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SAHARA DITCH IMPROVEMENTS - LEVEL II

EXECUTIVE SUMMARY

PREPARED FOR:

WYOMING WATER DEVELOPMENT COMMISSION
Herschler Building, 4th Floor-West
122 W. 25th Street
Cheyenne, WY 82002

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November, 1992

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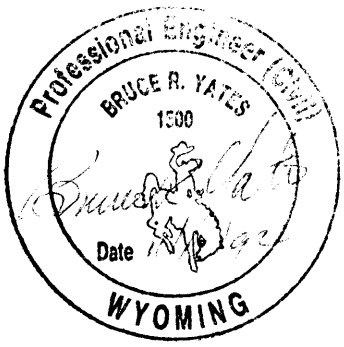

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INTRODUCTION

PROJECT LOCATION

The Sahara Ditch is located in north-central Wyoming beginning at a diversion dam on the Middle Fork Powder River about 4½ miles east of Kaycee, Wyoming. The Sahara Ditch parallels the Powder River to the east for about 15 miles.

PROJECT SETTING AND HISTORY

Twenty-three landowners receive water from the Sahara Ditch for the irrigation of 5116 acres. The primary crop is alfalfa and grass hay with flood irrigation used on the majority of the acreage, (Sahara Ditch is also referred to as the Sussex Ditch.)

Historically the irrigation system has been chronically short of water during the primary growing season of July and August. The Powder River Irrigation District (PRID) has tried for years to promote a reservoir project which would enhance their system, but presently they operate without stored water and can only rely on the direct flow occurring at their Powder River diversion. The water rights provide for a diversion of 77.77 cubic feet per second (cfs) at the headgate and the users could take as much as 155.54 cfs under their "double appropriation" flood rights. The irrigators utilize their early season water supply about as efficiently as possible resulting in good production from one or two cuttings of alfalfa with residual fall and winter grazing. Reservoir storage would enhance production.

The facilities were originally constructed in 1901 and have been modified several times but are basically very similar to the original system. The diversion dam remains at its original location and has had continual rock and riprap dumped into the stream to stabilize the structure. Although the dam is in poor condition, it has held up remarkably well over the many years of use. The headgate has been reconstructed at least twice and is presently about 100 feet downstream from the diversion dam. A concrete wall between the diversion dam and the headgate serves as an overflow spillway during high water periods.

CONDITION OF EXISTING SYSTEM

AUTHORIZATION AND SCOPE

The Wyoming Legislature authorized the Wyoming Water Development Commission (WWDC) to complete the Level II study of the Sahara Ditch Project and Level III final design and construction of the Sahara Diversion Dam. The WWDC contracted HKM Associates (HKM) of Sheridan, Wyoming to perform the Level II study. The Powder River Irrigation District (PRID) also requested proposals to perform a Level III Diversion Dam Project. After reviewing the proposals it was decided to lower the scope of study for the diversion dam to Level II and incorporate by amendment into HKM's Level II contract.

This Level II study resulted in conceptual design and cost estimates of sufficient detail such that eligible components could be presented to the WWDC and the 1993 Wyoming Legislature for funding of the Level III final design and construction. The scope of the study resulted in a Phase I - Rehabilitation Plan and a Phase II Conceptual Design and Costs Estimates. The Interim Report presented the rehabilitation plan developed in Phase I. A scoping meeting was held at Sussex Community Hall on June 16, 1992 and a presentation of the Phase I Rehabilitation Plan took place at the same location on August 28, 1992. Conceptual design and cost estimates (Phase II) were prepared after the PRID has an opportunity to review rehabilitation plan alternatives which best meets their needs.

CONDITION OF EXISTING SYSTEM

SAHARA DITCH

The carrying capacity of the Sahara Ditch was confirmed during this study to be about 100 cfs. Since no measuring flumes exist, streamflow measurements were relied upon. The Powder River flow was enhanced by numerous rain events during the 1992 season and it was possible to conduct measurements at various canal stages.

