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EXECUTIVE SUMMARY

Highline Watershed Improvement District Ditch Rehabilitation Project Level II

PREPARED FOR:

Wyoming Water Development Commission
122 W. 25th Street
Herschler Building
Cheyenne, WY 82002

PREPARED BY:

Anderson Consulting Engineers, Inc.
2900 South College Avenue, Suite 3B
Fort Collins, CO 80525
(ACE Project WYWDC14)



November 1, 1999



ANDERSON CONSULTING ENGINEERS, INC
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Authorization and Purpose

On June 1, 1999, Anderson Consulting Engineers, Inc. (ACE) entered a contract with the Wyoming Water Development Commission (WWDC) to provide professional services to the Highline Ditch Watershed Improvement District (District) Ditch Project. ACE was retained to conduct an irrigation rehabilitation study for the District. Severe erosional problems within the three main irrigation delivery ditches threaten the integrity of the existing structures and the irrigation system. The purpose of this study was to identify and evaluate the feasibility of various rehabilitation alternatives for mitigating the major erosion problems associated with the three main irrigation ditches. A final report summarizing the results of all tasks associated with the project was submitted to the WWDC on November 1, 1999.

History of the Project

The Highline Watershed Improvement District is in Carbon County, east of Saratoga, Wyoming. The boundary of the District is presented in Figure 1. Although greater than 10,000 irrigated acres are found within the district boundary, this project specifically involves the rehabilitation of the upper portions of three ditches: the Highline Ditch, Elk Hollow Ditch and Wiant Ditch. Consequently, this project focuses on the rehabilitation of irrigation facilities located in Sections 1 and 2 of Township 16 North, Range 82 West. Given the location of irrigation facilities identified for rehabilitation, not all of the irrigated acreage within the district will benefit by the improvements.

Historically, severe erosion of the existing canals associated with the Highline Ditch, Elk Hollow Ditch and Wiant Ditch have required continual maintenance. The Natural Resources Conservation Service (NRCS) has completed several studies related to the improvements necessary to mitigate the existing erosion problems. Recent NRCS studies documented costs exceeding \$120,000 to rehabilitate the existing facilities and mitigate the erosion problems. Faced with costs of this amount, the landowners irrigating under the three ditches decided to form a watershed improvement district to obtain funding for the improvements.

Summary of Existing Problems

As stated previously, major erosion and canal stability problems continue to plague the Highline Ditch, Elk Hollow Ditch and Wiant Ditch. The Highline Ditch is threatened by a massive headcut that is moving upstream and endangering existing facilities and adjacent irrigation ditches. This headcut is more than 25 feet high and is actively migrating upstream. Channel incision upstream of the headcut has produced near vertical streambanks greater than 20 feet. The Wiant Ditch is also deeply incised and is experiencing actively migrating headcuts. This type of canal erosion continues to threaten existing structures/flumes plus existing roadways next to the ditch. Three diversions from the Highline Ditch cross the Wiant Ditch via suspended pipelines. Efforts have been made to protect these pipelines from canal degradation by placing auto bodies along the banks.

