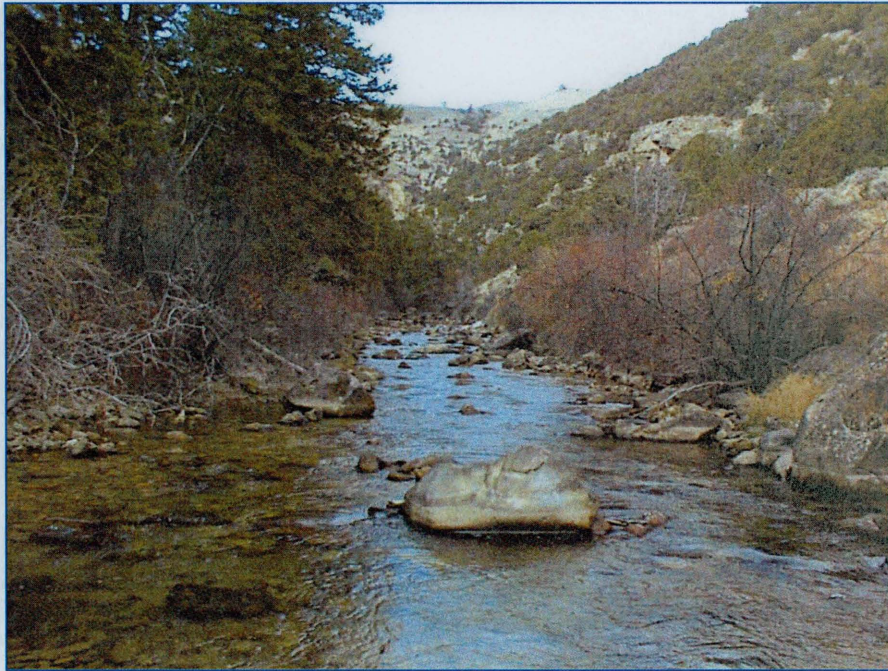
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EXECUTIVE SUMMARY
POPO AGIE RIVER
WATERSHED STUDY, LEVEL I



Prepared for:

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002

Prepared by:

Anderson Consulting Engineers, Inc.
772 Whalers Way, Suite 200
Fort Collins, CO 80525
(ACE Project No. WYWDC17)

July 9, 2003



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1.0 INTRODUCTION

On May 30, 2001 Anderson Consulting Engineers, Inc. (ACE) entered into a contract with the Wyoming Water Development Commission (WWDC) to provide professional services for the Popo Agie River Watershed Level I Study. ACE was retained to evaluate and describe the Popo Agie River watershed and specifically develop a watershed management plan. Problems and problem areas within the watershed were identified and practical economic solutions developed.

1.1 Project History

The Popo Agie River watershed is located on the eastern slope of the Wind River Range in Fremont County, Wyoming (Figure 1). The Popo Agie River watershed can be subdivided into three principal subbasins: the North Popo Agie River, the Middle Popo Agie River, and the Little Popo Agie River. The City of Lander is the economic and population center of the Popo Agie River Basin. Historically, mining activities dominated the local economy. Today, the economic growth has been dominated more by tourism and agricultural activities. Since 1990, Lander and the adjacent rural areas have sustained sufficient growth to alert community leaders to the needs for planning and consideration of the area's existing resources.

