

This is a digital document from the collections of the *Wyoming Water Resources Data System (WRDS) Library*.

For additional information about this document and the document conversion process, please contact WRDS at wrd@uwyo.edu and include the phrase “**Digital Documents**” in your subject heading.

To view other documents please visit the WRDS Library online at:
<http://library.wrds.uwyo.edu>

Mailing Address:

Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:

Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651

Fax: (307) 766-3785

Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission
(<http://wwdc.state.wy.us>)

CRAZY WOMAN WATERSHED PROJECT - LEVEL II

PHASE I
REHABILITATION PLAN
AND
PHASE II
CONCEPTUAL DESIGN AND COST ESTIMATES
FINAL REPORT

Prepared For:

WYOMING WATER DEVELOPMENT COMMISSION
Herschler Building
Fourth Floor - West
Cheyenne, WY 82002

Prepared By:

HKM ASSOCIATES
1842 Sugarland Drive, Suite 103
Sheridan, Wyoming 82801
307-672-9006

November 6, 1991



39092 05738673 4

PROPERTY OF
Water Resources Data System
Library
Wyo Hall 230
307-766-6661

CRAZY WOMAN WATERSHED PROJECT - LEVEL II

**PHASE I
REHABILITATION PLAN
AND
PHASE II
CONCEPTUAL DESIGN AND COST ESTIMATES**

Prepared For:

**WYOMING WATER DEVELOPMENT COMMISSION
Herschler Building
Fourth Floor - West
Cheyenne, WY 82002**

Prepared By:

**HKM ASSOCIATES
1842 Sugarland Drive, Suite 103
Sheridan, Wyoming 82801
307-672-9006**

November 6, 1991

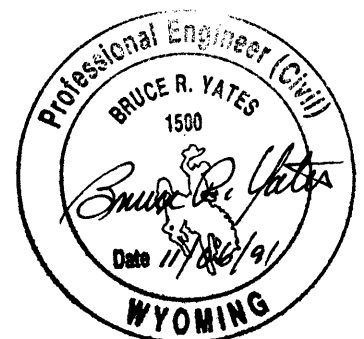


TABLE OF CONTENTS

	<u>PAGE</u>
INTRODUCTION	1
PHASE I - REHABILITATION PLAN	3
Scoping Meeting	3
Field Inspection	3
Draft Rehabilitation Plan	8
PHASE II - CONCEPTUAL DESIGN AND COST ESTIMATES	15
Surveying and Mapping	15
Geotechnical Analysis	15
Conceptual Design	17
Design Criteria	17
No. 1 Roger-Fraley-Benson Ditch	19
No. 2 Elsom-Espy-Benson Ditch	20
No. 3 Daley-Patch-Tass-McPhee Ditch	22
No. 4 Nimick-Fraley-41 Ditch	22
No. 5 Tass-Patch-McPhee Ditch	23
No. 6 41 Ranch-Bauer Ditch	25
No. 7 Riprap Repair - Muddy Guard No. Reservoir	26
No. 8 Repair Headgate and Diversion Dam on the Cook (No. 9) Ditch	27
No. 9 Replace Jensen-McPhee-Clow Drop Pipe Extension	28
No.10 Nimick-Fraley Pipeline	28
Cost Estimates	29
Permitting	40
PROJECT SUMMARY	43
REFERENCES	46

LIST OF TABLES

<u>Table No.</u>		
1	Facility Name Cross Reference	4
2	No. 1 Roger-Espy-Fraley-Benson Ditch	31
3	No. 2 Elsom-Espy-Benson Ditch	32
4	No. 3 Daley-Patch-Tass-McPhee Ditch	33
5	No. 4 Nimick-Fraley-41 Ditch	34
6	No. 5 Tass-Patch-McPhee Ditch	35
7	No. 6 41 Ranch-Bauer Ditch	36

LIST OF TABLES - (continued)

8	No. 7 Riprap Repair - Muddy Guard No. Reservoir	37
9	No. 8 Repair Headgate and Diversion Dam on the No. 9 Ditch	38
10	No. 10 Replace Nimick-Fraley Ditch with Pipeline	39
11	Permits Required in the Level III Design Stage	42
12	Cost Summary - Total Project Cost Estimate	44
13	Loan Amortization Schedule	45

LIST OF FIGURES

Figure No.

1	Location Map	1
2	Areas Irrigated from Ditches proposed for Rehabilitation	3
3	Land Ownership Map	3
4	Conceptual Design Map	19
5	Hydraulic Schematic - No. 1 Rogers-Fraley- Benson Ditch	19
6	Hydraulic Schematic - No. 2 Elsom-Espy-Benson Ditch	20
7	Hydraulic Schematic - No. 3 Daley-Patch-Tass-McPhee Ditch	22
8	Hydraulic Schematic - No. 4 Nimick-Fraley-41 Ranch Ditch	23
9	Hydraulic Schematic - No. 5 Tass-Patch-McPhee Ditch	24
10	Hydraulic Schematic - No. 6 41 Ranch-Bauer Ditch	25
11	Section A-A - South Embankment, Muddy Guard No. 2 Reservoir	26
12	Section B-B - South Embankment, Muddy Guard No. 2 Reservoir	26
13	Plan View - South Embankment, Muddy Guard No. 2 Reservoir	26
14	Typical Diversion Dam	27

APPENDICES

APPENDIX A - SCOPING MEETING MINUTES

APPENDIX B - PRESENTATION MEETING MINUTES

APPENDIX C - PHOTOGRAPHS

APPENDIX D - TYPICAL DETAILS

Figure D-1 Typical Trench Detail for PVC Pipe Installation

APPENDIX D (continued)

Figure D-2 Typical Pipeline Delivery Detail

Figure D-3 Typical Concrete Lined Section

Figure D-4 Typical Membrane Lining of Existing Ditch

Figure D-5 Typical Inverted Siphon

Figure D-6 Typical Stilling Well

Figure D-7 Typical Field Ditch Check Structure

Figure D-8 Typical Outlet to Open Ditch and Gated Pipe

Figure D-9 Typical Canal Delivery

Figure D-10 Typical Flared End Irrigation Inlet or Outlet

Figure D-11 Typical Precast Irrigation Inlet or Outlet

Figure D-12 Typical Trash Guard for Pipe Inlets

Figure D-13 Typical Pipeline Drain Detail

APPENDIX E - MUDDY GUARD RESERVOIR #2 INSPECTION REPORT

INTRODUCTION

The purpose of this Level II Study is to analyze the potential for the rehabilitation or replacement of selected irrigation structures in the Crazy Woman Watershed Improvement District. The district is located in Johnson County, Wyoming approximately 15 miles south of Buffalo, Wyoming (see Figure 1).

The study is divided into two phases. Phase I is the Preliminary Analysis and Phase II is the Conceptual Design and Cost Estimates. This report was partially prepared during Phase I and completed in Phase II.

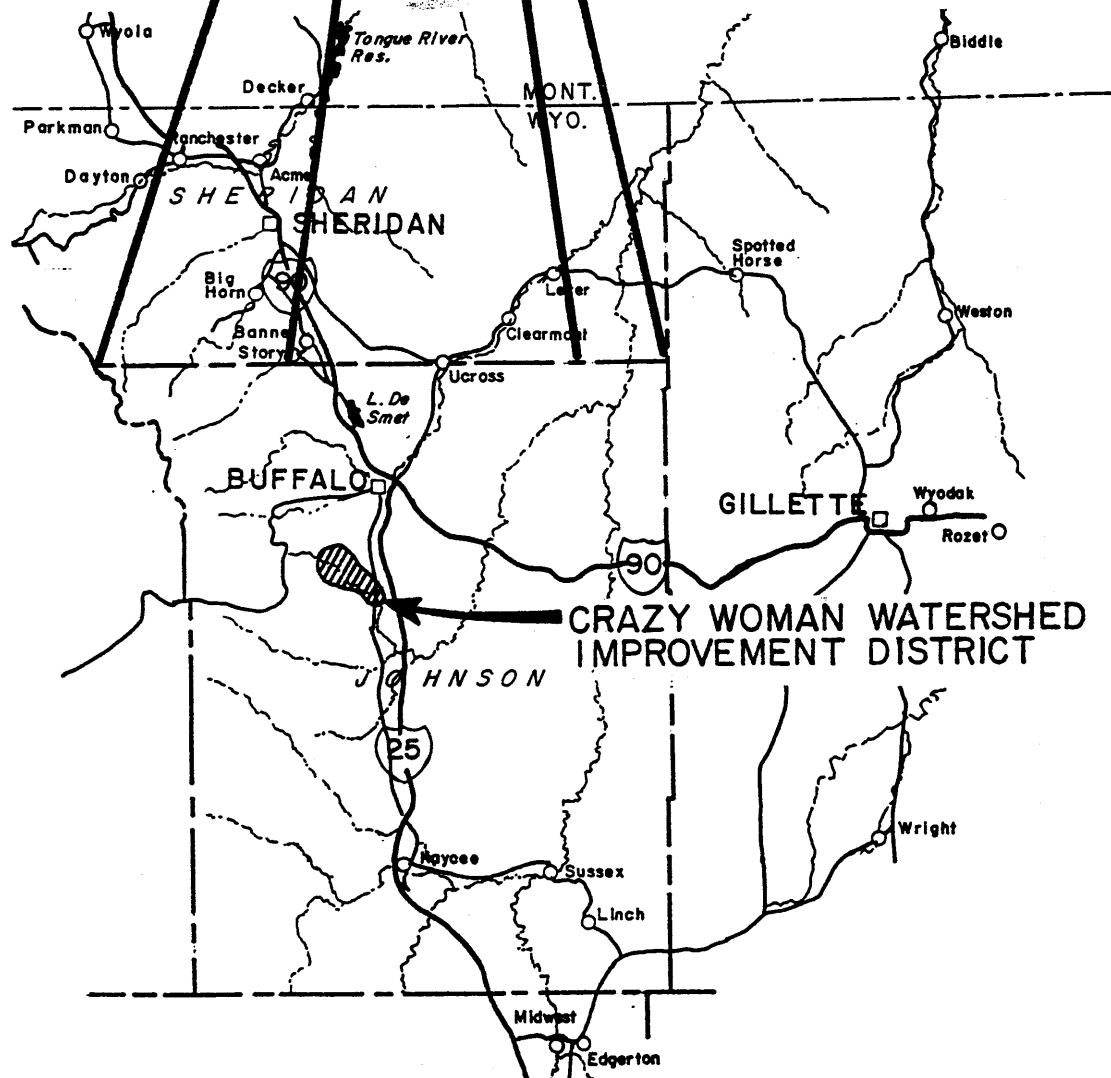
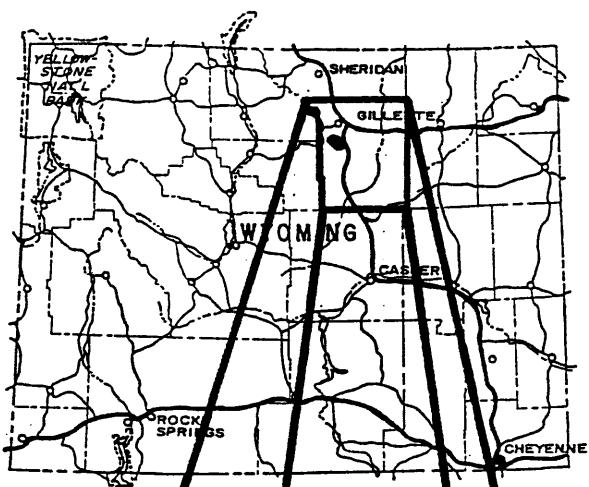
The first step was to hold a scoping meeting to advise local participants of the scope of work and to solicit input from those present. Mr. Evan Green, representing the Wyoming Water Development Commission stated that the preliminary work will consider two system sizing criteria:

1. Assume that the minimum flow will be 2 cfs per 70 acres for irrigated lands.
2. Assume that the maximum flow will be no greater than the historical diversion record.

The second part of the study was to inventory the irrigation facilities and structures, discuss irrigation practices with landowners, Soil Conservation Officials, and the local water commissioner, and to measure present ditch capacities where practical.

The next task was to evaluate specific sections of the irrigation systems as listed below (Ditches are shown on Figure 2):

1. Roger-Espy-Fraley-Benson Ditch
2. Elsom-Espy-Benson Ditch



LOCATION MAP

FIGURE 1

**HKA ASSOCIATES
ENGINEERS • PLANNERS**
10M183.123 | SEPT. 1991

3. Daley-Patch-Tass-McPhee Ditch
4. Nimick-Fraley-41 Ditch
5. Tass-Patch-McPhee Ditch
6. 41 Ranch-Bauer Ditch
7. Riprap Repair-Muddy Guard No. 2 Reservoir
8. Repair Headgate and Diversion Dam on the No. 9 Ditch
9. Replace Jensen-McPhee-Clow Drop Pipe Extension
10. Replace Nimick-Fraley Ditch with a pipeline

After analyzing the various system components a rehabilitation plan was to be prepared for each of the ten component projects.

Upon completion of this preliminary scope of work, the next step was the presentation to the landowners. After a period of review and comment by the landowners, the study was to proceed into the Phase II Conceptual Design and Cost Estimates.

PHASE I

REHABILITATION PLAN

PHASE I - REHABILITATION PLAN

The Phase I - Rehabilitation Plan included a scoping meeting, a field inspection and a draft rehabilitation plan.