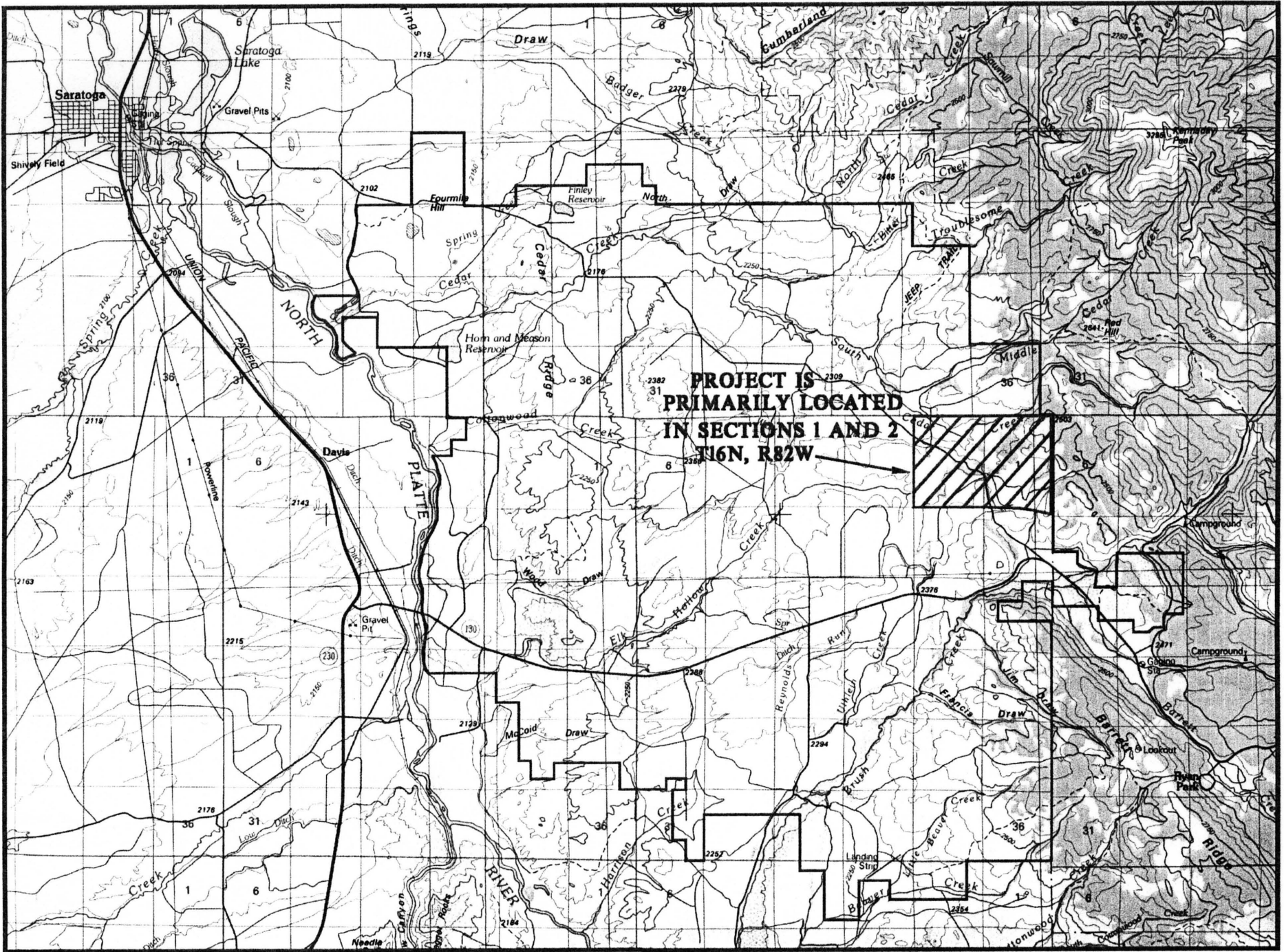


Figure 1 Project Vicinity Map

The Elk Hollow Ditch is experiencing similar erosion problems with deeply incised channels and actively eroding channel banks. The continual bank erosion and migration of the Elk Hollow Ditch have almost captured the Wiant Ditch.

In summary, the continual erosion problems in the three ditches threaten the existing flumes and crossover structures plus all other appurtenant structures. The magnitude and severity of the erosion create an opportunity for capture and commingling of the irrigation water diverted by the three ditches.

Inventory of Existing Structures

During the field investigations, an inventory of the existing structures within the study area was completed. This area extended a distance of approximately one-half mile upstream and downstream of the Wiant and Highline washouts. The inventory included field measurements of the structures, photographic documentation, and estimates of the remaining design life of each structure. Field measurements were taken to promote the hydraulic evaluation of the existing facility and design criteria for any proposed improvements.

Analysis of Water Rights

In order to hydraulically evaluate existing structures and to preliminarily design alternative solutions to the Wiant and Highline No. 4 Washouts, an evaluation was made to determine design discharges in various reaches of each ditch. Based on information from the Wyoming State Engineers Office, the Elk Hollow, Wiant and Highline No. 4 Ditches have single appropriations consisting of 10.4, 99.1, and 94.0 cfs respectively. Of the Highline No. 4 appropriation, 28.6 cfs is diverted to water users located along Buffalo Gulch and an estimated 10 cfs is diverted to each of the Gross, Twin Pipes, and Ryan Foreman Ditches. For design purposes, it was assumed that the Elk Hollow Ditch would remain inoperable and its appropriation would be carried in the Wiant Ditch. Design flows were computed by assuming a double appropriation in each ditch and adding approximately 20 percent to account for storm inflows.