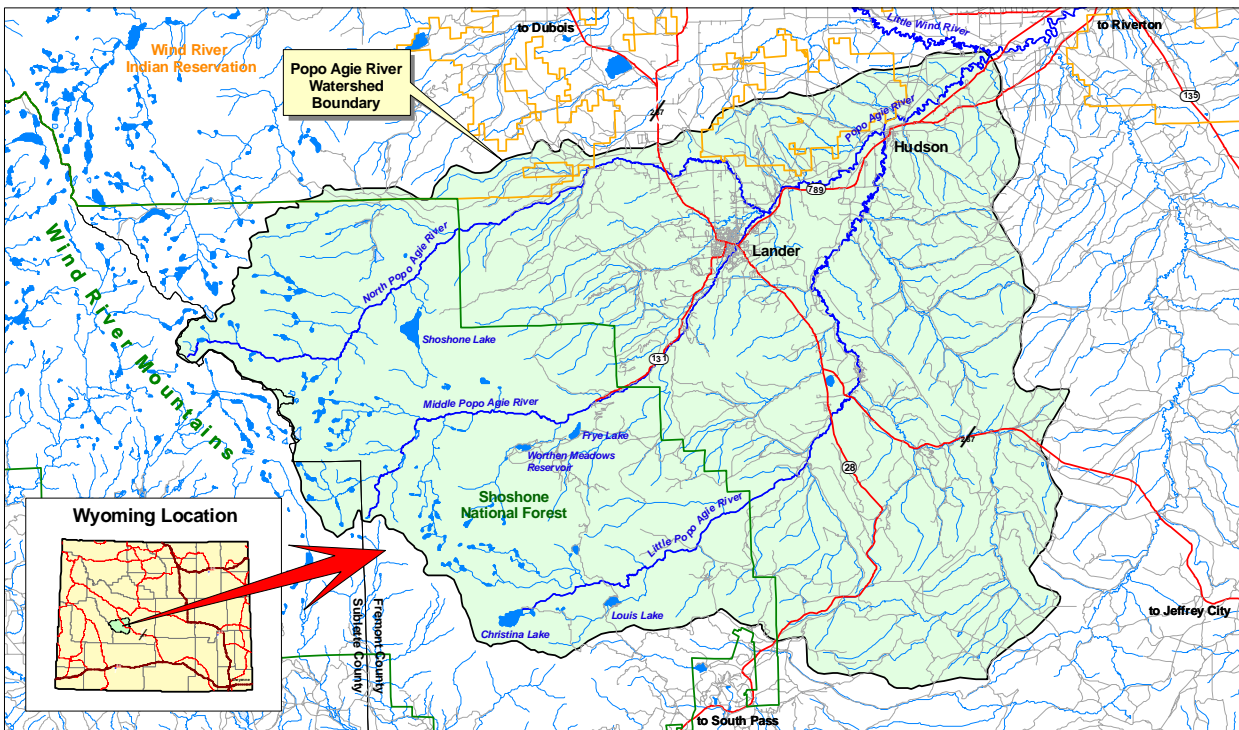


Figure 1. Popo Agie River Location Map.

In response to foreseen pressures on the area's natural resources, the Lander Valley 2020 Committee was formed and held their first meeting in 1994. In the group's second meeting on May 20, 1995, water quality and planning were identified as the issues of most concern. The Lander 2020 Water Planning Committee (LWPC) was formed to inventory and investigate water resources-related issues in the area. The Steering Committee, consisting of twenty volunteers representing a cross section of the community, was also formed. Its members include representatives of local community governments (City of Lander, Town of Hudson, and Fremont County), federal agencies (USFS and BLM), the Wind River Reservation, ranchers, outdoor enthusiasts, and others. The Steering Committee was established to develop the watershed plan by building agreement among citizens with diverse viewpoints. It receives technical assistance from United States Fish and Wildlife Service (USFWS), the Natural Resources Conservation Service (NRCS), the United States Environmental Protection Agency (USEPA) and other interested entities.

In 1999, following four years of research, the LWPC published the "Lander 2020 Water Planning Report". That document summarizes the planning area's demographics, surface and groundwater quality and quantity, aquifer sensitivity and vulnerability, important aquatic life, habitat quality, and riparian area conditions. The item presented in the 2020 Report that is especially pertinent to this Level I watershed study was the recommendation for further study and state assistance. The Lander 2020 Water Planning Committee suggested that, "...an agency whose public charge is to develop a watershed assessment be asked to fulfill these functions. In the Lander Valley, the Popo Agie Conservation District (PACD) is a likely candidate." This recommendation culminated in the application for a Level I study on behalf of the PACD as the project sponsor.

2.0 PROJECT OVERVIEW

The objective of this study is to generate a watershed management and irrigation rehabilitation plan that is not only technically sound, but also one that is practical and economically feasible. Formulation of the plan also includes providing the Popo Agie Conservation District with the data required to facilitate the planning process and make informed decisions regarding potential mitigation of several key issues/problems that presently exist within the watershed. The key issues/problems that were previously identified are summarized below:

- Augmentation of the low flows within various reaches of the Popo River system.
- Mitigation of flooding within the Popo Agie River watershed.
- Monitoring potential changes in water quality within the watershed.
- Mitigation of impaired reaches within the Popo Agie River watershed that presently experience problems with channel stability/degradation.
- Limited supplies to satisfy the needs of agricultural, municipal and industrial uses within the watershed (i.e., over-appropriation of water supply within the watershed).