The Sahara Ditch major structures include the diversion dam and four siphons throughout the length of the main canal. Two of the siphons are in poor condition and two are in good

condition. The diversion dam and two of the siphons will be discussed separately. Irrigated acreage below each structure is shown in Table 1.

TABLE 1

DISTRIBUTION OF ACREAGE AND FLOW THROUGH CONTROLLING STRUCTURES

	ACREAGES SERVED (BASED ON ASSESSMENT) (AC)	% OF ACREAGE SERVED (%)	DISTRIBUTION OF ORIGINAL APPROPRIATION @ 80 CFS (CFS)	DISTRIBUTION OF FLOOD FLOW @ 135 CFS (CFS)
Diversion Dam	5116	100	80	135
Sahara (River) Siphon	4911	96	77	130
Fifteen-Mile Siphon	4297	84	67	113
Chabot Siphon	4144	81	65	109
Morgariedge (Koch) Siphon	3530	69	55	93

During the period from July 14, 1992 through July 29, 1992 a site inventory of all canal structures was performed. The main canal (Sahara Ditch) contains 94 structures on 93,500 feet of canal. The East Lateral inspection included only a turnout and drop structure. The Supply Ditch Lateral includes 13 structures and 8,900 feet of canal. The total length of canal which was inspected is 102,400 feet. No individual on-farm laterals were inspected except to note the conditions at the main canal. The Supply Ditch Lateral and East Lateral were inspected since they serve several landowners and are maintained by the Powder River Irrigation District (PRID).

The entire length of the Sahara Ditch is generally in good condition. The overall drop from the diversion dam to the ditch end is approximately 80-feet and contains one drop structure at the end of the canal. The average slope is 0.00086 ft./ft. based on 80-feet divided by 93,500 feet. The canal gradient varies slightly throughout the reach of the Sahara Ditch. Although the Powder River carries tremendous sediment loads into the Sahara Ditch, there were no sediment problems encountered in the on-farm interviews conducted during the field investigation stage of this study. Most landowners and operators indicated that the sediment load actually was beneficial to them because it helped seal off seepage losses at structures and in the canal. Since

most of the water is applied by gravity flood irrigation, sedimentation problems were not evident.

Erosion of the main Sahara Ditch is not a problem from Station 0+00 to Station 862+00 except downstream of the highway culvert. There is some erosion occurring between Station 862+00 and the final structure at Station 935+00. Erosion is occurring on the Supply Ditch Lateral from Station 0+00 S.D. (Supply Ditch) through Station 32+50 S.D. and at the turnout and drop pipe of the East Lateral which diverts water from the main Sahara Ditch at Station 870+75.

Existing canal turnouts are generally of one type which seems to work well in the soil condition along the Sahara Ditch. Some are in poor condition or have been modified, but generally they consist of a vertical concrete headwall without wingwalls, with an outlet gate, and several feet of CMP outlet pipe.

Canal checks are used throughout the Sahara Ditch and the Supply Ditch Lateral to raise the canal level and back water into the turnouts. In some cases water could not be diverted without the check as the turnout is not on the canal bottom. In some cases, the lateral ditch can not be lowered and the headgate must be elevated to get water into the field lateral ditch. In other cases the headgate could be lowered to reduce the need for a check. Some turnouts are at the bottom of the canal and do not require a check structure. Several landowners indicated that the canal grade has dropped from bottom erosion to where their headgates are too high. Additional check structures will be needed where this has occurred.

A concrete box culvert on Highway #192 at Station 258+20 is currently restricting the canal flow. With the canal operating at approximately 60 cfs, the drop in water surface through the culvert was approximately one foot.

The existing Supply Ditch Lateral utilizes drop structures to dissipate energy. There are eight drops in 3250-feet with a total drop of 50-feet vertically. The existing structures are in poor condition and considerable erosion has occurred. The erosion will migrate upstream from the existing structures with failure of the main Sahara Ditch probable in the next year or two.