Rehabilitation Alternatives

Several conceptual rehabilitation alternatives were reviewed for each of the problem areas identified. The rehabilitation alternatives were developed using two primary water management strategies: (1) the irrigation diversions of the Highline No. 4 and Wiant Ditches remain separated and (2) the irrigated diversions are commingled. The purpose of the "Commingled Diversions" scenario was to determine if combining the diversions would be cost effective in comparison with the "Separate Diversions" scenario. Several alternatives were reviewed for each of the individual components necessary to rehabilitate the system under either scenario. Additional remediation measures, which are not affected by the water management scenarios, were developed for the rehabilitation of the Macannany Washout, the Ryan Foreman Washout, and installation of measurement structures.

Conceptual Design

Following review of the conceptual rehabilitation alternatives and their relative costs, the “Separate Diversion” scenario was determined to be the most cost effective rehabilitation strategy. The cost associated with this suite of alternatives comprising this scenario was exceeded by those of the “Commingled Diversion” scenario. It is our understanding that the District is interested in pursuing a “Commingled Diversion” scenario if significant cost savings are incurred. Given the lower costs associated with maintaining separated diversion, conceptual designs were prepared for rehabilitation of the Highline and Wiant Ditches.

Highline No. 4 Ditch Rehabilitation

The recommended alternative for rehabilitation of the Highline No. 4 Ditch consisted of stabilization of the existing ditch by building a pipe outfall structure, and placement of two grade control structures at appropriate locations in the reach. Diversion Structure No. 2 requires no modifications or improvements. The flows conveyed through the structure would not change because there is no commingling of diversions. The structure is in good condition and improvements are not recommended at this time.

The pipe outfall structure will facilitate the vertical drop required to convey the water from the existing channel upstream of the headcut to the stable ditch downstream of the washout. The outfall structure incorporates an anchored steel pipeline, 48-inches in diameter, which projects approximately 5-feet beyond the lip of the ditch bed. The pool below the outfall will be stabilized by placing rock riprap over an impermeable liner. Where necessary, appropriate bedding material should be placed over the liner to prevent puncturing during placement of the rock riprap.

Grade control structures placed at key locations upstream of the pipe outfall structure would mitigate potential degradation between the pipe outfall structure and Diversion Structure No. 2.

Wiant Ditch Rehabilitation

The rehabilitation alternative generally follows that of the alternative previously evaluated by the NRCS. The design objective of this alternative is to relocate Wiant Ditch diversions from the existing section of canal that is highly erosive and erosionally unstable. A 48-inch RCP pipe drop structure approximately 600 feet long would be built to convey flows downslope. At its downstream end, a pipe outlet with an energy dissipation baffle would be constructed. The pipe outlet would discharge to a stable portion of the Elk Hollow Ditch.

Flows would be conveyed from the Wiant Ditch to the pipe drop structure by way of an earthen channel beginning at a berm built across the existing Wiant Ditch. An additional berm would be placed at the Elk Hollow Ditch. Downstream of the pipe drop structure, flows would be conveyed through a stable reach of the Elk Hollow Ditch for approximately 450 feet. At that point, an earthen berm would be constructed to divert flow to an earthen canal returning to the Wiant Ditch.

A rock riprap grade control structure will be placed in the reach between the Wiant Ditch diversion berm and Diversion Structure No. 2 to add further protect of upstream structures from potential channel incision. An additional grade control structure would be placed in the Elk Hollow Ditch downstream of the pipe drop structure outlet.

Macannany Washout Rehabilitation

The recommended alternative for rehabilitation of the Highline No. 4 Ditch through the Macannany Washout consists of stabilizing the ditch by building a series of pipe drop structures within the existing canal, constructing a grade control structure in the downstream reach to prevent additional canal incision, and rehabilitating the upper 500 feet of the Hill No. 2 Ditch by constructing a 12-inch PVC pipeline beginning at Diversion Structure No. 3.