In conjunction with the development of a database for the watershed, the investigative phase of this study focused on an assessment of the watershed and the identification and

evaluation of improvements to address those issues/problems described above. Potential improvements were developed and categorized into the following:

- Irrigation System Conservation and Rehabilitation. The inventory and evaluation of the existing infrastructure was completed and improvements identified for the rehabilitation of existing structures and the potential conservation of existing irrigation diversions.
- Stream Channel Condition and Stability. Several stream channels within the watershed were characterized with respect to their condition and stability. Impaired reaches were identified for further evaluation and alternative improvements developed.
- Storage Opportunities. Based on flow availability and site-specific topography, potential storage reservoirs were identified, screened and evaluated. Existing reservoirs were also investigated with respect to flow availability and the potential to increase existing storage capacity.
- On-farm Improvements. An evaluation of the potential conservation benefits associated with the implementation of various on-farm improvements was conducted.
- Water Quality. No specific improvements were identified for water quality. Sources of water quality data were identified and integrated into a GIS database. The database serves as a tool to track the benefits of potential improvements on the water quality within the watershed.

Information collected during the Watershed Inventory phase of the project was collated into a comprehensive Geographic Information System (GIS). The GIS facilitated evaluation of spatial data and served as a "clearinghouse" of all project information. Links to data analysis spreadsheets (Excel) and documents (MS Word and PDF format) were developed to enable review of associated information.

Watershed or irrigation rehabilitation plans have been developed for each category, with the exception of water quality. These plans have been prepared to provide an overview of potential improvements that can partially or fully address the key issues/problems identified within the watershed.

During the completion of this work effort, it became evident that the most severe problems with respect to the watershed were experienced within the Middle Popo Agie River. Due to the nature of the irrigation systems, the river appears to be over-appropriated with insufficient supplies to meet the needs of its water users. That is, under existing conditions, the demands exceed the supply during a normal year. These conditions exist to a lesser degree on the Little Popo Agie River and assuming consideration of all water rights of record, similar shortages may be expected on the North Popo Agie River. Flood control needs also appear to be greater on the Middle Popo Agie River as well as augmentation of low flows. Consequently, the improvements earmarked for the watershed and irrigation management plan were prioritized to reflect an increased need in the Middle Popo Agie River, followed by the Little Popo Agie River and finally the North Popo Agie River.

The individual plans were screened and further evaluated with respect to providing benefits to flood control and low-flow augmentation, and improving the existing water supply

through conservation. The results of the channel stability assessment are further refined to identify those impaired reaches that merit more immediate attention. With respect to irrigation rehabilitation, the plans prepared for each irrigation entity are further screened to identify those improvements that provide the most benefit considering the overall condition of the watershed. In summary, the PACD was provided with a plan that will guide future efforts to mitigate existing problems and enhance the water resources within the watershed.

2.1 Irrigation System Rehabilitation

The results of this work effort confirm information presented in previous reports that indicate the existing water supply from the watershed is not capable of fully satisfying the requirements of all water users (irrigation, municipal, industrial, domestic, etc.), especially in the Middle Popo Agie River. Given that the majority of the water use within the watershed is associated with irrigation, it is reasonable to assume that irrigation will play a vital role in meeting the goals of conservation of the existing water supplies as well as augmentation of low flows.

A comprehensive list of irrigation rehabilitation improvements was provided. While all improvements are worthy of consideration, several criteria and assumptions were developed to determine the improvements that provide the most benefit with respect to the goals and objectives of the study. The evaluation categories were:

- Rehabilitation of Existing Infrastructure
- Water Measurement
- Conservation Potential
- Existing Storage
- River Priority
- Protection of Reductions in Diversions
- Ditch Location

Based on these criteria and assumptions, the individual irrigation rehabilitation plans were evaluated and screened. As indicated, rehabilitation efforts that provide the most benefit to the watershed appear to be related to the following ditch systems:

- Cemetery Ditch
- Dutch Flat / Taylor Ditch
- Enterprise Ditch
- Gaylor Warnock Ditch
- Nicol – Table Mountain Ditch
- Wise Ditch

These systems are all located on the Middle Popo Agie River and upstream of the City of Lander with the exception of the Wise Ditch which is located on the lower Little Popo Agie River.