SCOPING MEETING

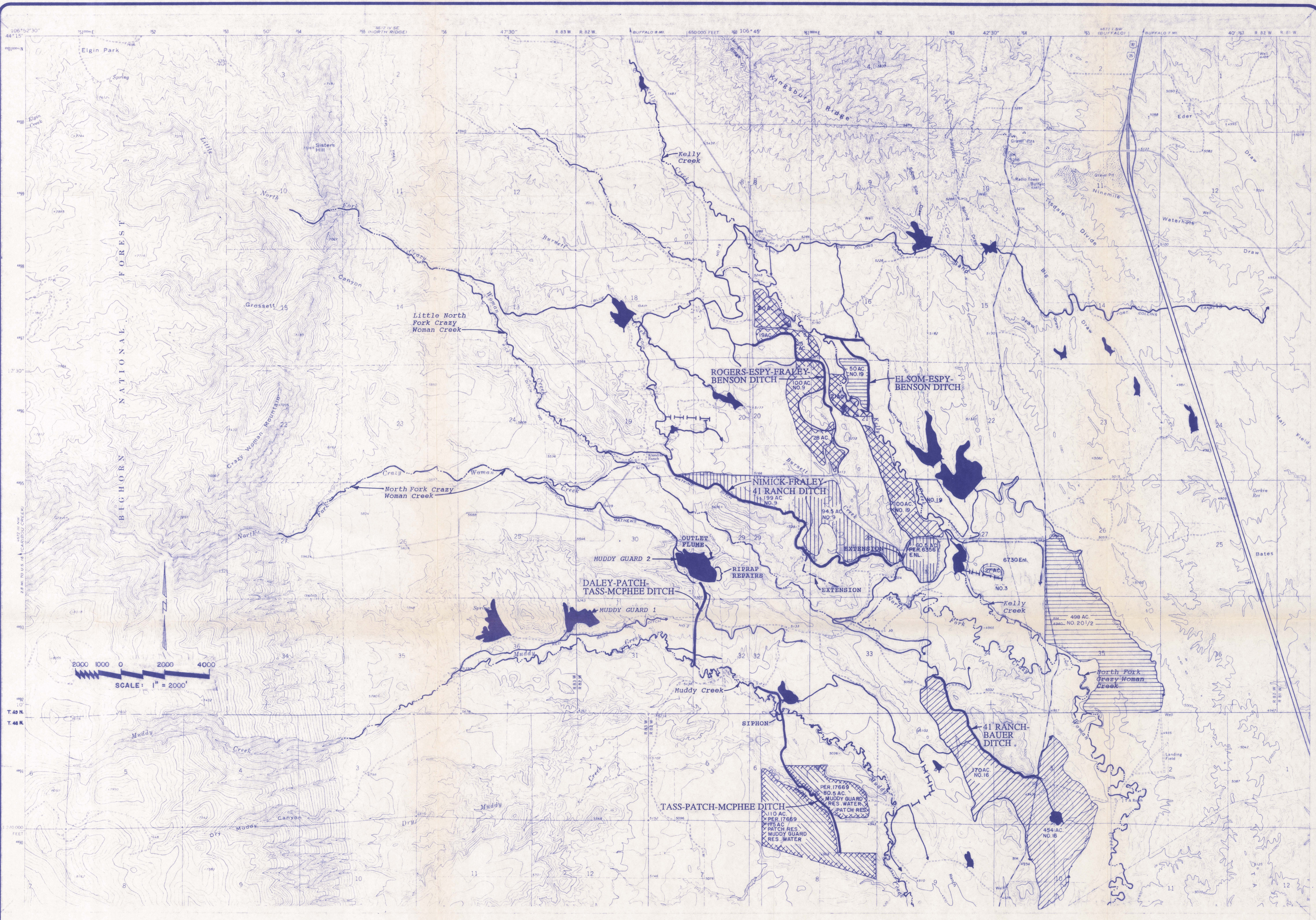
A scoping meeting was held in Buffalo, Wyoming on June 25, 1991 to discuss the project. A copy of the meeting minutes is found in Appendix A.

FIELD INSPECTION

A field inspection was performed to determine the present condition and capacity of the existing water distribution system. A structural inventory of existing headgates, flumes, splitter boxes, drop structures and ditches was prepared. The number of acres being served by each of the system components was also estimated.

Figure No. 1 shows the general location of the facilities. Figure 2 illustrates areas irrigated from ditches slated rehabilitation. Figure 3 shows land ownership throughout the project area.

The introduction of this report identifies facility names which were introduced by the Crazy Woman Watershed Improvement District (CWWID). To correlate those names with water rights and water commissioner records, Table No. 1 was prepared as a cross reference.

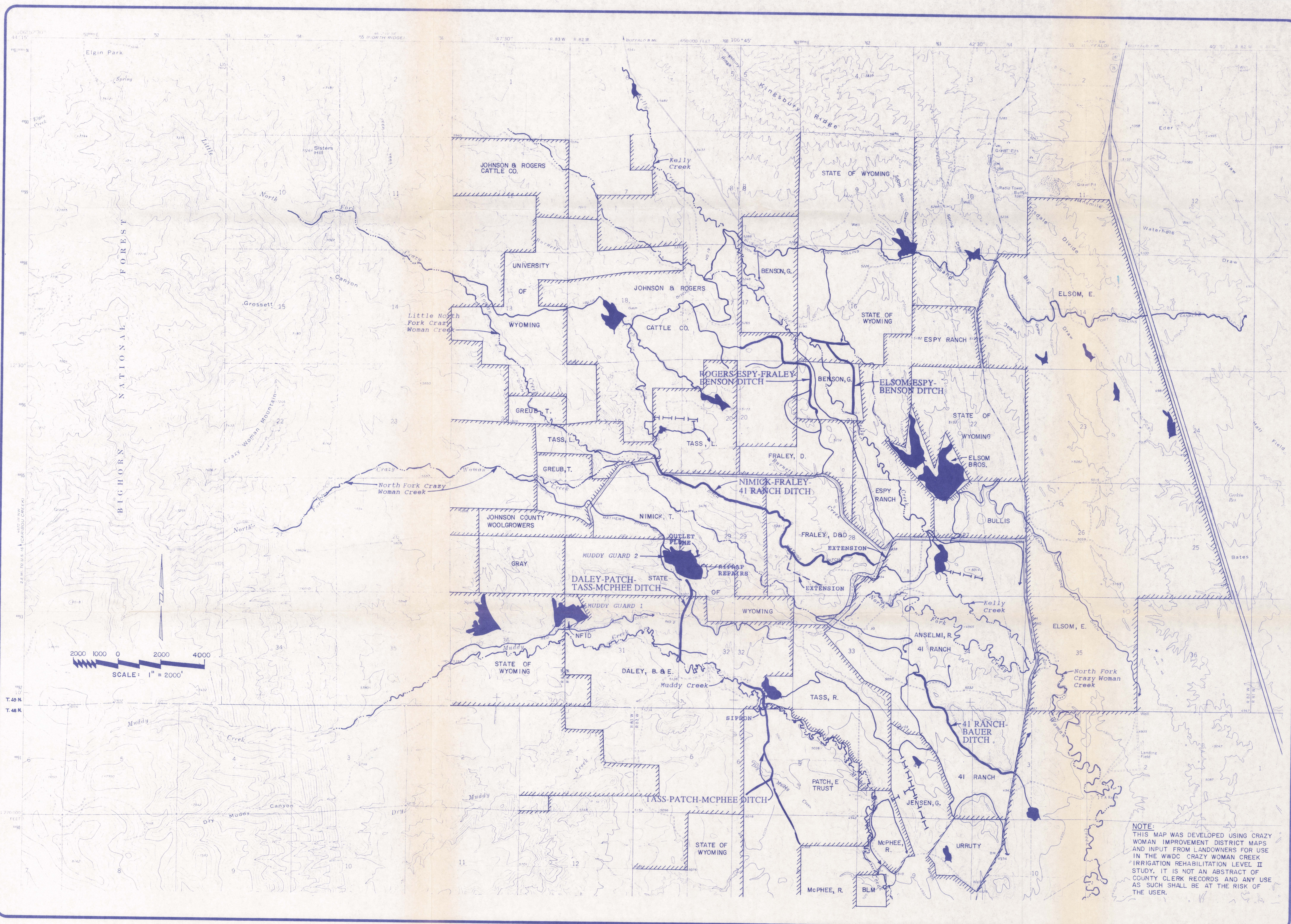


No.	Revision	By	Date

Project No. IOM183.123 I.D. No. _____ Date APRIL 1991 Designed BY: Drawn: MNG Checked: Approved: _____
CRAZY WOMAN CREEK IRRIGATION REHABILITATION STUDY
 PHASE I REHABILITATION PLAN
 AREA IRRIGATED FROM DITCHES PROPOSED FOR REHABILITATION

HKA ASSOCIATES
ENGINEERS-PLANNERS
 Home Office: P.O. Box 31318
 • Airport Industrial Park
 Suite 103
 Sheridan Wyoming 82801 • Billings, Montana 59107

Sheet No. _____
FIGURE
 2
 of _____



NOTE: THIS MAP WAS DEVELOPED USING CRAZY WOMAN IMPROVEMENT DISTRICT MAPS AND INPUT FROM LANDOWNERS FOR USE IN THE WWDC CRAZY WOMAN CREEK IRRIGATION REHABILITATION LEVEL II STUDY. IT IS NOT AN ABSTRACT OF COUNTY CLERK RECORDS AND ANY USE AS SUCH SHALL BE AT THE RISK OF THE USER.

Project No. IOM183.123		Date OCT 1991		Designer: BRY Drawn: LNC		Checked: Approved	
No.	Revision	By	Date				
CRAZY WOMAN CREEK IRRIGATION REHABILITATION STUDY				LAND OWNERSHIP MAP			

HKA ASSOCIATES
ENGINEERS-PLANNERS
 Home Office: P.O. Box 31318
 • Airport Industrial Park
 Suite 103 • Billings, Montana 59107
 Sheridan Wyoming 82801

Sheet No
FIGURE 3

TABLE 1
FACILITY NAME CROSS REFERENCE

<u>CWWID Name</u>	<u>Water Right</u>
1. Roger-Espy-Fraley-Benson Ditch:	Cook Ditch Lateral
2. Elsom-Espy-Benson Ditch:	Cross Over Ditch and Lateral
3. Daley-Patch-Tass-McPhee Ditch:	Thompson & Mathews Extension Lateral
4. Nimick-Fraley-41 Ditch:	Watkins Lateral Cook Ditch
5. Tass-Patch-McPhee Ditch:	Bash's PX Ditch Lateral (Mitten Ditch)
6. 41 Ranch-Bauer Ditch:	Kennedy Ditch Lateral
7. Riprap Repair-Muddy Guard Reservoir:	(No change)
8. Repair Headgate No. 9 Ditch:	Cook Ditch (Little North Fork Crazy Woman Creek)
9. Jensen-McPhee-Clow Drop Pipe:	No. 16 Extension
10. Nimick-Fraley Ditch:	Watkins Lateral Extension-Cook Ditch

Aerial photographs were not obtained for this project due to cost constraints. Therefore, photographs from the Soil Conservation Service along with U.S.G.S. topographic quadrangle maps were used for the field investigation work. A field inspection was made during July, 1991. HKM Associates inspected each facility being considered for rehabilitation and measured ditch slopes using a level and a measuring wheel. Each facility is reported in the following descriptions. Irrigated areas presented in the rehabilitation plan at the September 6, 1991 Presentation Meeting are shown on Figure 2.

NO. 1 Roger-Espy-Fraley-Benson Ditch

The Rogers-Espy-Fraley-Benson Ditch is a lateral of the Cook Ditch which diverts water from the Little North Fork and the North Fork

of Crazy Woman Creek. Land served by the ditch are owned by G. Benson, Johnson & Rogers Cattle Company, D. Fraley, and the Espy Ranch.

The headgate at station 0+00 on Figure No. 2 which diverts from the Cook Ditch is a concrete structure which is in good condition (Refer to the Photograph C-1 in Appendix C). From Station 0+00 to Station 37+00 the ditch is in good condition and does not need repair work. Headgates and culverts along this 3700 foot section are in good, usable condition.

At Station 37+00 severe ditch erosion begins as depicted in a photograph taken at Station 45+12. (See Appendix C - Photograph C-2 and C-3) Most of the headgate turn-outs and splitter boxes appear to be reusable. The drop structures may not be reusable. The drop structures appear to function alright, but they collect considerable trash in the trash rack.

The flow rate of 7.00 cfs was measured at full capacity. In several sections, water was spilling from the ditch.

NO. 2 Elsom-Espy-Benson Ditch

The Elsom-Espy-Benson Ditch is used to take water from Kelly Creek to an unnamed gulch which delivers water to Kingsbury-Todd No. 1 and Kingsbury-Todd No. 2 Reservoirs. (See Figure 2) Water follows the first 630 feet of what is otherwise known as the cross over ditch and then follows what is otherwise known as the cross over lateral. The Elsom-Espy-Benson ditch also delivers water to irrigated lands below the Kingsbury-Todd Reservoir outlets. The irrigated lands are Priority No. 20½ on the Crazy Woman Creek Court Decree.

The cross over ditch is eroding and needs to be replaced by a pipeline or an open ditch with drop structures. The cross over ditch is approximately 1680 feet with the last 1050 feet serving

only one landowner. Since the cross over ditch serves only one landowner beyond Station 6+30, no further consideration was given to the final 1050 feet.

At Station 6+30 the cross over lateral serves land owned by three landowners. The lateral beginning at Station 6+30 is 4108 feet in length and is eroded severely.

NO. 3 Daley-Patch-Tass-McPhee Ditch

Project No. 3 will be used to divert North Fork Crazy Woman Creek surplus flow from the terminal end of the Thompson and Mathews Ditch for use in the Muddy Creek drainage. It will also provide an overflow system for Muddy Guard No. 2 Reservoir. Portions of an existing overflow ditch is eroded severely and needs to be replaced. It is proposed that the existing ditch be replaced with a pipeline and an energy dissipator where it discharges to Muddy Creek. (See Figure 2)

NO. 4 Nimick-Fraley-41 Ditch

This facility is also known as the Watkins Lateral of the Cook Ditch. The headgate in the Cook Ditch is in good condition and the first 1463 feet of ditch is in good condition. The next 1200 feet of ditch is eroding severely. The ditch stabilizes for about 2700 feet and then experiences severe erosion for another 300 feet. The next 3100 feet of ditch is stable with erosion again occurring in the final 5650 feet. A total of 7150 feet of ditch is experiencing moderate to severe erosion. (See Figure 2.) Erosion is shown in Appendix C on Photograph C-4, C-5, and C-6.