Ryan Foreman Ditch Washout Rehabilitation

The recommended alternative for rehabilitation of the Ryan Foreman Ditch consists of stabilizing the ditch with a bypass of the unstable portion of the Ryan Foreman Ditch with approximately 700 lineal feet of 12-inch PVC.

Measurement Structures

The recommendation for installation of measurement structures consists of the placement of Cipolletti weirs and Parshall flumes in the vicinity of the existing diversion structures in order to maximize the operation and management of the irrigation delivery system. A total of seven Cipolletti weirs ranging in size from 7 feet to 18 feet would be installed. In addition, 6 Parshall flumes would be installed (three 9-inch and three 18-inch). Staff gages will be placed in the vicinity of each structure to facilitate flow measurement.

Cost Estimates

Based on the conceptual design details provided in Chapter V, detailed cost estimates for construction of the improvements to the irrigation ditch system of the Highline Watershed Improvement District were prepared. The construction cost components associated with the recommended improvements were identified and construction costs assigned to each component.

A final cost estimate and repayment plan, presented in Table 1, was generated for the project improvements. The final cost estimate and repayment plan includes 10% for engineering services during construction and 15% for construction contingencies. The WWDC funding for the project was assumed to be in the form of a 50% grant and 50% loan. The terms of the loan were assumed to be 6.0% for a period of 20 years.

The cost estimates are based on placement of RCP for the pipe drop structure in the Wiant Ditch improvements. It is acknowledged that alternative pipe materials (such as High Density Polyethylene) exist which may be less costly to install. The magnitude of the momentum forces in the pipeline along with the proposed life expectancy of the improvements (greater than 40 years) resulted in the selection of RCP for the pipe drop structure.

Table 1. Final Cost Estimate and Repayment Plan.

Item Description	Highline Rehabilitation	Wiant Rehabilitation	Macannany Rehabilitation	Ryan Foreman Rehabilitation	Measurement Structures	Total
Cost of Project Components	\$65,400	\$179,365	\$174,000	\$10,500	\$84,200	\$513,465
Engineering (10%)	\$6,540	\$17,937	\$17,400	\$1,050	\$8,420	\$51,347
Subtotal	\$71,940	\$197,302	\$191,400	\$11,550	\$92,620	\$564,812
Contingency (15%)	\$10,791	\$29,595	\$28,710	\$1,733	\$13,893	\$84,722
Total Construction Cost	\$82,731	\$226,897	\$220,110	\$13,283	\$106,513	\$649,533
Final Plans / Specifications	\$8,273	\$22,690	\$22,011	\$1,328	\$10,651	\$64,953
Permitting and Mitigation	\$1,500	\$1,500	\$1,500	\$500	\$250	\$5,250
Legal Fees	\$1,000	\$1,000	\$1,000	\$500	\$250	\$3,750
Access and Rights-of-way	\$500	\$500	\$500	\$500	\$250	\$2,250
Total Project Cost	\$94,004	\$252,586	\$245,121	\$16,111	\$117,914	\$725,737
50% Loan	\$47,002	\$126,293	\$122,561	\$8,055	\$58,957	\$362,868
Repayment Factor (20 years @ 6.0%)	0.08718	0.08718	0.08718	0.08718	0.08718	0.08718
Annual Payment	\$4,098	\$11,011	\$10,685	\$702	\$5,140	\$31,637

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Economic Analysis

Economic factors and the ability-to-pay of the water users often become the overriding factors which determine project feasibility and implementation. Consequently, an economic analysis was completed to assess the ability of the users for the District to pay for the cost associated with the proposed improvements. This District is in its infancy with respect to an annual assessment levied to its water users. The need to implement this project resulted in the formation of the District; consequently, historic data related to the annual assessment is not available.

The legal entity sponsoring this project is an improvement district. It is our understanding that only those water users which benefit from the improvements will incur an increase in assessment. Consequently, a map of irrigated acreage which derive water downstream of the proposed improvements is necessary to determine the per-acre increase in assessment. Presently, neither the District or the State Engineers' Office has compiled the information necessary to accurately determine the location and number of irrigated acres which will benefit from the proposed improvements. This information must be compiled and utilized to ultimately determine the assessment. In the meantime, the analysis for this project estimated the number of irrigated acres which benefit by applying the 1 cfs/70 acres criteria to the irrigation diversions above the proposed improvements.