2.2 Stream Channel Condition and Stability

The general condition and stability of the principal river channels and primary tributaries were evaluated during the geomorphic investigation. During the evaluation of existing channel conditions, several impaired reaches were identified and four classes of impairments noted. The impairments were classified as indicated below:

- Riparian Vegetation: loss of riparian condition and habitat due to grazing, crop encroachment, and loss of riparian buffers
- Riparian Degradation: bank erosion, channel downcutting
- Channel Encroachment: levees, loss of floodplain access
- Rigid Planform Control: loss of meander capacity

Based on the number and relative magnitude of the impairment, the following reaches were identified as priority reaches with respect to improvements and are recommended for inclusion in the watershed management plan:

- Middle Popo Agie River – Confluence with North Popo Agie River to Mortimer Lane
- Popo Agie River – Hudson Siding to confluence with North Popo Agie River
- Little Popo Agie River – Lyons Valley to confluence with Popo Agie River.
- Twin Creek – Upper Hwy 287 crossing to confluence with Little Popo Agie River.

2.3 Storage Evaluation

Several potential storage site locations were initially identified, screened and evaluated. These sites ranged from small off-channel or tributary sites to larger reservoir sites along the principal river channels. Those sites that passed the initial screening effort are evaluated in terms of the overall watershed planning objectives and reservoir feasibility.

Storage is recognized as a highly desirable solution with respect to satisfying many of the study objectives. A reservoir ideally located in the watershed and with ample storage capacity could potentially provide the flood protection needed for the City of Lander and the Town of Hudson while providing a means of storing water for irrigation use and augmentation of late season low flows.

To facilitate the evaluation of the reservoir sites, screening criteria were developed. The evaluation categories are listed below:

- | | |
|---------------------------|-----------------------------|
| • Flood Control Benefit | • Construction Costs |
| • Streamflow Augmentation | • Cost Per Acre-Foot |
| • Irrigation Benefits | • Related Costs |
| • Flow Availability | • Flood Control Integration |
| • Permitting | |

Based upon the results of the evaluation and screening process, several sites have been identified for further investigation and included as part of the watershed management and irrigation rehabilitation plan. These sites are specifically listed below:

- Sawmill Creek – Neff Park (Middle Popo Agie River)
- Crooked Creek – Meyer Basin (Middle Popo Agie River)
- Little Popo Agie – Red Canyon (Little Popo Agie River)
- Mid-Valley – (Middle Popo Agie River)
- Middle Popo Agie – Roaring Fork (Middle Popo Agie River)

2.4 On-Farm Improvements

The potential conservation savings associated with various improvements compared to existing irrigation practices were estimated and presented. In general, programs to promote the transition from less efficient to more efficient application methods are recommended as a means of conservation within the watershed. Several existing agencies provide partial funding for conversion of irrigation application methods that provide conservation of water. Incentives to further enhance the enrollment of individual irrigators into such a program should be developed as part of the watershed management and irrigation rehabilitation plan.

Similar to the evaluation and screening of irrigation rehabilitation plans, several criteria can be developed to identify those locations where conversion of on-farm application methods provide the most benefit to the watershed. The evaluation criteria are listed below:

- First, those irrigators located in the Middle Popo Agie River basin will provide the most benefit with respect to conservation and potential augmentation of late season low flows. This statement assumes that headgate diversions are reduced and that all, or a portion of the water conserved remains in the stream.
- To the extent that all or a portion of the conservation savings in irrigation rehabilitation projects result in a reduction in headgate diversions, it is assumed that these diversions could be “shepherded” downstream to the critical reaches where flow augmentation is desired.
- In view of the difficulties that may exist in arriving at system-wide cooperative agreements, the location of the ditch headgates along the river system was integrated into the evaluation process. The ditches were ranked in order of their relative location to the critical reaches identified for low flow augmentation. Irrigators associated with those ditches located immediately upstream of the critical reach received a higher priority with respect to eligibility for programs developed through the watershed management and irrigation rehabilitation plan.
- Finally, irrigators associated with ditches that have storage facilities within the watershed were assumed to increase the potential benefits associated with on-farm improvements.