NO. 5 Tass-Patch-McPhee Ditch

The existing Mitten Ditch serves lands south of Muddy Creek owned by Patch Trust and Ron McPhee. The Muddy Creek diversion is in poor condition and the first 500 feet of ditch is experiencing

extreme sloughing as the ditch exits the Muddy Creek banks. The sloughing is primarily caused by irrigation tailwater seeping into the vertical embankments and causing instability. Correcting this problem by reconstructing the ditch does not appear to be practical as the problem will likely reoccur.

There are two alternatives involving the use of the existing Thompson Brothers Ditch or the Bash's PX Ditch. The alternatives are discussed in a later section, but the condition of the ditches is discussed in this section.

The Bash's PX Ditch serves land on the north side of Muddy Creek. The headgate and the first 800 feet of ditch which would be used are in good condition. The ditch will need to be cleaned and slightly enlarged.

The Thompson Brothers Ditch on the south side of Muddy Creek has a headgate that is in fair condition. The ditch would need to be enlarged as it currently only serves about 50 acres.

NO. 6 41 Ranch - Bauer Ditch

The 41 Ranch-Bauer Ditch is also known as the Kennedy Ditch lateral. (See Figure 2.) The headgate out of the Kennedy Ditch is in good condition. The ditch for the first 6146 feet is in good condition. Severe erosion is occurring in two sections of ditch 260 feet and 265 feet each. Except for the 525 feet of erosion, the 41 Ranch-Bauer Ditch is in good condition. Erosion is shown in Appendix C - on Photographs C-7 and C-8.

NO. 7 Riprap Repair - Muddy Guard Reservoir

At the start of the field investigation, the water level of Muddy Guard No. 2 was at the spillway elevation and riprap could not be inspected. On October 2, 1991 the reservoir south embankment was inspected with the water level below the embankment and riprap.

The original riprap appeared to have been placed on the embankment face with no overlap from the abutment onto original ground. Some riprap sloughing has occurred from about 15 feet below the dam crest to the water edge at 65 feet below the dam crest. The present embankment slope was measured at 3.1:1 indicating a slight change from the original 3:1 design. The top 10 feet of embankment is slightly steeper than the lower 55 feet, thus verifying a slight sloughing of the embankment materials. It appeared that the riprap in the upper 15 feet was generally larger and it was at a higher density than that in the lower 55 feet. Bedding material was not apparent and has probably washed out from under the riprap. (See Photograph C-9, Appendix C.)

In April 28, 1989 the State of Wyoming, Assistant Dam Safety Engineer inspected the Muddy Guard No. 2 Reservoir pursuant to the Wyoming Safety of Dam's Law (W.S. 41-3-307 through 41-3-318). In that inspection, the south dam of Muddy Guard No. 2 Reservoir was classified as a significant hazard or Class II Dam. During that inspection, significant displacement and erosion resulting from wave action were reported. The inspection report is provided in Appendix E.

NO. 8 Repair Headgate No. 9 (Cook) Ditch

The Cook Ditch diverts water from North Fork of Crazy Woman Creek then brings it a short distance where it is co-mingled with Little North Fork of Crazy Woman Creek and rediverted. (See Figure 2.) The headgate and ditch bringing water from North Fork are in fair condition. The headgate at the Cook Ditch diversion from Little North Fork is also in fair condition. The main concern is that a serious flood event could cause extensive damage or complete failure. It was reported that the dike containing the headgates is frequently overtopped and some bank sloughing has occurred immediately downstream from the spillway (see photograph C-10 of Appendix C).

Trash accumulates and must be cleared frequently from the headgates. The trash is a severe nuisance but does not appear to be an eminent structural problem (see photograph C-11 of Appendix C).

The diversion consists of dike with a concrete overflow spillway. Little North Fork Creek water and water diverted from North Fork Creek flow directly into a pool above the spillway. A dike contains two headgates that form the beginning of the Cook Ditch. The dike also contains a gated pipe and an uncontrolled outlet pipe which returns water to the stream channel below the diversion.

The structure appears to have underwent considerable repair and stabilization. However, it works quite well and appears to be stable at least for normal conditions. A 4-foot Parshall flume located 530 feet downstream in the Cook Ditch provides measurements of the diversion.

The structural foundation appears to be bearing on glacial deposits of cobbles and boulders to considerable depth.

No. 9 Jensen-McPhee-Clow Drop Pipe

There was no inspection/inventory because it was considered single user.

NO. 10 Nimick-Fraley Pipeline

This is a new project, therefore, there was no inspection/inventory.

DRAFT REHABILITATION PLAN

During Phase I, HKM Associates prepared rehabilitation plans for the ten projects identified in the previous section titled Field Inspection. The plan, with preliminary costs for several of the

projects, was presented to the Crazy Woman Watershed Improvement District on September 6, 1991. The following summary describes the plan as presented on September 6, 1991 which is more specifically described in a Phase I, Preliminary Report dated September 1991. A copy of the Presentation Meeting Minutes are enclosed in Appendix B.

No. 1 Rogers-Espy-Fraley-Benson Ditch

The proposed rehabilitation plan was to correct severe erosion problems by replacing open ditch with 10,972 feet of PVC (P.I.P.) pipeline. The plan included:

Irrigated Area	313 Acres
Diversion Rate	8.94 CFS
Pipe Length	10,972 Feet
Pipe Size	6 inch to 18 inch
Preliminary Cost	\$84,174

This pipeline would serve two separate landowners with the WWDC portion of the project terminating at Sta. 109+72 where the pipeline becomes a single user system. Modification to this rehabilitation plan was discussed on September 6, 1991 and incorporated into the Phase II Conceptual Design.

No. 2 Elsom-Espy-Benson Ditch

The original plan proposed by the CWWID was to serve lands owned by landowners Elsom, Espy and Benson. It was HKM Associates conclusion that the first 630 feet of the proposed plan was a multiple user system and that was the only portion of the project that the WWDC could participate in. Since the 630 feet was such a small part of project No. 2, HKM Associates recommended that the WWDC should not participate in this project. Therefore, no hydraulic sizing nor preliminary costs were prepared.

At the presentation meeting held September 6, 1991, the CWWID concluded that modification could be made to the original plan which would benefit the users and make Project No. 2 a viable multi-user plan. Therefore, the Phase II Conceptual Plan readdressed Project No. 2.

No. 3 Daley-Patch-Tass-McPhee Ditch

During the Phase I study, it was determined that water rights did not exist for the proposed project. The source of water for Project No. 3 was not established. Therefore, HKM Associates recommended that the WWDC should not participate in this project. Further analysis of hydraulics or preliminary costs was not made.

At the presentation meeting held September 6, 1991 at Buffalo, Wyoming the CWWID requested that this project be reconsidered by the WWDC. Mr. Evan Green pointed out that a commitment on the part of the CWWID to file appropriate water rights for Project No. 3 would allow the WWDC to participate. The CWWID agreed to prepare a filing for an appropriation to enlarge the Thompson and Mathews Ditch and divert water from the North Fork Crazy Woman Creek into the Thompson and Mathews Ditch to this project. It was stated by landowners along the North Fork Crazy Woman Creek that they are opposed to the filing. Based on the conclusions at the presentation meeting, Mr. Evan Green advised HKM Associates to proceed and include this Project No. 3 into the Phase II Conceptual Design stage.

NO. 4 Nimick-Fraley-41 Ditch

During Phase I, a rehabilitation plan was prepared for the plan proposed by the CWWID. The plan was to replace an eroding Watkins Ditch with pipeline starting at the point of diversion in the Cook Ditch. The plan included:

Irrigated Area

354 Acres

Diversion Rate	10.11 CFS
Pipe Length	14,441 Feet
Pipe Size	8 inch to 24 inch
Preliminary Cost	\$212,881.00

At the presentation meeting held September 6, 1991 the CWWID decided to include one additional landowner into the system. Mr. Evan Green agreed to modify the plan and advised HKM Associates to make changes in the Phase II, Conceptual Design.

No. 5 Tass-Patch-McPhee Ditch

The original plan proposed by the CWWID was to deliver water to three landowners. During the Phase I investigation, HKM Associates concluded that Project No. 5 was a single user system. Therefore, it was recommended that the WWDC should not participate in funding.

During the presentation meeting held on September 6, 1991, landowners present identified separate land ownership by differentiating between Ron McPhee and his father-in-law, Ellis Patch. Mr. Evan Green evaluated the ownership conditions and concluded that HKM Associates should proceed with this project in the Phase II, Conceptual Design.

No. 6 41 Ranch-Bauer Ditch

The original plan as proposed by the CWWID was to eliminate an existing lateral ditch which was flat and seeping in the first 3,000 to 4,000 feet and eroding severely in the second 4,500 feet. The plan included:

Irrigated Area	624 cres
Diversion Rate	17.33 CFS
Pipe Length	7673 Feet
Pipe Size	16 inch to 18 inch
Preliminary Cost	\$62,246

At the presentation meeting held on September 6, 1991, one of the landowners requested consideration of an alternate to construct a pipeline in another location thus allowing him to better utilize elevation drop to pressurize sprinkler irrigation systems. It was concluded that the other landowner in Project No. 6 could also benefit from this change. Mr. Evan Green instructed HKM Associates to consider the alternative in the Phase II, Conceptual Design.

No. 7 Riprap Repair - Muddy Guard Reservoir

During the Phase I study the water level was too high in Muddy Guard No. 2 Reservoir to make an inspection of the riprap. Therefore, this work was delayed to the Phase II, Conceptual Design stage.

No. 8 Repair Headgate and Diversion Dam on the Cook (No. 9) Ditch

During the Phase I rehabilitation plan HKM Associates concluded that the Cook Ditch diversion dam and headgate is functioning satisfactorily. However, a new structure is recommended which would be capable of handling a 50 year frequency storm event. The preliminary cost for replacement of the existing structure was estimated at \$31,000. Sheetpiling cost was not verified in the preliminary cost estimate. The cost is increased some in the Phase II, Conceptual Design.

No. 9 Jensen-McPhee-Clow Drop Pipe

During the Phase I rehabilitation plan study HKM Associates concluded that Project No. 9 was not a multiuser project and therefore, recommended the WWDC should not participate in the project.

At the presentation meeting held September 6, 1991 landowners indicated that system modifications would result in multiple user benefits. Mr. Evan Green advised HKM Associates to reconsider this

project in the Phase II, Conceptual Design, if a field investigation resulted in a multiple user conclusion. The CWWID was asked to contact the other potential users to determine interest.

No. 10 Nimick-Fraley Pipeline

During the Phase I study HKM Associates did not find any interest in this project with the CWWID members who were contacted. Since the Phase I presentation meeting, landowners have contacted HKM Associates and asked for the project to be reconsidered. The project is discussed in the Phase II, Conceptual Plan in this report.

PHASE II

**CONCEPTUAL DESIGN
AND
COST ESTIMATES**

PHASE II CONCEPTUAL DESIGN AND COST ESTIMATES

The conceptual design and cost estimates phase includes surveying and mapping, geotechnical analysis, conceptual design, cost estimate and permitting tasks.

SURVEYING AND MAPPING

Preliminary surveying consisted of determining relative elevation differences and stationing along the selected ditches. Ditch slopes were estimated using a level and measuring wheel.

What is considered irrigated land and what is not is an important factor. Maps which accurately delineate irrigated areas are not available and the scope of this project did not allow for mapping of irrigated lands. Therefore, several sources of information was used to delineate irrigated lands as follows:

1. Meetings with landowners
2. CWWID Maps
3. U.S.G.S. Quadrangles
4. SCS Aerial Photographs
5. Petition Maps
(Osland, 1976)
6. Crazy Woman Creek Ditches
and Irrigated Lands
(Burritt, 1935)
7. Individual Appropriation Maps
8. State Engineer's Range Plats
9. State Engineer's Ditch Plats

GEOTECHNICAL ANALYSIS

A brief geotechnical investigation was performed during the field studies and data accumulation. The primary focus of the investigation was to determine, if possible, soil classifications, depth to bedrock, and corrosion potential of the soil. The investigations consisted of visual observation and soil sampling during the field visits. The samples were then returned to the HKM Materials Lab in Sheridan where testing was then performed. The tests performed included resistivity measurements, grain-size analysis, and Atterberg Limits. Three locations were sampled.

Each sample was selected to represent the typical soils found along that stretch of ditch. The three locations were at Project No. 1 Rogers-Espy-Fraley-Benson Ditch, Project No. 3 Daley-Patch-Tass-McPhee Ditch and Project No. 4 Nimick-Fraley-41 Ditch.

Sample No. 1

A thirty pound sample was obtained at Station 59+25. The soils resistivity measurements were 1235 ohm/cm. This value of resistivity is indicative of aggressive or corrosive soils. Moderate to severe corrosion may occur to unprotected metal surfaces in this soil depending upon moisture content of the material. The soil is a dark clay having a plasticity index of 17. A grain size analysis of the material revealed no material larger than the No. 4 screen. Approximately sixty percent of the sample was comprised of clay particles with the remaining being sand. No evidence of any rock formations or gravel layers were visual.

Sample No. 2

A thirty pound sample was obtained at Station 0+00. The soils resistivity measurements were 1533 ohm/cm. The value of resistivity is indicative of aggressive or corrosive soil. Moderate to severe corrosion may occur to unprotected metal surfaces in this soil depending upon moisture content of the material. The soil was a reddish brown clay having a plasticity index of 27. The entire sample passed a No. 4 screen with approximately two-thirds of the material comprised of clay particles. Visual study during the field reconnaissance did not reveal any evidence of rock formations or gravel layers.

Sample No. 3

A thirty pound sample was obtained at Station 103+50. A bedrock formation was exposed for about fifty feet in the ditch section from Station 104+00 to 104+50. The soils resistivity measurement

was 835 ohm-cm. This was the lowest value of any of the samples taken. A soil possessing this value of resistivity will be corrosive to unprotected metal surfaces. The soil was a grayish to dark brown clay with a plasticity index of 20. Eighty-six percent of the sample consisted of clay particles with the entire sample passing the No. 16 sieve.