Table 2 summarizes the results of the economic analysis. If the District decides to construct all of the proposed improvements and the costs associated with the improvements are assessed equally to all acreage, the annual assessment will need to be increased by \$2.75. Assuming the improvements are assessed based only on the number of acres which directly benefit from a given improvement, the annual assessment varies as tabulated in Table 2. It should also be noted that irrigators downstream of the Macannany Washout will also benefit by the Highline No. 4 Ditch rehabilitation. Consequently, the assessment for these water users may be as high as \$5.21 per acre.

Table 2. Summary of Annual Assessment for Remediation Alternatives.

Alternative	Annual Payment	Acres Benefitted	Annual Per Acre Assessment
Highline Rehabilitation	\$4,098	4,578	\$0.90
Wiant Rehabilitation	\$11,011	6,937	\$1.59
Macannany Rehabilitation	\$10,685	2,478	\$4.31
Ryan Foreman Rehabilitation	\$702	700	\$1.00
Measurement Structures	\$5,140	11,515	\$0.45
All Projects	\$31,637	11,515	\$2.75

During completion of the project, discussions with the representatives of the District indicated that the ability-to-pay among the majority of the water users was limited. The limited ability-to-pay of the water users was one of the incentives for formation of the District and the pursuit of funding through the Wyoming Water Development Program. Given this consideration, alternative sources of funding become vital if the District wishes to implement all of the proposed improvements.

One potential source of funding may be the state or county highway departments. The close proximity of the roadway to the Wiant Ditch may create a hazard to vehicular traffic should the

ongoing canal erosion migrate closer to the roadway. Stabilizing this erosion and canal instability provides benefit to the users of the roadway. Consequently, additional discussions with the highway departments are warranted.

An additional alternative to reduce the costs associated with construction of the proposed improvements may also exist. The WWDC could approve the utilization of the grant portion of the appropriation for the materials associated with the improvements. This funding alternative has been successfully implemented for the Horse Creek Conservation District in Hawk Springs as well as the Goshen Irrigation District in Torrington. To be approved for this funding alternative, the WWDC may require that the District demonstrate the capability to install the improvements. Furthermore, the District would be responsible for all engineering, legal, and permitting costs as well as the acquisition of access/right-of-way. The engineering must be performed by a professional engineer registered in the State of Wyoming. It is recommended that the District consider this alternative to reduce the costs associated with the improvements and initiate discussions with the WWDC to determine the requirements.

Permitting

For this project to proceed to construction, the District will be required to obtain certain permits, rights-of-way and easements. Given the scope of the improvements as presented in this report, Section 404 permitting may be required but may not involve the submittal of an individual permit. If so, coordination with other agencies is necessary, including; Wyoming Game and Fish Department (404 approval), Wyoming DEQ, Water Quality Division (401 certification), State Historic Preservation Office(404 approval), Wyoming State Engineer's Office (approval of plans and specifications), and property owners (right-of-access).

Conclusions and Recommendations

Based on the information presented in the previous chapters, the following conclusions and recommendations are provided.

1. The Highline Watershed Improvement District (District) is presently experiencing erosion and stability problems associated with three existing supply ditches (Wiant Ditch, Elk Hollow Ditch and Highline No. 4 Ditch). These problems threaten existing structures as well as the long-term conveyance of irrigation deliveries to the water users within the District. Previous studies completed by the NRCS have documented improvements that ultimately resulted in the formation of the District and the submittal of an application to the WWDC for funding this Level II Rehabilitation Project.
2. A detailed field investigation was conducted to identify and document the nature and magnitude of the existing stability problems. This work was followed by the development and evaluation of alternative improvements to mitigate these problems. The alternative evaluation resulted in the preparation of conceptual designs and cost estimates for the items listed below.

Highline No. 4 Ditch Improvements: Construction of a pipe outfall structure, rock riprap plunge pool and two grade control structures. The total project cost associated with the construction of these items is estimated to be \$94,004. Assuming a 50% grant and 50% loan

(20 years @ 6.0%), the annual payment necessary to reduce the loan is estimated to be \$4,098.