The Supply Ditch Lateral below Station 32+50 S.D. is in good condition with the only consideration being the replacement of turnouts. Minor ditch cleaning is needed in a portion of the ditch but was considered to be a normal PRID maintenance matter and was not included in this study. The velocity in the Supply Ditch Lateral below Station 32+50 S.D. appears to be suitable.

The Supply Ditch Lateral is used to irrigate 1358.6 acres of land of which 1278.6 acres are diverted at or below Station 32+50 S.D. It is recommended that the design capacity through Station 32+50 S.D. should be 40.0 cfs which is two times the appropriation of one cubic foot per seventy acres for 1400 acres.

The East Lateral is used to irrigate about 750 acres of land. The turnout and outlet drop structure are in poor condition and need to be replaced.

DIVERSION DAM

In most years the diversion dam experiences overflows during the spring runoff season typically occurring in June and thereafter, most of the river flow is diverted into the canal. During the study period from June until August, 1992 the Middle Fork Powder River was unusually high in response to continuous rainfall. This allowed for observations of how the structure performs, but it created difficulty in access for geotechnical exploration. Trash on the diversion dam and in the inlet channel or headgate is a major problem. Access for removal of trash is also a problem. Considerable floating debris in the river accumulates and requires extensive manual labor to removed. The diversion dam currently seeps water from underneath the concrete cap in several locations, has foreign material interbedded in the rock, and the concrete cap has collapsed at the downstream toe. The headgate is serviceable and the 2-4'x4' gates will open and close completely. The concrete wall forming the inlet channel has areas of serious deterioration. The worst deterioration is in the upstream section of the wall that was part of earliest structure.

SAHARA SIPHON

The Sahara (River) Siphon inlet and outlet structures are located on Terrace Deposits with the main pipe dropping into the flood plain and alluvial deposits of Powder River (also referred to as Middle Fork Powder River). The siphon is a 66-inch welded steel pipe with 1/4-inch wall thickness. At the actual river crossing the wall thickness is 5/16-inches for 100 feet in length. Concrete inlet and outlet headwalls are in good condition with no noticeable signs of settlement or cracking. The maximum water surface elevation difference as originally designed was 2.10 feet with a design capacity of 100 cubic feet per second (cfs). The welded steel pipe is 1015 feet in length and has a maximum sag of 31.6 feet and total drop measured to be 2.07 feet from end to end.

In April, 1992 both inlet and outlet headwall structures were examined when there was no flow in the canal. The concrete in both structures appeared to be in very good condition and does not require repairs or replacement. The initial 10 feet of welded steel pipe was inspected on the inside and considerable corrosion could be seen. Almost all of the original asphaltic coating was gone or flaking off.

A steel trash rack had been removed. In discussions with the district personnel it was stated that the trash racks were removed shortly after construction because they clogged up quickly and blocked the siphon inlet. Trash is difficult to remove and most of it apparently goes through the siphon without serious problems. It is recommended that trash racks on all siphons be reinstalled for safety reasons. If someone fell into the inlet section there would be no way to avoid being sucked into the siphon pipe. This same condition occurs on all four of the Sahara Ditch Siphon structures. An upstream trash rack with a side channel sluiceway could be devised to handle the extensive floating trash generated by cottonwood trees and tumble weeds, however they would be costly structures. The laborious task of cleaning the trash rack and sluiceway would still exist (although reduced), but would not require working directly over the siphon inlets. At the east end of the siphon where the welded steel pipe rises from under the creek bed, the left creek bank has scoured away leaving pipe exposed from about the middle of the river for about 120 feet into the left bank. Erosion around the outside of the pipe is an indication that this section of pipe might be leaking. It was concluded that this 120 foot section of pipe could

fail in the next year or two and should be replaced. Further investigation into the welded steel pipe corrosion condition was necessary to judge the rehabilitation potential. The District expressed unwillingness to shut down the canal during the study which coincided with the irrigation season. A method of evaluation from the pipe exterior had to be devised. Therefore, the pipe was excavated in two locations on the west side of the river and an ultrasonic instrument was used to measure remaining metal thickness.