In view of these criteria, the maximum benefit associated with on-farm improvements appears to coincide with those irrigators located under the following ditches, in order of priority:

- Cemetery Ditch
- Dutch Flat / Taylor Ditch
- Enterprise Ditch
- Nicol – Table Mountain Ditch
- Gaylor Warnock Ditch

2.5 The Watershed Management and Irrigation Rehabilitation Plan

Recommendations for improvements associated with irrigation system conservation and rehabilitation, stream channel condition and stability, storage opportunities, and on-farm improvements were developed. These improvements focus on potential mitigation of several key issues/problems that presently exist within the watershed.

For the Popo Agie River basin, the watershed management and irrigation rehabilitation plan consists of a compilation of the recommendations for each category. The plan is summarized in Table 1.

3.0 CONCLUSIONS

Several key issues and problems were identified and ultimately, project goals and objectives were formulated to address these issues and problems. Specifically, plans were developed to address issues associated with irrigation rehabilitation and conservation, flood control, and augmentation of low flows. Water quality data was obtained and integrated into a database to promote the monitoring of water quality within the watershed. Channel stability assessments were completed to identify reaches that are presently impaired. Flow availability was evaluated and provided the information necessary to identify and assess potential storage sites within the watershed. An investigation of on-farm improvements was conducted and potential conservation opportunities identified through the implementation of more efficient irrigation application techniques.

In summary, the following conclusions and recommendations are provided and are based on the information presented in the previous chapters.

- Under existing conditions, the water supply within the watershed is not sufficient to satisfy the demands associated with all the water users; in other words, the surface water resources within the watershed appear to be over-appropriated, especially in the Middle Popo Agie River. This conclusion is supported by the results of the flow availability analysis, field observations and conversations with community residents. These conditions exist to a lesser degree on the Little Popo Agie River and assuming consideration of all water rights of record, similar shortages may be expected on the North Popo Agie River.
- Flood control needs appear to be greater on the Middle Popo Agie River as well as augmentation of low flows (in the reach upstream of the City of Lander). Flood control needs also exist in the Town of Hudson as a result of flood flows generated from both the Middle Popo Agie River as well as the Little Popo Agie River.
- Irrigation water use dominates water usage within the watershed and accounted for approximately 96% of the basin's total use of surface water in 1990. Since the existing surface water sources appear to be "supply limited", improvements to existing irrigation facilities and practices that conserve water will be instrumental in "stretching" the existing the water supplies to meet all the needs within the watershed.

Table 1. Popo Agie Watershed Management and Irrigation Rehabilitation Plan.

Irrigation System Rehabilitation Components				
Ditch System	Irrigation Rehabilitation Plan Component	Description	Cost	
Cemetery Ditch	1	Rehabilitate Parshall Flume	\$500	
	2	Install measurement devices at lateral split (2)	\$4,000	
	3	Install measurement devices on 10 turnouts	\$10,000	
	4	Line reach CD-c	\$31,000	
	5	Install 2 wasteways / slide gates	\$10,000	
Dutch Flat - Taylor Ditch	1	Replace Parshall Flume	\$5,000	
	2	Repair geotextile liner	\$2,000	
	3	Rehabilitate unstable ditch (GEI, 1984)	\$200,000	
	4	Install measurement devices at approximately 31 farm turnouts	\$31,000	
Enterprise Ditch	1	Install measurement device at Sawmill Creek headgate	\$5,000	
	2	Install measurement device at Crooked Creek headgate	\$5,000	
	3	Install pipe drop structure	\$250,000	
	4	Replace drop structure/turnout	\$69,000	
	5	Replace splitter box	\$20,000	
	6	Rehabilitate Gabion drop structures (5)	\$20,000	
	7	Install approximately 15 measurement devices at farm turnouts	\$15,000	
	8	Line Reach ED-a (approx. 2,500 LF)	\$124,000	
Gaylor Warnock Ditch	1	Rehabilitate Parshall Flume	\$2,000	
	2	Install approximately 10 measurement devices at farm turnouts	\$10,000	
	3	Line Reach GW-a (approx. 500 LF)	\$18,000	
	4	Install inverted siphon - Option A	\$45,000	
Nicol Table Mountain Ditch System	Nicol-Table Mountain Ditch	1	Replace diversion structure	\$38,000
		2	Replace headgate bypass	\$37,000
		3	Replace Parshall Flume	\$5,000
		4	Install inverted siphon at Frye Gulch	\$50,000
		5	Install approximately 12 measurement devices at farm turnouts	\$12,000
		6	Rehabilitate weir	\$2,000
	North Lateral	7	Install pipe drop structure (SCS)	\$65,000
		8	Rehabilitate inverted siphon	\$40,000
		9	Install pipe drop structure (SCS)	\$65,000
		10	Replace approximately 11 farm turnouts / install slide gates	\$22,000
		11	Install measurement devices (21)	\$21,000
	Parker - McBride Lateral	12	Line reaches of North Lateral (SCS) (approx. 3000 LF)	\$135,000
		13	Replace flume with inverted siphon (SCS)	\$50,000
		14	Install inverted siphon (SCS)	\$43,000
		15	Replace approximately 6 farm turnouts / install slide gates	\$12,000
		16	Install measurement devices (12)	\$12,000
	Wise Ditch	17	Line ten reaches on Parker McBride lateral as per SCS (approx. 4000 LF)	\$180,000
1		Rehabilitate headgate/wasteway	\$4,000	
2		Rehabilitate Parshall Flume / stabilize banks	\$5,000	
3		Replace drop structure/turnout/hills stabilize ditch/lining	\$80,000	
4		Replace flume with inverted siphon	\$45,000	
5		Replace approximately 10 farm turnouts / install slide gates	\$20,000	
6		Install approximately 10 measurement devices at farm turnouts	\$10,000	
7		Line Reach WD-a (approx. 1500 LF)	\$70,000	
8	Little Popo Agie River bank stabilization	\$20,000		