It is this report's findings, that constructibility of an underground piping network consisting of a poly vinyl chloride plastic irrigation pipe is recommended. Installation should be able to be completed through the use of conventional construction methods including both trenching and backhoe excavation. Due to the corrosive nature of the soils encountered, corrosion inhibitors should be used on all buried metal appurtenances. Additionally, any concrete mix shall include a Type V, sulfate resistant cement.

CONCEPTUAL DESIGN

This section includes a discussion of design criteria and the conceptual design for each of the project components. Project No. 9 is not included because it was dropped during Phase I. Project No. 9 (Jensen-McPhee-Clow Drop Pipe Extension) was discontinued because it is a single user system.

Design Criteria

The purpose of this study is to rehabilitate projects proposed by the Crazy Woman Watershed Improvement District and determine the associated costs. Engineering design was to be conceptual level which means taking the design far enough to establish a plan and cost estimate. Final design work will take place in the Level III Final Design and Construction.

A number of factors had to be considered to establish engineering criteria. Those included: water rights, irrigated lands, system operations, landowners desires, and WWDC requirements. Each factor

had influence on the engineering decisions in establishing the following design criteria.

- Use a minimum of 2 cfs per 70 acres or a flow equivalent to the existing system where practical.
- For areas that are primarily sprinkler irrigated use 1 cfs per 70 acres for the maximum facility size.
- Poly vinyl chloride (PVC) plastic irrigation pipe (PIP) in diameters from 6 to 27 inches is used where possible. The maximum diameter that can be placed by combination trenching-pipe placement methods is 16 inch. Typical pipe installation details are shown on Appendix Figure D-1.
- Alfalfa valves are used for flood irrigation which is delivered from a pipeline. (See Appendix Figure D-2.) The required hydraulic grade line (HGL) is equal to the ground elevation plus 5 feet to account for delivery losses.
- It is assumed that sprinklers will be low pressure units requiring approximately 20 pounds per square inch (psi) or a HGL equal to approximately ground elevation plus 46 feet.
- Inlet and outlet losses to pipelines are assumed to be one velocity head or $v^2/2g$.
- Maximum pipe velocities are approximately 10 feet per second (fps) following U.S. Bureau of Reclamation (USBR) criteria.
- The Hazen-Williams formula is used to estimate pipeline friction losses with $c=140$ (Lindeburg, 1989).
- Gate valves are located downstream of all pipeline deliveries and at the end of pipelines.
- Wasteways are located at the inlet to all pipelines.
- Concrete lined canals are designed with a 1 foot base width, and 1:1 sideslopes. (See Appendix Figure D-3.)
- Membrane lined canals are designed with a 1 foot base width, 2:1 sideslopes, and a 30 mil PVC liner 6 inches below the surface. (See Appendix Figure D-4.)

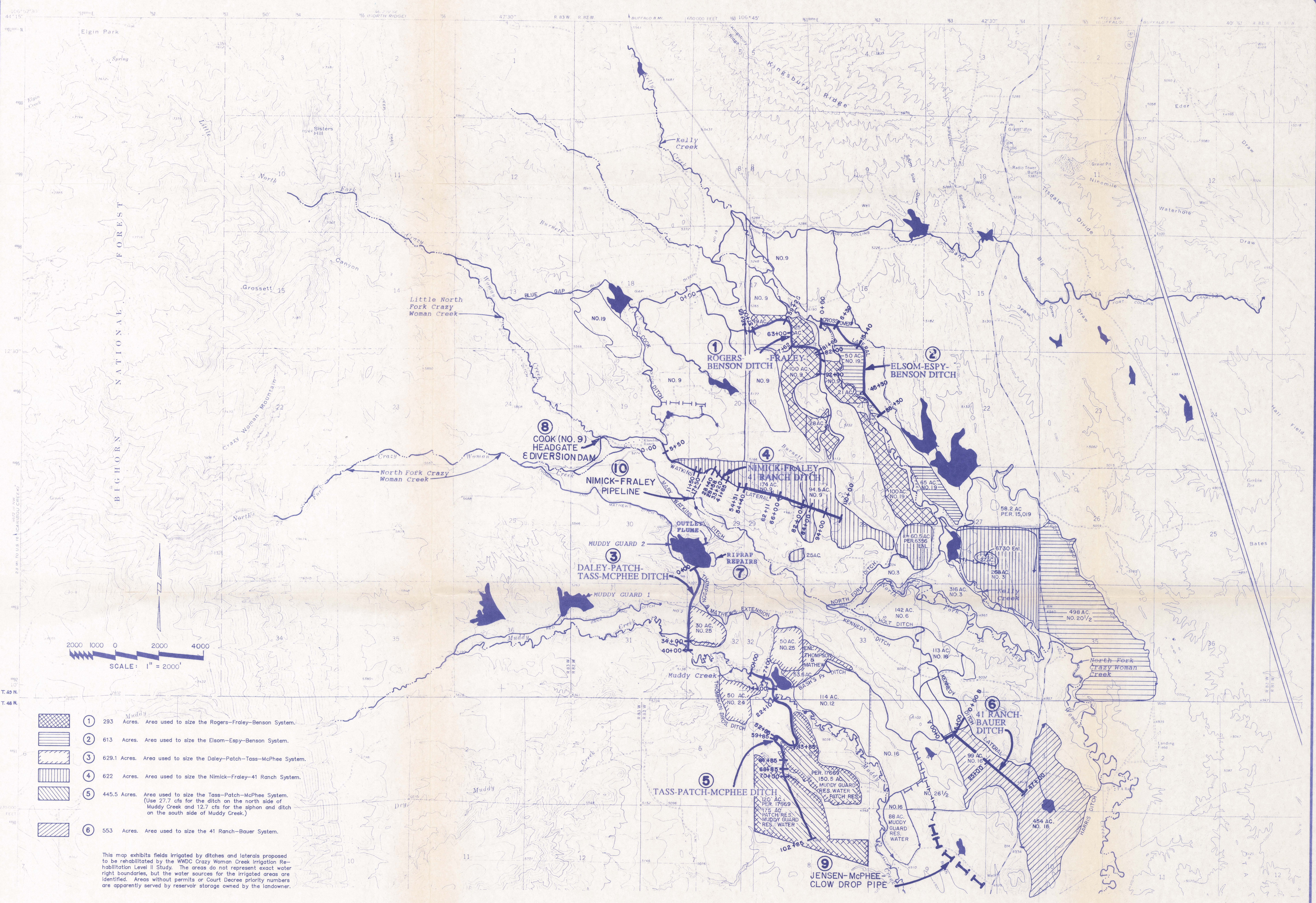
Water rights are an important factor in the Crazy Woman Watershed Improvement District area. Most of the irrigated land is

appropriated under the July, 1889 Crazy Woman Court Decree which delineates 27 priorities. Some acreages do not match what is actually irrigated and many of the appropriations are greater than or less than the current State Board of Control restriction of 1 cfs per 70 acres. Some of the adjudicated rates were readjudicated to 1 cfs per 70 acres by court order in 1984. State Board of Control Official, Frank Carr, recommended that this project rehabilitation should not exceed the present capacities of the various systems. This would limit the potential of increasing the irrigated acreage. Some water rights are recent priority appropriations and only receive water during the early spring flood stage. There are some storage reservoir water rights owned by a few of the landowners.

Systems operations are important factors. The Crazy Woman Creek irrigators generally divert a large amount of water onto their lands in early spring during the flood stage. Except for those who have the No. 1 or No. 2 court decreed priority or for those who have reservoir storage, they experience water shortages after the first crop irrigation. These shortages vary, but they are a wide spread problem throughout the area.

No. 1. Rogers-Fraley-Benson

Project No. 1 or the Rogers-Fraley-Benson Ditch serves approximately 293 acres. (See Figure 4.) The name Espy has been removed at the request of the CWWID, as the system will not benefit that landowner. Improvements recommended include concrete lining of 2,225 feet of open ditch from Station 37+00 to Station 59+25 and the installation of 3,275 feet of pipeline from Station 59+25 to Station 92+00 (see Figure 5). Pipeline was maintained to the end at Station 92+00 because the landowners prefers high pressure sprinkler irrigation below the end point. Ending the pipeline at 92+00 is recommended because the system becomes a single user system beyond this point.



- ① 293 Acres. Area used to size the Rogers-Fraley-Benson System.
- ② 613 Acres. Area used to size the Elsom-Espy-Benson System.
- ③ 629.1 Acres. Area used to size the Daley-Patch-Tass-McPhee System.
- ④ 622 Acres. Area used to size the Nimick-Fraley-41 Ranch System.
- ⑤ 445.5 Acres. Area used to size the Tass-Patch-McPhee System. (Use 27.7 cfs for the ditch on the north side of Muddy Creek and 12.7 cfs for the siphon and ditch on the south side of Muddy Creek.)
- ⑥ 553 Acres. Area used to size the 41 Ranch-Bauer System.

This map exhibits fields irrigated by ditches and laterals proposed to be rehabilitated by the WNDP Crazy Woman Creek Irrigation Rehabilitation Level II Study. The areas do not represent exact water right boundaries, but the water sources for the irrigated areas are identified. Areas without permits or Court Decree priority numbers are apparently served by reservoir storage owned by the landowner.

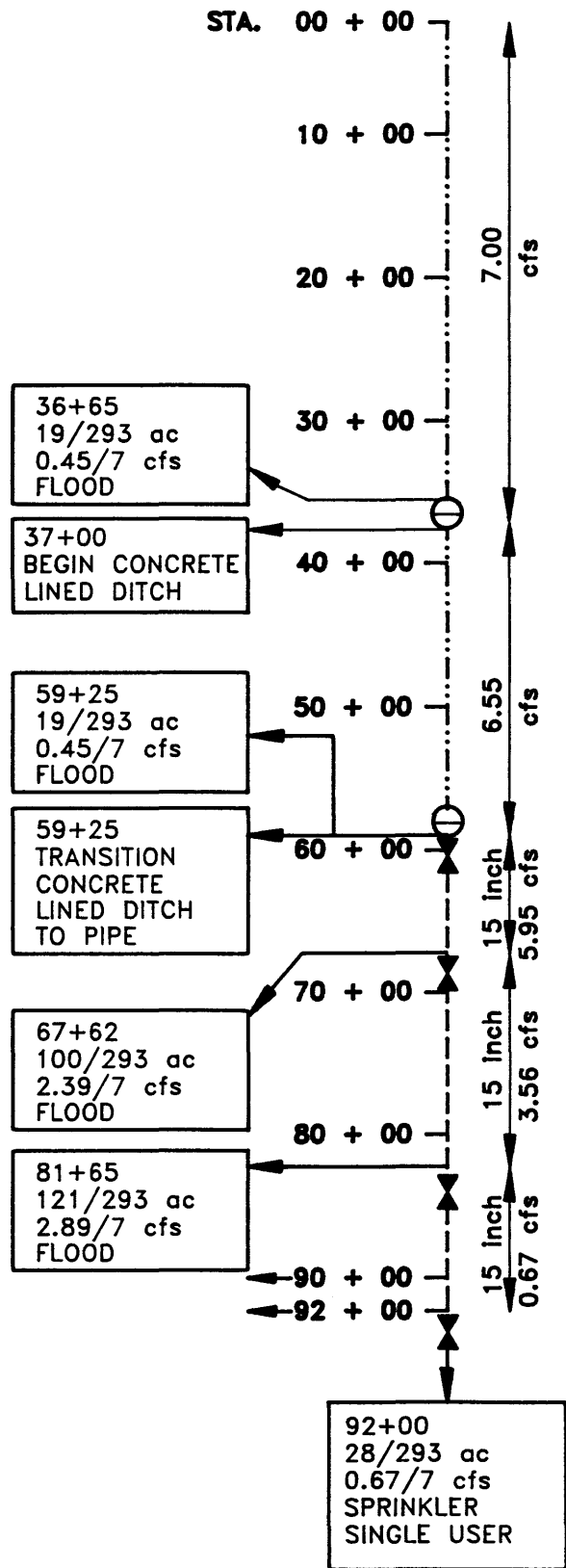
Project No. IOM183.123 I.D. No. _____ Date OCT 1991 Approved _____
 Designed/BRY Drawn/IMG Checked _____
CRAZY WOMAN CREEK IRRIGATION REHABILITATION STUDY
 PHASE II CONCEPTUAL DESIGN MAP

HKAM ASSOCIATES
ENGINEERS • PLANNERS
 Home Office: P.O. Box 31318
 Airport Industrial Park
 Suite 103
 Sheridan Wyoming 82801 • Billings, Montana 59107

Sheet No. _____
FIGURE
4

LEGEND:

- EXISTING SYSTEM
- - - - - NEW PVC PIPE
- ······ NEW OPEN LINED DITCH
- ⊗ GATE VALVE
- ⊖ WASTEWAY



**WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
HYDRAULIC SCHEMATIC
No. 1 ROGERS - BENSON DITCH**

FIGURE 5

**HKA ASSOCIATES
ENGINEERS · PLANNERS**

10183.123

10/01/91

Water rights for land served by Project No. 1 are from North Fork Crazy Woman Creek diverted through the Cook Ditch under Crazy Woman Court Decree Priority 9 (193 acres) and Priority 19 (100 acres). The No. 9 right is restricted to 0.71 cfs per 70 acres with a 2 cfs per 70 acres flood right, and the No. 19 right is for 1.0 cfs per 70 acres with a 2 cfs per 70 acres flood right.

The water rights design capacity for Project No. 1 allows 2 cfs per 70 acres or a total of 8.37 cfs. This is close to the present capacity of the ditch which was measured at 7.00 cfs when flowing full. Based on direction from the State of Wyoming, the existing capacity of 7 cfs is used to design the system.

Structures will include a new concrete transition from earth ditch to concrete ditch. The transition will include an overflow wasteway section designed to prevent the capacity of the concrete section from being overtopped. Likewise, a wasteway will be installed ahead of the pipe section. Turn outs shall be installed at Station 36+65 and at Station 59+25. "Alfalpa" Valve type risers shall be installed at Station 63+00, 67+62 and at Station 81+65. A gate valve shall be installed at each turn out and at Station 92+00.