Wiant Ditch Improvements: Construction of two diversion berms, two diversion channels and a pipe drop structure. The total project cost associated with the construction of these items is estimated to be \$252,586. Assuming a 50% grant and 50% loan (20 years @ 6.0%), the annual payment necessary to reduce the loan is estimated to be \$11,011.

Macannany Washout Rehabilitation: Construction of three pipe drop structures with rock grade control structures, and a separate grade control structure. In addition, 500 feet of the Hill No. 2 would be improved with the placement of a 12-inch PVC pipeline. The total project cost associated with the construction of these items is estimated to be \$245,121. Assuming a 50% grant and 50% loan (20 years @ 6.0%), the annual payment necessary to reduce the loan is estimated to be \$10,685.

Ryan Foreman Ditch Rehabilitation: Construction of 700 lineal feet of 12-inch PVC pipeline. The total project cost associated with the construction of this item is estimated to be \$16,111. Assuming a 50% grant and 50% loan (20 years @ 6.0%), the annual payment necessary to reduce the loan is estimated to be \$702.

Measurement Structures: Installation of 7 Cipolletti weirs and 6 Parshall flumes to facilitate accurate flow measurement at the diversion structures and optimize operation and management of irrigation water deliveries. The total project cost associated with the construction of these items is estimated to be \$117,914. Assuming a 50% grant and 50% loan (20 years @ 6.0%), the annual payment necessary to reduce the loan is estimated to be \$5,140. Costs of this alternative is assumed to be shared by all water users in the District.

3. The improvements benefit approximately 11,515 acres within the District based on an evaluation of the water rights appropriations conveyed within each ditch and a criteria of 1 cfs/70 acres. To meet debt retirement, the District will need to assess the water users \$2.75 per acre if all improvements are constructed and the assessment is equally allocated to all water users which benefit from the improvements.

Assuming the improvements to the Highline No. 4 Ditch and Wiant Ditch are assessed on an individual basis, the annual assessment becomes \$0.90 per acre for the users associated with the Highline No. 4 Ditch and \$1.59 per acre for the users associated with the Wiant Ditch. If the Macannany Washout is included, assessment to those Highline No. 4 Ditch water users increases by an additional \$4.31 per acre. Those irrigators benefitting from rehabilitation of the Ryan Foreman Ditch will incur an assessment of \$1.00 per acre. The assessment for installation of the measurement structures is estimated to be \$0.45 per acre.

4. Alternative funding sources may provide monies to offset the potential loan obligations associated with construction of the improvements. Given the proximity of the Wiant Ditch to the county road, an additional source of funding through the state or county highway departments should be investigated.

The WWDC could also approve the utilization of the grant portion of the appropriation for the materials associated with the improvements. The District would be responsible for the engineering and installation of the improvements. To be approved for this funding alternative, the WWDC may require that the District demonstrate that it has the capability to install the improvements. Furthermore, the District would be responsible for all engineering, legal and permitting costs as well as acquisition of access/right-of-way. It is recommended that the District investigate this alternative to reduce the costs associated with construction of the improvements.

Numerous benefits may be gained by the District and the State of Wyoming with the implementation of this project. In addition to significant improvements to the overall operation and management of the irrigation delivery system, other benefits associated with the project include: (1) existing flumes, diversion structures, crossover structures and other appurtenant structures associated with the District would no longer be threatened by canal erosion and incision; (2) County Road 504, which has already been relocated due to erosion of the Wiant Ditch, would no longer be threatened; and (3) adverse impacts to existing agriculture and ranching activities and livelihoods within the District could be avoided by reducing the potential for loss of the irrigation delivery canals.

Environmental benefits associated with the project include: (1) severe and continuing erosion of private and State lands may be significantly reduced or eliminated; and (2) potential improvement of downstream water quality and fisheries.

Given the information presented above, it is recommended that the District identify and prioritize the improvements that require immediate implementation. Considering the magnitude of the existing stability hazards, the improvements to the Wiant Ditch should receive the highest priority. Following this work, an application for funding of the proposed improvements should be prepared and submitted to the WWDC. Depending on the ability-to-pay of the individual water users as well as the availability of alternative funding sources/strategies, several of the project improvements, especially those on the Wiant Ditch, should be seriously considered for Level III design and construction.