Storage Components					
Basin	Site Number	Site Name	Storage Volume	Cost	
			(ac-ft)	Construction	\$/ac-ft
Priority 1 Sites					
Middle Popo Agie	6	Crooked Creek - Meyer Basin	5,680	\$ 6,912,000	\$ 1,220
Middle Popo Agie	17	Middle Popo Agie - Roaring Fork	22,260	\$ 36,540,000	\$ 1,640
Middle Popo Agie	24	Sawmill Creek - Neff Park	6,440	\$ 11,696,000	\$ 1,820
Little Popo Agie	12	Little Popo Agie - Red Canyon	5,880	\$ 4,204,000	\$ 710
Priority 2 Sites					
North Popo Agie	28	Surrel Creek No. 1	3,880	\$ 3,885,000	\$ 1,000
Middle Popo Agie	33	Worthen Meadows Reservoir	450	\$ 800,000	\$ 1,780
Little Popo Agie	11	Little Popo Agie - Onion Flats	9,000	\$ 8,592,000	\$ 950
Little Popo Agie	13	Little Popo Agie - Twin	4,600	\$ 1,944,000	\$ 420
Little Popo Agie	14	Little Popo Agie - Lyons	9,776	\$ 37,660,000	\$ 3,850

Stream Channel Restoration Components	
Stream	Reach
Middle Popo Agie	Mortimer Lane to confluence with North Popo Agie River
Little Popo Agie	Lyons valley to confluence with Popo Agie River
Popo Agie	Confluence North Popo Agie and Middle Popo Agie to Hudson Siding
Twin Creek	Confluence with Little Popo Agie to upstream crossing of Hwy 287
Potential Restoration Strategies	
Riparian Vegetation Degradation: Grazing management Riparian buffer zones Revegetation	Riparian Degradation: Restoration of channel profile Structural rehabilitation measures Non-structural rehabilitation measures
Levee Confinement and Floodplain Isolation: Restore floodplain access Gradient restoration facility	Rigid Platform Control : Apply bioengineered erosion control methods Establish migration corridors / erosion setback limits where feasible

On-Farm Components		
Ditches:	Potential Improvements	
Cemetery Ditch	} Low Pressure Sprinkler Conversions: \$500 - \$600/Acre LEPA Sprinkler Conversions 700/Acre Gated Pipe Installation \$150-\$250/Acre Surge Irrigation Conversion \$350-\$450/Acre Information Based Irrigation Scheduling \$1/Acre ⁽¹⁾ Subsurface Drip Irrigation Systems \$600-\$1500/Acre	
Dutch Flat / Taylor Ditch		
Gaylor - Warnock Ditch		
Nicol-Table Mountain Ditch		
Enterprise Ditch		

(1) Assumes two stations at \$10,000 each providing benefit to all irrigated acres.