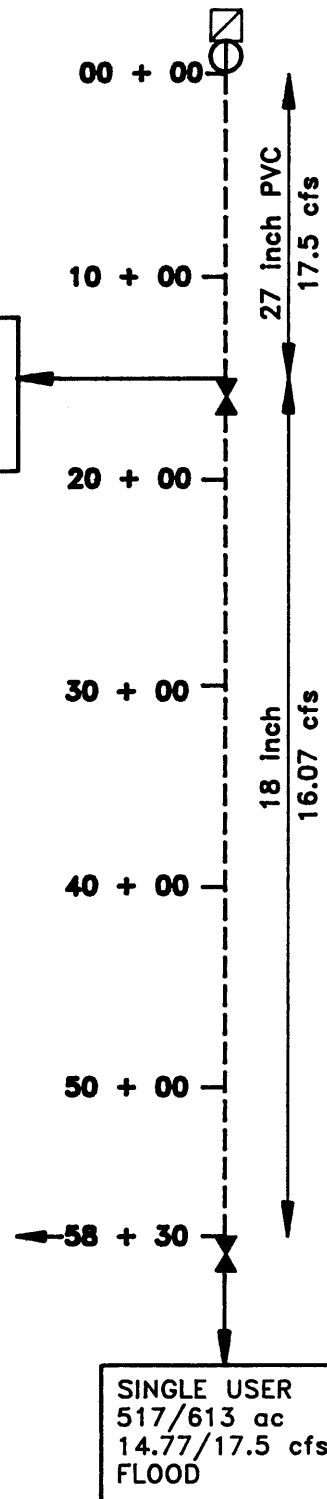
A concrete transition from the concrete lined channel to a pipeline will be constructed at Station 59+25.

No. 2. Elsom-Espy-Benson Pipeline

Project No. 2 or the Elsom-Espy-Benson Pipeline serves approximately 613 acres. Recommended improvements include a new diversion box in Kelly Creek and 5830 feet of pipeline to carry 17.51 cfs (see Figure 4). A hydraulic schematic is shown on Figure 6. It is recommended that the pipeline be installed adjacent to the Cross Over Ditch which diverts water from Kelly Creek into an unnamed drainage to the Kingsbury-Todd Reservoirs. The owner of those reservoirs indicated that he would not allow the Cross Over

LEGEND:

- EXISTING SYSTEM
- NEW PVC PIPE
- NEW OPEN LINED DITCH
- ⋈ GATE
- ⊖ WASTEWAY
- ⊠ NEW DIVERSION BOX (CHECK STRUCTURE)



WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 HYDRAULIC SCHEMATIC
 No. 2 ELSOM-ESPY-BENSON DITCH

FIGURE 6

HKA ASSOCIATES
 ENGINEERS · PLANNERS

10M183.123

10/01/91

ditch to divert less than 25 cfs plus the irrigation needs which would be over 42 cfs. This would not be a practical design capacity. In addition, the Cross Over Ditch becomes a single user ditch after the first 630 feet, thus eliminating WWDC participation. At the end of this Project No. 2 at Station 58+30 a energy dissipator and a bifurcation structure is recommended to split water into an existing ditch and into the upper Kingsbury-Todd Reservoir. Water to irrigate the lower 498 acres of Project No. 2 must pass through the two Kingsbury-Todd Reservoirs and is delivered to the irrigated land via the North Fork Ditch below the reservoirs. Water for the remaining 65 acres will be discharged into an existing ditch for delivery to the irrigated land.

Water rights for the land served by Project No. 2 are primarily from the Little North Fork and North Fork Crazy Woman Creek. Diversion of the No. 19 Crazy Woman Court Decree is through the Blue Gap Ditch (which combines with the Cook Ditch) then into Kelly Creek as a means of conveyance to the No. 2 Project headgate. The Crazy Woman Court Decree Priority No. 20½ diverts water from North Fork Crazy Woman into the Cook Ditch, then into Kelly Creek, then into the Cross Over Ditch serving the Kingsbury-Todd Reservoirs, then into the North Fork Ditch Extension which delivers water to the 498 acres under Priority 20½. (The North Fork Ditch Extension is also known as the May and Covington Enlargement and as the No. Twenty and One-Half Ditch).

There are two irrigated areas containing between 50 and 80 acres along the east side of Project No. 2 which do not appear to have water rights. These areas are not continuously irrigated, but they are irrigated. The lessees on this land indicated that it has always been assumed to have water rights. They were not interested in filing for permits, so it was determined not to include the acres in Project No. 2.

The recommended design capacity for the project is 2 cfs per 70 acres or a total of 17.51 cfs. Structures will include a headgate

at Kelly Creek and four "Alfalpa Valve" risers to be installed between Station 15+40 and Station 45+30. A gate valve energy dissipator and bifurcation structure will be installed at the end of the pipeline at Station 58+30.

No. 3. Daley-Patch-Tass-McPhee Drop Pipe

Project No. 3 or the Daley-Patch-Tass-McPhee Ditch will serve approximately 629.1 acres of land. (See Figure 4.) Improvements recommended include an inlet structure designed to split the flow into the Thompson and Mathew Extension Ditch or into this Project No. 3 drop pipe. Water flowing down the Thompson and Mathews Ditch will serve approximately 103.6 acres. Project No. 3 pipeline will be sized to provide 2 cfs per 70 acres for 525.5 acres. (See Figure 7.) Water will be put through approximately 4,000 feet of pipeline with a gate valve and an energy dissipator at the end of the pipe. (See Appendix Figure D-6) One "Alfalpa Valve" and a gate valve will be installed at Station 20+00.

Water rights do not presently exist for Project No.3. The sponsors agreed to prepare a permit for the diversion from North Fork Crazy Woman Creek. The permit should be issued before any funds are advanced from the WWDC.

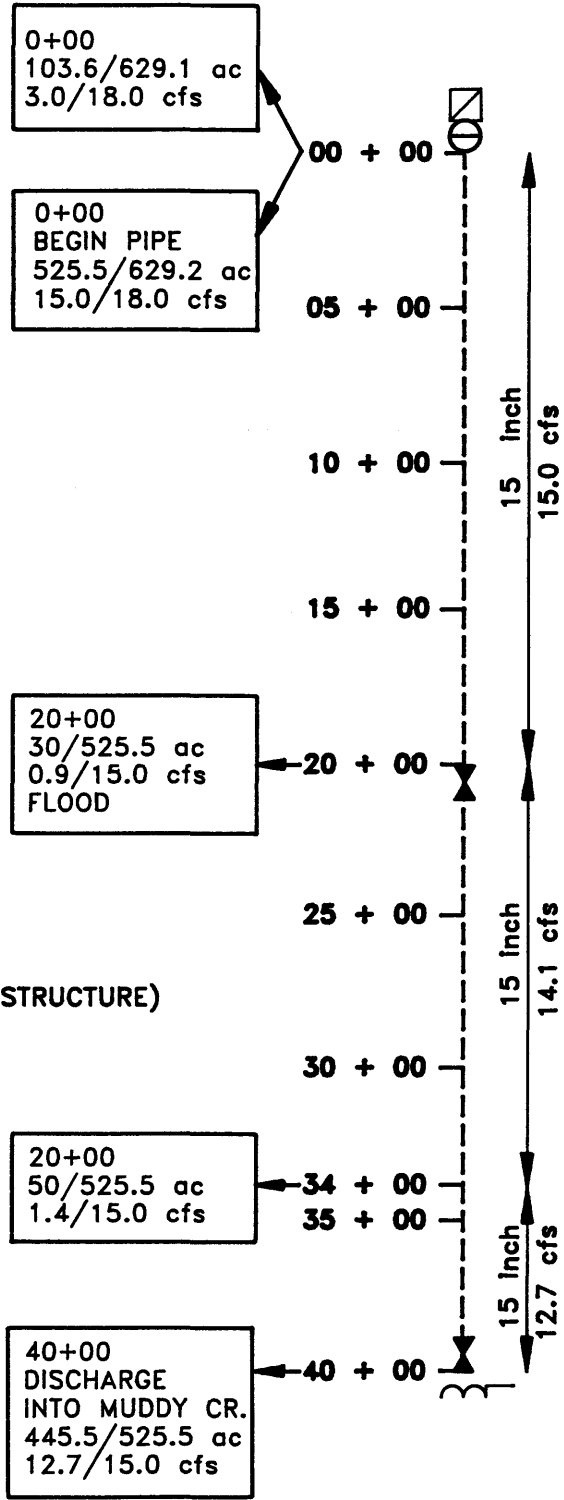
The recommended design capacity for Project No. 3 is 2 cfs per 70 acres or a total of 2.97 cfs in the Thompson and Mathew Extension Ditch and 10.43 cfs in the Project No. 3 pipeline.

No. 4. Nimick-Fraley-41 Ditch

Project No. 4 or the Nimick-Fraley-41 Ditch (Watkins Lateral of the Cook Ditch) will receive minor turn-out repairs for the first 5,440 feet. A closed pipeline will be installed for 7,780 feet from Station 54+40 to Station 110+00. The system becomes a single user system beyond Station 110+00, therefore this project ends at Station 110+00. (See Figure 4.) Landowners in the ditch portion

LEGEND:

- EXISTING SYSTEM
- - - - - NEW PVC PIPE
- · - · - · - NEW OPEN LINED DITCH
- ⌋ ENERGY DISSIPATOR
- ⊖ WASTEWAY
- ⊠ NEW DIVERSION BOX (CHECK STRUCTURE)
- ⋈ GATE VALVE



WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II

HYDRAULIC SCHEMATIC

No. 3 DALEY-PATCH-TASS-McPHEE DITCH

FIGURE 7

HKA ASSOCIATES
ENGINEERS · PLANNERS

10M183.123

10/01/91

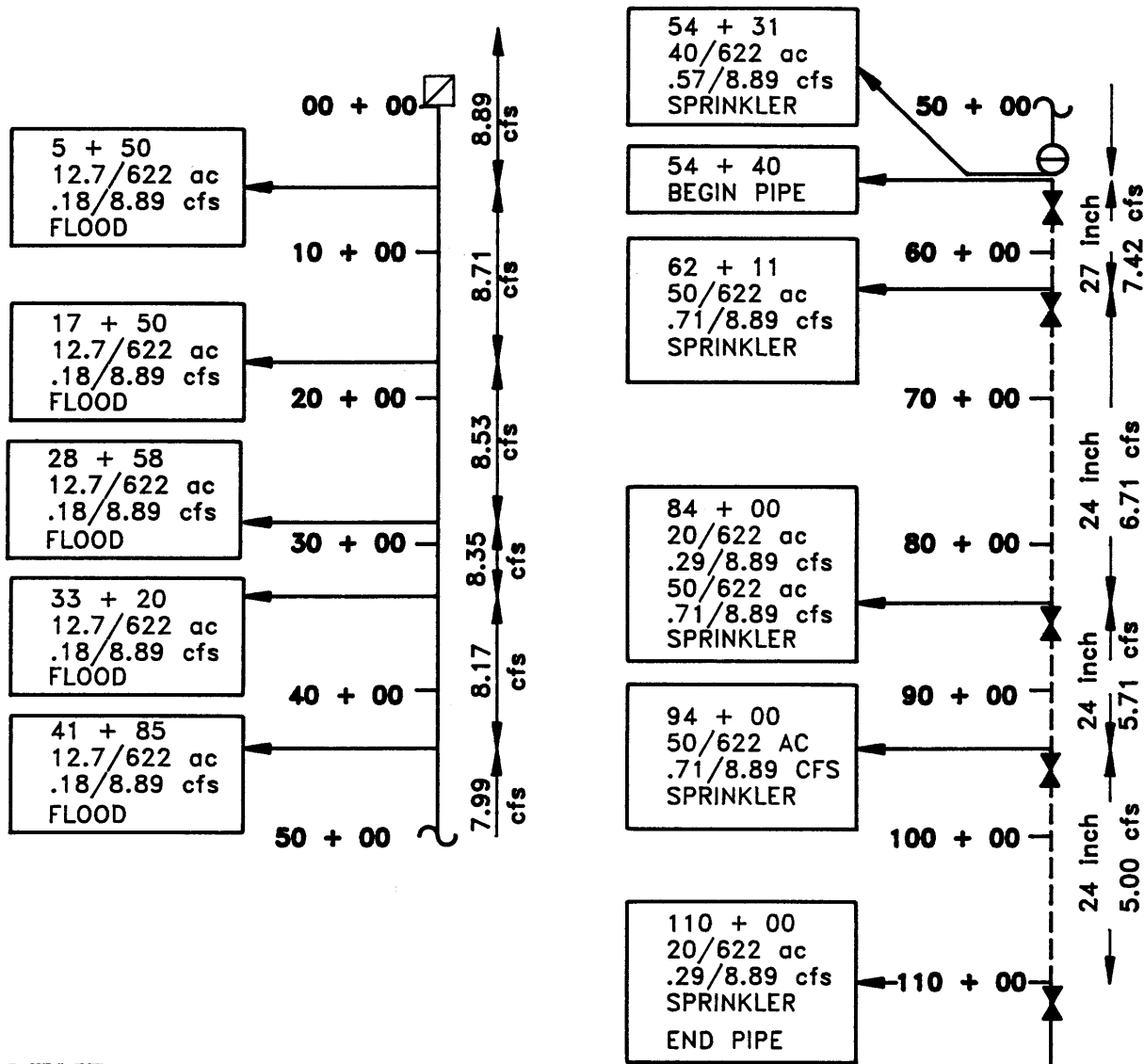
will continue with flood irrigation (or use gated pipe) and those beyond Station 54+40 will utilize sprinkler irrigation systems requiring pressure. Although some sprinklers will require booster pumps, pressure gained from the mainline elevation drop will be used. Booster pumps are not part of the WWDC mainline rehabilitation and will not be funded by the WWDC.