FIFTEEN MILE SIPHON

Both inlet and outlet structures were examined. Rotation and settlement of the wing walls and settlement of the transition structure on the inlet and outlet structures was evident. As a result of the movement, rupture and stressing of the expansion joint connections between the wingwalls and transition walls has occurred. The inlet and outlet structures were originally equipped with steel trash rack assemblies. For safety purposes those trash racks should be reinstalled. They were apparently removed due to interference with the operations. In April, 1992 HKM Associates had an opportunity to inspect the upper 15 ft. of the siphon interior. The concrete transition section was in very good condition. Cracks were not evident in the floor slab with the only problem being water leakage out of the construction joints which have spread due to the structural settlement described above. Examination of the inlet and outlet pipe behind the structures indicate elliptical stressing of the pipe, crimping of the pipe bottom and open cracks at the top of the pipe. It appears that stressing of the pipe has occurred in this fashion due to excessive settlement of the inlet and outlet structure. The settlement most likely has occurred due to inadequate compaction and subsequent consolidation of the embankment fill.

ALTERNATIVES CONSIDERED

During this Level II Study considerable effort was made to determine the feasibility of constructing reservoir storage. Several alternatives were reviewed, however the cost in all cases was considerably higher than the participants were willing to pay. Comments expressed at the Interim Report presentation meeting indicated that a maximum annual cost of $5.00 per acre for improvement with some interest as high as $10.00 per acre assessment for reservoir storage. The least expensive reservoir storage alternative would enhance existing irrigation at an annual

RECOMMENDED PLAN

cost of $69.06 per acre which is a factor of 7 times the landowners willingness to pay. (This assumed a 50% Grant and a 50% Loan at 4% interest for a term of 40 years.)

The various alternative considered in this study are listed below:

- Canal Improvement (turnouts, checks and drops).
- Sahara Diversion Dam Alt. 1
- Sahara Diversion Dam Alt. 2
- Sahara Diversion Dam Alt. 3
- Sahara Diversion Dam Alt. 4
- Sahara Siphon Repair
- Sahara Siphon Replacement
- Fifteen Mile Siphon Repair
- Fifteen Mile Siphon Replacement
- Sahara Ditch Realignment (To eliminate the Sahara Siphon)
- Off-Channel Reservoir - Alt. 1A
- Off-Channel Reservoir - Alt. 1B
- Off-Channel Reservoir - Alt. 1C
- Off-Channel Reservoir - Alt. 2A
- Off-Channel Reservoir - Alt. 2B

Other upstream storage reservoirs discussed in previous studies were also reviewed and discussed in the Sahara Ditch Improvement - Level II - Final Report from which this Executive Summary was written.

RECOMMENDED PLAN

The recommendations resulting from the Sahara Ditch Improvement - Level II Project includes the following facilities:

Sahara Ditch Improvements. The improvements include the replacement of turn-out structures, check structures, drop structures and miscellaneous riprap and canal grade changes.

Sahara Diversion. It is recommended that the dam and headgate structure be replaced with an entirely new facility as shown in Figure 1.

Sahara Siphon. It is recommended that the entire Sahara Siphon be replaced with a new siphon with a designed capacity of 135 cfs.

Fifteen Mile Siphon. It is recommended that the entire Fifteen Mile Siphon be replaced with a new siphon designed for a capacity of 135 cfs.