 Irrigation component providing conservation benefits

- Of the irrigation systems inventoried and evaluated during this study, several structures are in immediate need of rehabilitation. Additional or improved measurement structures are needed to monitor the deliveries and improve the operation and management of the irrigation diversions. Several improvements have been identified to reduce potential seepage and conserve water.
- The majority of irrigation within the Popo Agie River Basin is dominated by conventional flood irrigation methods. Given the irrigated acreage within the basin, a significant potential exists to conserve water through the implementation of more efficient on-farm application methods.
- Based on the channel stability assessment, several impaired channel reaches were identified within the watershed. It is recommended that these reaches be further investigated. Site-specific solutions should be developed to mitigate the channel impairment and ultimately included in the watershed management and irrigation rehabilitation plan.
- Available water quality data have been incorporated into a database accessible through the project GIS. This information should be accessed and expanded as the PACD continues their water quality monitoring programs.
- The results of the flow availability investigation confirmed that water is available and flows out of the watershed during the spring runoff period, predominantly during May and June.
- Should irrigation rehabilitation or on-farm improvements result in conservation of water and ultimately, reduced diversions at the headgate, several institutional constraints must be addressed. These include the administration of water rights associated with all downstream diversions, cooperative agreements likely required to “shepherd” the water to reaches impacted by low flows, and development of incentives for irrigators to enroll in the conservation projects.
- Based on the flow availability and site-specific topography, several existing and potential storage sites were evaluated. Existing reservoirs offer limited potential for enlargement and provide limited benefits to address the key issues and problems in the watershed. Based on the needs within the watershed, reservoirs located in the Middle Popo Agie River watershed were prioritized during the evaluation. Several potential reservoir sites were identified for further investigation. Storage at these sites provides benefits for flood control and low flow augmentation. In addition, the benefits of conservation associated with either on-farm improvements or rehabilitation of irrigation conveyance facilities may be enhanced through storage.
- During a more detailed investigation of potential storage sites, several institutional constraints must be addressed. These include the release of water from storage and the administration of water rights associated with all downstream diversions, and cooperative agreements likely required to “shepherd” the water to reaches impacted by low flows. In

addition, objectives of the recently completed Wind River/Big Horn River Basin Plan must be considered and the impact of these storage sites evaluated in the context of the basin plan. Finally, stipulations and conditions in the Yellowstone River Compact should be more fully evaluated.

- Construction of various components of the watershed and irrigation rehabilitation plan will require certain permits, rights-of-way and easements. Depending upon the nature and location of the project, they could include (among others) NEPA compliance, Section 404 permitting through the U.S. Army Corps of Engineers, and coordination with the Wyoming State Engineer's Office, Wyoming Department of Environmental Quality, USDA Forest Service (Shoshone National Forest), Wyoming Game and Fish Department and the State Historic Preservation Office. Where applicable, permission should be negotiated for easement/right-of-way access for all construction activities associated with the project.
- The NRCS has recently completed a flood control study of alternative improvements in the City of Lander. Storage within the watershed may potentially reduce the costs associated with the alternatives proposed by the NRCS and provide for savings associated with flood control within the community. Additional investigation into this issue is warranted.
- Several funding sources exist for funding of improvements within the watershed including on-farm improvements, irrigation rehabilitation projects, stream enhancements/restoration projects, and conservation and flood control projects. Creative strategies for funding/financing of projects should be more fully investigated following identification of projects worthy of additional evaluation and potential implementation.
- One of the most critical issues that must be addressed is the need for a clear and concise consensus among the parties/entities within the watershed. The community has made significant progress in this area through outreach programs and public meetings. Implementation of projects within the watershed will likely require consensus and continued effort in this area is recommended.

As stated previously, implementation of a watershed management and irrigation rehabilitation plan will require funding from several sources. To be eligible for funding from WWDC, a district must be formed that has the capability to incur debt and assess its users. This issue must be addressed to facilitate the progression of this Level I study into a Level II study associated with selected project improvements and ultimately to construction in Level III.

Finally, to move forward in the planning process following the completion of this Level I study, procedures and criteria may be needed to prioritize those projects worthy of additional consideration. This process may be facilitated by initial consideration of smaller projects to “test the waters” associated with district formation as well as consensus among the water users and beneficiaries.