The transition from earthen ditch to PVC pipe at Station 54+40 will contain an overflow section for excess water. Five turn outs will be repaired along the earthen section. The pipeline will be equipped with tees risers, and gate valves at each pipeline turn-out. A total of four turn-outs are estimated between Station 54+40 and Station 110+00. A gate valve will be installed at the end of the WWDC portion of the project. (See Figure 8.)

Water rights on Project No. 4 are from Crazy Woman Court Decree Priority No. 3 and 9 and Permit No. 6356 Enlargement and 6730 Enlargement. In order to include the No. 3 priority, 6356 Enlargement and the 6730 Enlargement, a petition for change in point of diversion and means of conveyance will need to be approved by the State Board of Control before funding is advanced by the WWDC. The recommended design capacity for Project No. 4 is based on 1 cfs per 70 acres for a total capacity of 8.89 cfs. The total acreage is 622 acres. Sizing for double appropriation for flood flows was not practical for Project No, 4 as it would require a much larger pipe. The irrigation is primarily sprinkler irrigation and the present ditch capacity was measured at 7.77 cfs.

No. 5. Tass-Patch-McPhee Ditch

Project No. 5 or the Tass-Patch-McPhee Ditch will serve approximately 445.5 acres on the south side of Muddy Creek. (See Figure 4.) Two alternatives were considered. An enlargement of the Thompson Brothers Ditch was considered. It would require a new head gate and diversion structure, reconstruction of the existing ditch and an extension of the ditch. The landowners expressed



LEGEND:

- EXISTING SYSTEM
- - - - - NEW PVC PIPE
- ⊗ GATE
- ⊖ WASTEWAY
- ◻ EXISTING DIVERSION

**WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
HYDRAULIC SCHEMATIC
No. 4 NIMICK - FRALEY - 41 RANCH DITCH**

FIGURE 8

**HKA ASSOCIATES
ENGINEERS · PLANNERS**

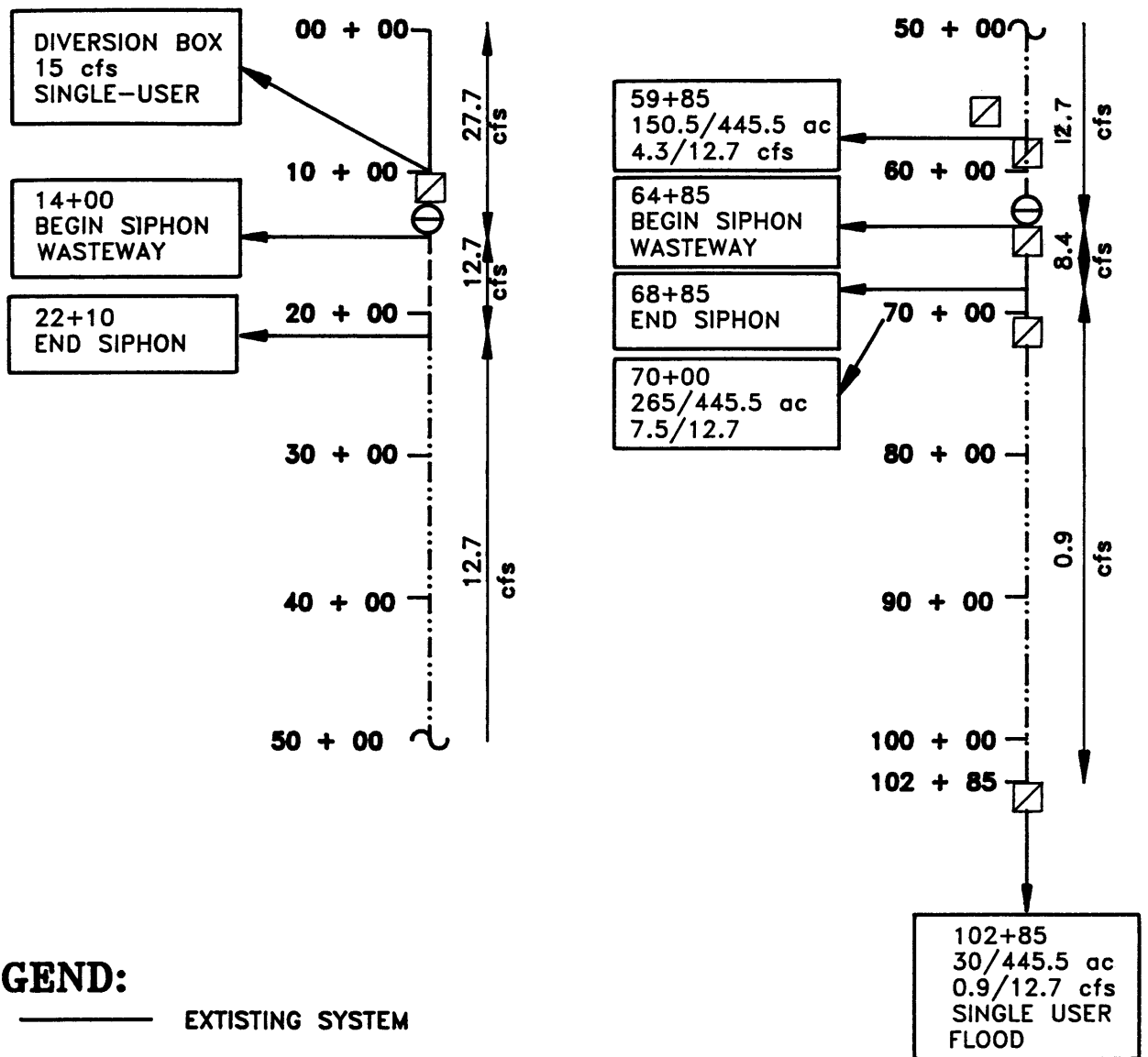
10M183.123

10/01/91

opposition to this alternative, so the second alternative was considered and is recommended. The second alternative is to utilize the Bash's PX Ditch which diverts water from Muddy Creek on the north side. Approximately 1400 feet of the existing ditch will be cleaned. A headgate will be installed in the Bash's PX Ditch to divert water into a 24-inch, 810-foot inverted siphon taking water to the south side of Muddy Creek. (See Appendix Figure D-5.) Water will discharge into a new membrane lined ditch to replace the existing Mitten Ditch. (See Appendix Figure D-4.) The new ditch is on a flatter slope and ultimately ends up serving the same irrigated land as presently irrigated from the Mitten Ditch. A portion of the land to be served appears to be new acreage not previously irrigated. A second inverted siphon will be installed where the new ditch crosses Dry Muddy Creek. The second siphon will be approximately 400 feet in length and have a diameter of 15 inches. (See Figure No. 9)

The owner of the Bash's PX Ditch will benefit from the cleaning of the Bash's PX Ditch. Two owners will be served by the new inverted siphons and ditch.

Water rights for this Project No. 5 are marginal at best. The lands served is by the existing Mitten Ditch Permit No. 17669. This is a very recent permit and is only good when Muddy Creek is at flood stage and there is surplus water available. The owners also have irrigation water available from Muddy Guard No. 1 Reservoir and from Patch Reservoir. This water will be used on land which does not have a direct flow water right as well as on land under the Permit 17669. The landowners also intend to use water from Project No. 3 on this land. In summary, the water supply for this Project No. 5 is marginal and will probably only be a reliable supply for early spring flows when flood water is available. The reservoir water available for Project No. 5 is an amount of about 158 acre-feet based on $\frac{2}{3}$ of Patch Reservoir at 108 acre-feet and Muddy Guard No. 1 Reservoir storage of 50 acre-feet. Verification of reservoir ownership was requested from landowners.



LEGEND:

- EXISTING SYSTEM
- NEW PVC PIPE
- NEW OPEN LINED DITCH
- ⊗ GATE
- ⊖ WASTEWAY
- ◻ DIVERSION BOX (CHECK STRUCTURE)

**WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
HYDRAULIC SCHEMATIC
No. 5 TASS-PATCH-McPHEE DITCH**

FIGURE 9

**HKA ASSOCIATES
ENGINEERS · PLANNERS**

10M183.123

10/01/91

It is recommended that this verification be required prior to release of any WWDC funding.

The present capacity of the Bash's PX Ditch is approximately 20 cfs as indicated by the landowners. This project recommends enlarging the Bash's PX Ditch to 27.7 cfs. This can be accomplished by cleaning the ditch from the headgate to the diversion into the inverted siphon. The inverted siphon and new ditch construction is designed for 12.7 cfs based on 2 cfs per 70 acres for 445.5 acres to be irrigated on the south side of Muddy Creek. A second inverted siphon will be constructed at Station 64+85 and is sized to irrigate 295 acres at the rate of 2 cfs per 70 acres. The design capacity for the second siphon is 8.4 cfs.

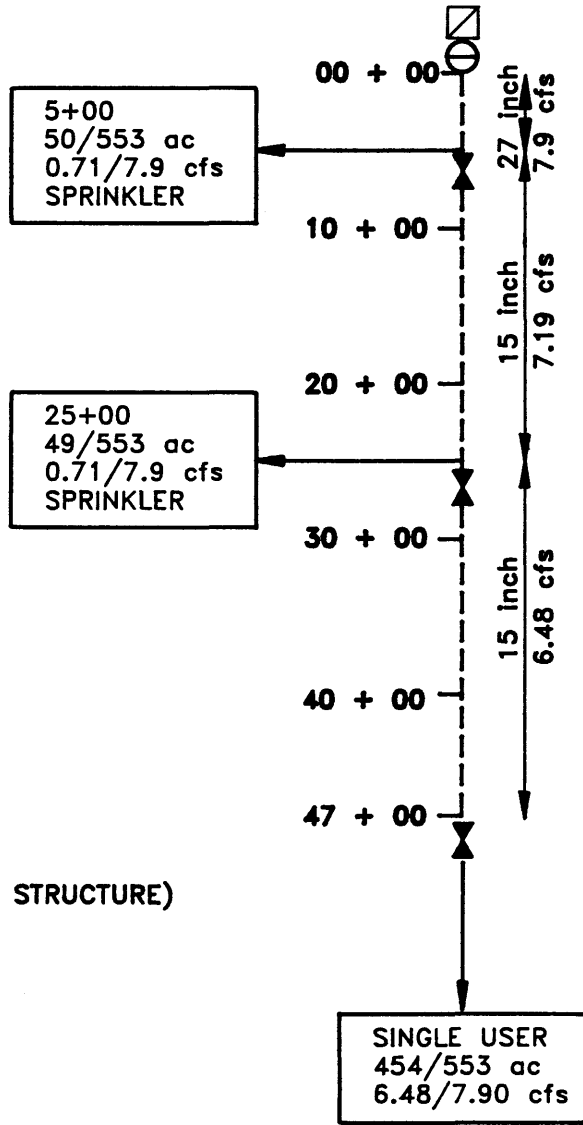
No. 6. 41 Ranch-Bauer Ditch Pipeline

Project No. 6 or the 41 Ranch-Bauer pipeline is on lateral off of the Kennedy Ditch. The original plan was to rehabilitate the east lateral with lining and drop structures or to put it in a pipeline. (See Figure 2.) However, the first 6,146 feet of the lateral is very flat and the users experience considerable ditch loss. The lower one-half of the east and west lateral ditches are experiencing severe erosion around existing drop structures. The recommendation from this study is to continue flood irrigating out of the upper end of two existing laterals, and eliminate the lower portion of both laterals and divert water for those irrigated fields from the west lateral and the east lateral into a closed pipe system. (See Figure 4.)

The recommended plan for Project No. 6 is to divert water from the west lateral and the east lateral of the Kennedy Ditch into a new PVC pipeline. An existing check structure will be used with modifications to accommodate a pipe inlet. A new check structure and pipe inlet will be required at the east lateral. Tees, risers and gate valves will be installed at Stations 5+00 and 25+00 to accommodate sprinkler systems. Booster pumps will be necessary,

LEGEND:

- EXISTING SYSTEM
- NEW PVC PIPE
- · - · - · - NEW OPEN LINED DITCH
- ⊗ GATE
- ⊖ WASTEWAY
- ⊠ NEW DIVERSION BOX (CHECK STRUCTURE)



WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 HYDRAULIC SCHEMATIC
 No. 6 41 RANCH-BAUER DITCH

FIGURE 10

NKA ASSOCIATES
 ENGINEERS PLANNERS

10M183.123

10/01/91

but are not part of this project. At Station 47+00 the system becomes a single user system, which ends the involvement of the WWDC.

The design acreage is 553 acres. The hydraulic capacity is designed for 7.90 cfs. (See Figure 10.) A flow rate of 1 cfs per 70 acres was used since sprinkler irrigation is planned by the owners.

Water rights for this project are from the Crazy Woman Court Decree Priority No. 16.