LEGEND

STRUCTURE TO BE REMOVED

STRUCTURE TO REMAIN

NEW RCC DAM

NEW CONCRETE WALL

-N-

DH-5

DH-4

DH-3

DH-2

DH-1

20 0 20 40
scale feet

TELE POLE & BOX

BANK PROTECTION

EL.=93.0

NEW RCC DAM

NEW SLUICE PIPE

BANK PROTECTION

NEW CONCRETE HEADGATE

CP-1

EXISTING CONCRETE DAM

ABANDON OR REUSE OLD GATES

BACKFILL

90 92 84 100 110 120 130

DIVALT4A.DWG

FIGURE # 1

HKM ASSOCIATES
ENGINEERS · PLANNERS
10M103.128 AUG. 1992

SAHARA DIVERSION DAM IMPROVEMENTS
DIVERSION DAM IMPROVEMENTS
ALTERNATIVE 4

COST OPINION

COST OPINION

Several major components of the Sahara Ditch system are deteriorated with a very limited remaining life. A large portion of the project acreage will be left without irrigation water if any one of those components fails. It is recommended that the Sahara Siphon, Fifteen-Mile Siphon, and Sahara Diversion Dam be reconstructed. In addition, it is recommended that the eligible canal improvements identified during the structural inventory be made. An opinion of total cost to make these improvements is provided in Table 2.

The annual cost per acre to the Sahara Ditch water users is summarized in Table 3. The annual cost assumes a WWDC loan on all of the recommended canal improvements resulting in a net grant/loan ratio of 45/55. The recommended grant amount if $524,535 and the recommended loan amount is $635,233.

TABLE 2
COST OPINION
SAHARA DITCH IMPROVEMENTS
TOTAL PROJECT COSTS

Prepare Final Plans and Specifications		$ 66,220
Permitting and Mitigation		$ 20,300
Legal Fees		$ 20,000
Acquisition of Access and Right-of-Way		$ 0
Cost of Project Components: Canal Improvements Sahara (River) Siphon Fifteen-Mile Siphon Sahara Diversion Dam	 $ 131,000 $ 398,200 $ 120,400 $ 95,500	
Construction Cost Sub-Total #1	$ 745,100	
Engineering Costs = CCS #1 x 10%	$ 74,510	
Sub-Total #2	$ 819,610	
Contingency = Sub-Total #2 x 15%	$ 122,940	
Construction Cost Total		$ 942,550
Project Cost Total		$1,049,070
WWDC Grant (50%)		$ 524,535

TABLE 3
COST OPINION
SAHARA DITCH IMPROVEMENTS
ANNUAL COST PER ACRE

Item	Priority	50% of Construction Cost ($)	Engineering (10%)	Subtotal ($)	Contingency (15%)	Subtotal	Final Plans and Specifications	Permitting and Mitigation	Legal Fees	Total Loan Amount ($)	Total Annual Costs Per Acre ($/Acre)[1/]
Canal Improvements	3	$148,500[2/]	$ 14,850	$163,350	$ 24,503	$187,853	$ 11,880	$ 4,020	$ 4,510	$208,263	2.06
Sahara (River) Siphon	2	$199,100	$ 19,910	$219,010	$ 32,850	$251,860	$ 15,950	$ 4,000	$ 2,750	$274,560	2.71
Fifteen Mile Siphon	2	$ 60,200	$ 6,020	$ 66,220	$ 9,930	$ 76,150	$ 4,800	$ 1,000	$ 1,000	$ 82,950	0.82
Sahara Diversion Dam	1	$ 47,750	$ 4,780	$ 52,530	$ 7,880	$ 60,410	$ 3,800	$ 2,250	$ 3,000	$ 69,460	0.69
TOTAL LOAN AMOUNT AND COST PER ACRE										$635,233	**6.28**

1/ Based on 5116 acres and an interest rate of 4% for 40 years.

2/ Costs shown are not eligible for WWDC Grant. Grant amount is one-half of the eligible construction costs or $65,500 plus a proportionate part of engineering, permitting and mitigation, and legal fees for a total grant amount of $91,860.