No. 7. Riprap Repair - Muddy Guard No. 2 Reservoir

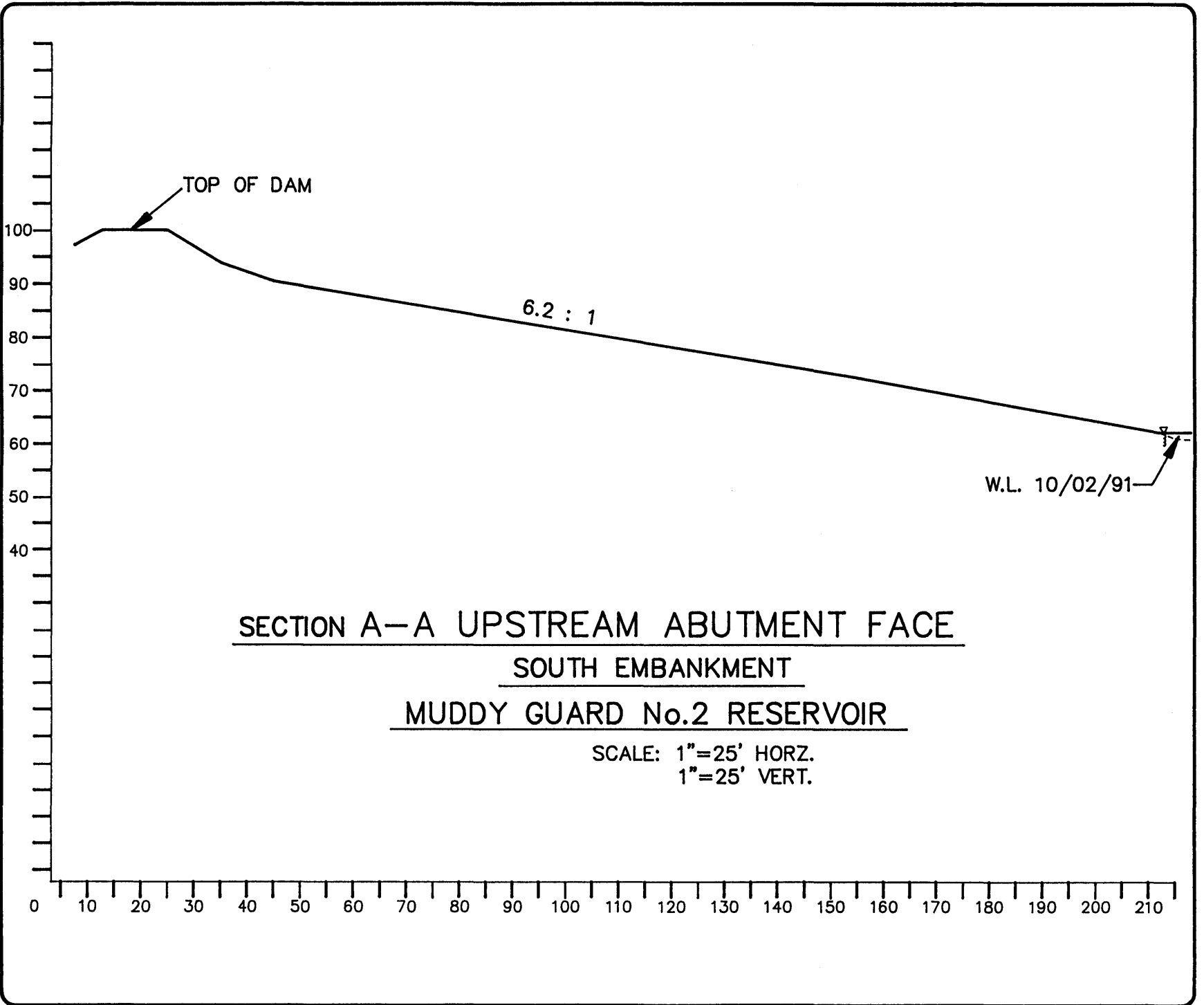
On April 19, 1989 Muddy Guard No. 2 Reservoir was visually inspected by Mr. Russell Dahlgren, Assistant Safety of Dams Engineer. In his report dated Mr. Dahlgren identified that riprap on the dam had been displaced and broken down on the upstream face (left abutment or east end) of the south embankment. Other deficiencies were also noted by Mr. Dahlgren, but CWWID only requested assistance for this left abutment area repair.

Two conditions appear to exist in the left abutment area. First, there appears to be some riprap shifting and erosion due to wave action as the water fluctuates from high water to low level. Bare areas are present and some benches are forming. Generally, the erosion is minor and the slope of the 3.1:1 face is approximately the same as the designed 3:1 slope. (See Figure 11 and 12). Secondly, it appears that the south embankment was the final area to receive riprap in the original construction. The top 15 to 20 feet of embankment appears to be adequately covered with large 12 to 30 inch rock. Below the 15 to 20 foot level the amount of large rock varies and there is significant small rock in the 3 to 12 inch range.

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
SECTION A-A SOUTH EMBANKMENT
MUDDY GUARD No. 2 RESERVOIR

HKA ASSOCIATES
ENGINEERS & PLANNERS
10M183.123

FIGURE 11

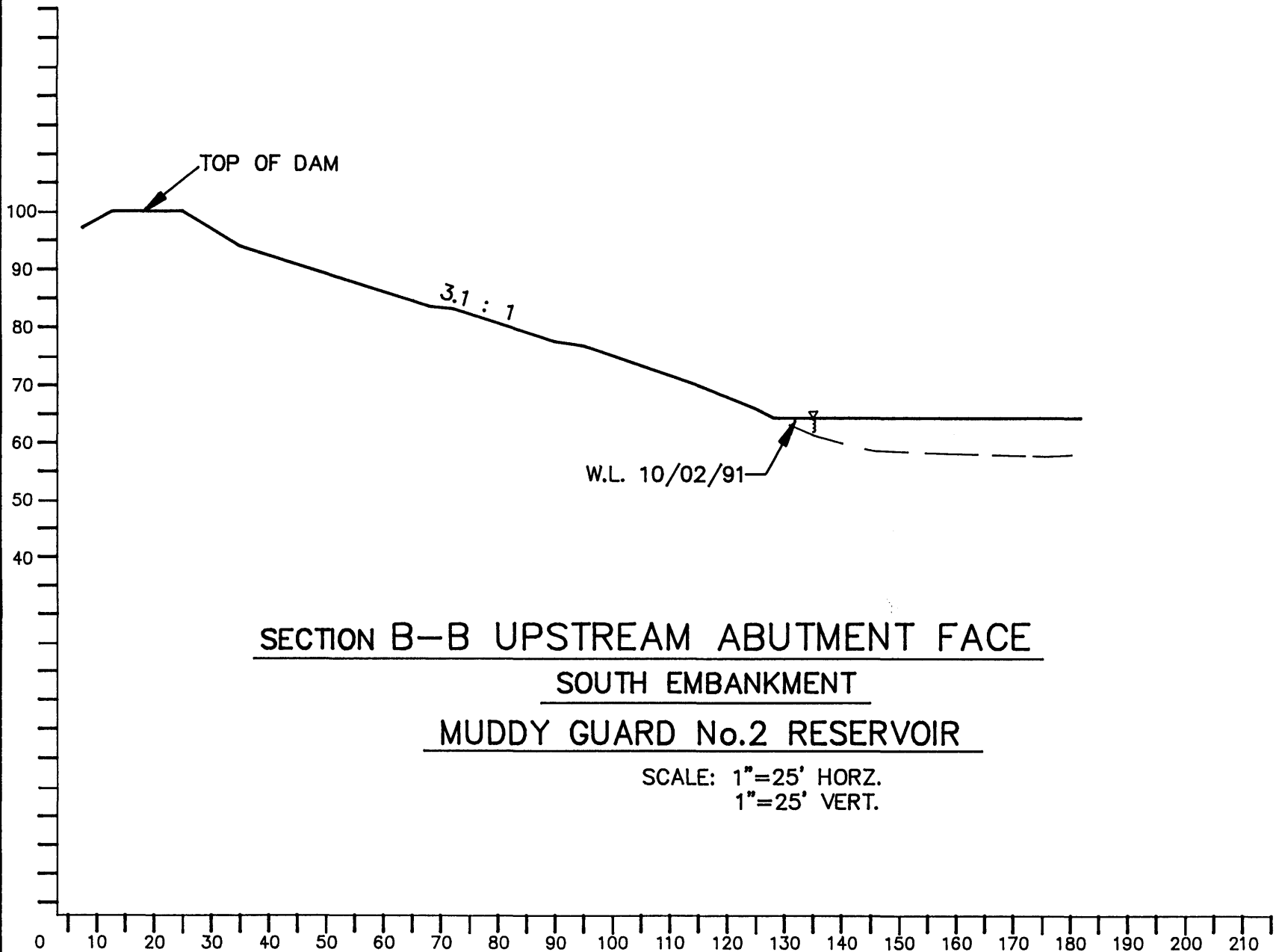


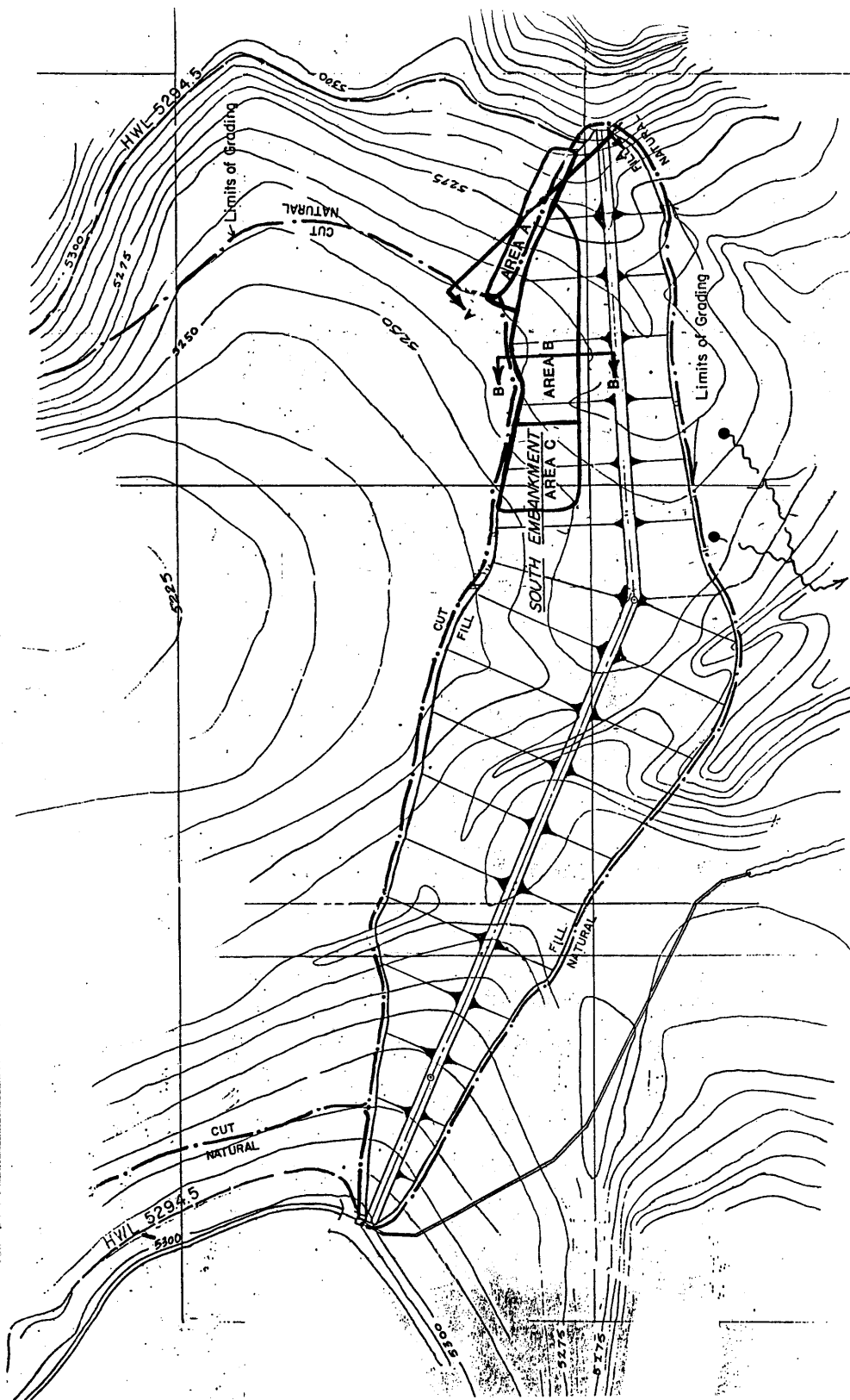
10/01/91

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
SECTION B-B SOUTH EMBANKMENT
MUDDY GUARD No. 2 RESERVOIR

HKA ASSOCIATES
ENGINEERS & PLANNERS
10M183.123 10/01/91

FIGURE 12





**WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 PLAN VIEW SOUTH EMBANKMENT
 MUDDY GUARD No. 2 RESERVOIR**

FIGURE 13

HKA ASSOCIATES
ENGINEERS • PLANNERS

10M183.123

10/01/91

The plan view shown on Figure 13 identifies three areas near the left (east) abutment where the placement of additional riprap is recommended. Area A is at the abutment and consists of 670 square yards, Area B consists of 1,800 square yards and Area C consists of 1,000 square yards. It is estimated that riprap in these areas is deficient by 100%, 50%, and 30% respectively. Assuming an average rock diameter of 16 inches results in a total riprap quantity of 935 cubic yards. It has been assumed that 1,000 cubic yards of riprap will be required.

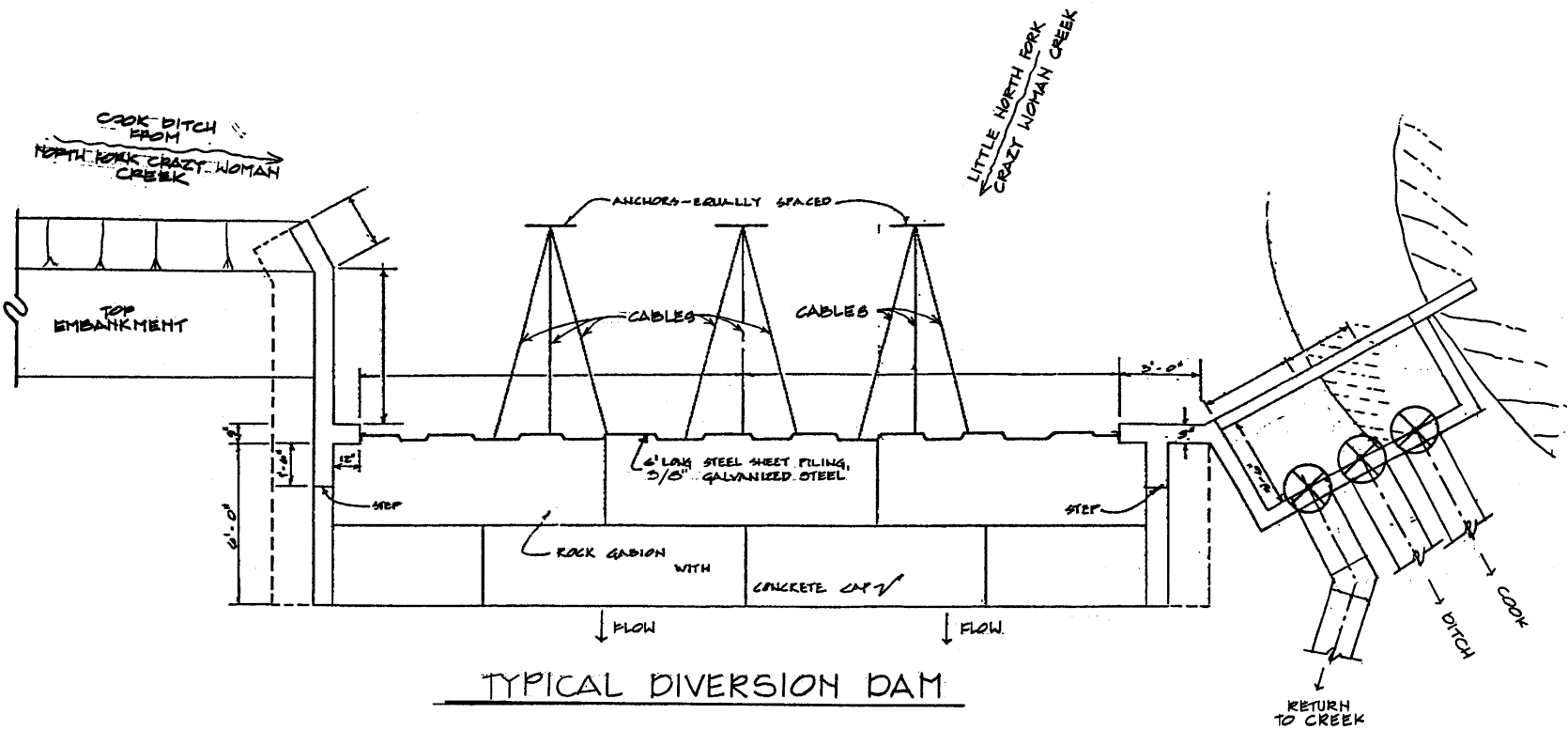
It is assumed that the area could be corrected by dozing the existing Area B rock toward and into Area C. Then, new rock will be hauled and dozed into Area B and Area A. The rock size will be 12 inch to 24 inch similar to the existing large size riprap. Adequate rock appears to be available at the end of the previous borrow area which has a haul distance of about $\frac{1}{2}$ mile. Exploration of the borrow area will be conducted in the Level III design phase.

No. 8. Replace Headgate and Diversion Dam on the Cook (No. 9) Ditch

Two alternatives were considered for rehabilitation of the Cook (No. 9) Headgate and Diversion Dam. One alternative is to do nothing. The structure is functioning, but it is very susceptible to flood damage and trash accumulation is a continuous maintenance problem. The recommendation is to undertake the second alternative and replace the structure completely.

A typical plan view of the recommended replacement diversion dam and headgate is shown on Figure 14. The structure consists of steel sheet piles dam with cable tie backs and a rock gabion downstream face. The structure will be designed to handle a 50 year frequency storm runoff with a fuse plug embankment on the south or right end. For example, if the design storm is exceeded the earthen fuse plug embankment will breach, washing out the fuse plug but not the dam. Of course, if that occurs, then repairs to

WWDG CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
TYPICAL DIVERSION DAM



TYPICAL DIVERSION DAM

FIGURE 14

the earthen embankment would be necessary, but the diversion dam and headgate would be preserved.

Three headgates will be installed. One will be gated and will return water to the creek channel. The other two gated outlets will divert water into the Cook Ditch similar to the way it is currently handled. The canal gates will be 36 inch cmp attached to new headgates. During the Level III Design phase the existing gates will be inspected to determine if they can be reused. New gates were included in the cost estimate.

No. 9 Replace Jensen-McPhee-Clow Drop Pipe Extension

Project No. 9 is not recommended for funding because it is a single user system. Therefore, a conceptual design was not completed.

No. 10 Nimick-Fraley Pipeline

Project No. 10 will provide for pumping Muddy Guard No. 2 Reservoir water into the Watkins Lateral of the Cook Ditch. (See Figure 4.) A pump intake and pump will be constructed on the outlet channel of the reservoir.

A total of 291 acres will receive water from this project. The pipe length is about 1,800 feet and the elevation lift is about 80 feet. The pump and pipeline were sized for 4.16 cfs.

COST ESTIMATES

Costs are based upon typical costs for other similar projects. It is recommended that pipeline installation specifications be set up so that the alternate methods can be considered (i.e., conventional backhoe and pipe laying crews vs trenching and laying the pipe by above ground assembly methods.). For the purpose of this cost estimate, conventional backhoe costs were used to estimate the project.

- Costs for PVC PIP are based on material costs from Northwest Pipe (1991) times a multiplier to estimate the installed cost. Multipliers were determined based on installed costs from other projects. The pipe is rated for 100 psi:

DIAMETER (INCHES)	MULTIPLIER	INSTALLED COST (\$/FOOT)
6	5.43	5
8	3.77	6
10	3.21	8
12	2.78	10
15	2.12	12
18	1.75	15
21	1.67	20
24	1.57	25
27	1.46	30

- Gate valves are Mueller A2380 double disk, mechanical joint valves. To hold down costs, it is assumed that the largest size valve will be 14 inches and pipeline reducers will be used for valves in lines greater than 14 inches. Material prices were obtained from Northwest Pipe (1991) and an installation cost based on other projects was added to the material costs to estimate an installed cost:

DIAMETER (INCHES)	GATE COST (\$)	BELL REDUCERS (\$)	INSTALLATION (\$)	INSTALLED COST (\$)
6	217	----	300	517 USE 500
8	338	----	300	638 USE 600
10	525	----	300	825 USE 800
12	663	----	400	1063 USE 1100
14	2032	----	500	2532 USE 2500
18	2032	246	600	2878 USE 2900
21	2032	396	700	3128 USE 3100

- The price for a 48-inch diameter, precast inlet/outlet structure is \$2,000 based on other projects.
- Sheet piling cost for the Cook Ditch (No. 9) Diversion structure is based upon costs of \$15 to \$18 per square foot of face area installed per N.A. Nelson Construction Company, Sheridan, Wyoming. Wyoming Transportation Department bid tabulations were also consulted. The concrete structures and rock gabions costs were based on other projects.
- Riprap needed on the left abutment and upstream face of the dam is based on 660 square yards with 100% coverage, 1800 square yards with 50% loss of coverage, and 1,000 square yards with 30% loss of coverage. Assuming riprap with an average diameter of 16 inch, the total riprap requirement is 1,200 cubic yards. Riprap shall be 12 inch to 16 inch diameter.

TABLE 2
COST SUMMARY
NO. 1 ROGER-BENSON DITCH

STA	TO STA	PVC - PIP PIPE (FEET)					GATE VALVE (14" VALVES AND REDUCERS)			INLET/OUTLET (ENERGY DISSIP) STRCTR	ALFALFA VALVE DELIVERY	SPRINKLER DELIVERY	WASTEWAY	CONCRETE LINED CANAL (FEET)	MEMBRANE LINED CANAL (FEET)	RECLAIM/ CLEAN/ EXISTING CANAL (HR)	RESEEDING (AC)
		12"	16"	18"	24"	27"	VALVE 14" PIPE 15"	14" 18"	14" 24"								
36+85										1							
37+00	59+25											1	2225				
59+25	67+13		788				1		1	1		1					
67+13	67+62		49														
67+62	75+42		780				1			1					30	2.8	
75+42	77+41		199														
77+41	78+99		158														
78+99	81+85		288														
81+85	92+00		1035				1			1							
92+00							1		1								
TOTAL		0	3275	0	0	0	4	0	0	2	4	0	2	2225	0	30	2.8
UNIT COST		\$10	\$12	\$15	\$25	\$30	\$ 2,500	\$2,900		\$2,000	\$200	\$400	\$2,000	\$20	\$10	\$65	\$930
TOTAL COST		\$ 0	\$39,300	\$ 0	\$ 0	\$ 0	\$10,000	\$ 0	\$ 0	\$4,000	\$800	\$ 0	\$4,000	\$44,500	\$ 0	\$1,950	\$2,418

Preparation of Final Design & Specifications:	\$ 8,557
Permitting and Mitigation	\$ 0
Cost of Project Components	\$106,988
Mobilization 10%	\$ 10,897
Construction Cost Sub-total #1	\$117,885
Engineering Costs = CCS#1x10%	\$ 11,788
Sub-Total #2	\$129,431
Contingency = Sub-total #2x15%	\$ 19,415
Construction Cost Total	\$148,846
PROJECT NO. 1 COST TOTAL	\$167,403

TABLE 3
COST SUMMARY
NO. 2 ELSOM-ESPY-BENSON DITCH

STA	TO STA	PVC - PIP PIPE (FEET)					GATE VALVE (14" VALVES AND REDUCERS)			INLET/OUTLET (ENERGY DISSIP) STRCTR	ALFALFA VALVE DELIVERY	SPRINKLER DELIVERY	WASTEWAY	CONCRETE LINED CANAL (FEET)	MEMBRANE LINED CANAL (FEET)	RECLAIM/ CLEAN EXISTING CANAL (HR)	RESEEDING (AC)
		12"	15"	18"	24"	27"	VALVE 14" PIPE 15"	14" 18"	14" 24"								
													1				
0+00	6+30					630				1							
6+30	15+40					910											
15+40	45+30			2990				1			4					20	1.2
45+30	58+30			1300				1									
58+30									1								
TOTAL		0	0	4290	0	1540	0	2	0	2	4	0	1	0	0	20	1.2
UNIT COST		\$10	\$12	\$15	\$25	\$30	\$ 2,500	\$2,900	0	\$2,000	\$200	\$400	\$2,000	\$20	\$10	\$65	\$930
TOTAL COST		\$ 0	\$ 0	\$84,350	\$ 0	\$48,200	\$ 0	\$5,800	\$ 0	\$4,000	\$800	\$ 0	\$2,000	\$0	\$ 0	\$1,300	\$1,118

Preparation of Final Design & Specifications:	\$ 10,045
Permitting and Mitigation	\$ 0
Cost of Project Components	\$125,588
Mobilization 10%	\$ 12,557
Construction Cost Sub-total #1	\$138,123
Engineering Costs = CCS#1x10%	\$ 13,812
Sub-Total #2	\$151,935
Contingency = Sub-total #2x15%	<u>\$ 22,790</u>
Construction Cost Total	<u>\$174,725</u>
PROJECT NO. 2 COST TOTAL	<u>\$184,770</u>

TABLE 4

COST SUMMARY
NO. 3 DALEY-PATCH-TASS-MCPHEE DITCH

STA	TO STA	PVC - PIP PIPE (FEET)					GATE VALVE (14" VALVES AND REDUCERS)			INLET/OUTLET (ENERGY DISSIP) STRCTR	ALFALFA VALVE DELIVERY	SPRINKLER DELIVERY	WASTEWAY	CONCRETE LINED CANAL (FEET)	MEMBRANE LINED CANAL (FEET)	RECLAIM/ CLEAN EXISTING CANAL (HR)	RESEEDING (AC)
		12"	15"	18"	24"	27"	VALVE 12" PIPE 12"	14" 18"	14" 24"								
0+00	40+00		\$ 4,000				3			1	2		1			30	2.3
40+00										1							
TOTAL		0	\$ 4,000	0	0	0	3	0	0	2	2	0	1	0	0	30	2.3
UNIT COST		\$10	\$12	\$15	\$25	\$30	\$ 2,500	\$2,900	0	\$2,000	\$200	\$400	\$2,000	\$20	\$10	\$85	\$930
TOTAL COST		\$ 0	\$48,000	\$0	\$ 0	\$0	\$ 7,500	\$0	\$ 0	\$4,000	\$400	\$ 0	\$2,000	\$0	\$ 0	\$1,950	\$2,139

Preparation of Final Design & Specifications:	\$ 5,279
Permitting and Mitigation	\$ 2,800
Cost of Project Components	\$ 65,989
Mobilization 10%	\$ 6,599
Construction Cost Sub-total #1	\$ 72,588
Engineering Costs = CCS#1x10%	\$ 7,259
Sub-Total #2	\$ 79,847
Contingency = Sub-total #2x15%	\$ 11,977
Construction Cost Total	\$ 91,824
PROJECT NO. 3 COST TOTAL	\$ 96,963

TABLE 5
COST SUMMARY
NO. 4 NIMICK-FRALEY-41 RANCH DITCH

STA	TO STA	PVC - PIP PIPE (FEET)					GATE VALVE (14" VALVES AND REDUCERS)			INLET/OUTLET (ENERGY DISSIP) STRCTR	ALFALFA VALVE DELIVERY	SPRINKLER DELIVERY	WASTEWAY	CONCRETE LINED CANAL (FEET)	MEMBRANE LINED CANAL (FEET)	RECLAIM/ CLEAN EXISTING CANAL (HR)	RESEEDING (AC)
		12'	15'	18'	24'	27'	VALVE 14" PIPE 15"	14" 18"	14" 24"								
0+00	54+40															10	
54+40	82+11					771			1	1			1				
82+11	77+07				1498				1		1	1					
77+07	84+00				893											40	8.4
84+00	94+00				1000				1			1					
94+00	110+00				1800				1			1					
110+00									1	1		1					
TOTAL		0	0	0	4789	771	0	0	5	2	1	4	1	0	0	40	8.4
UNIT COST		\$10	\$12	\$15	\$25	\$30	\$ 2,500	\$2,900	\$3,200	\$2,000	\$200	\$400	\$2,000	\$20	\$10	\$85	\$930
TOTAL COST		\$ 0	\$0	\$ 0	\$119,725	\$23,130	\$0	\$ 0	\$12,800	\$4,000	\$200	\$1,600	\$2,000	\$0	\$ 0	\$2,600	\$5,952

Preparation of Final Design & Specifications:	\$ 13,781
Permitting and Mitigation	\$ 2,000
Cost of Project Components	\$172,007
Mobilization 10%	\$ 17,201
Construction Cost Sub-total #1	\$189,208
Engineering Costs = CCS#1x10%	\$ 18,921
Sub-Total #2	\$208,129
Contingency = Sub-total #2x15%	\$ 31,219
Construction Cost Total	\$239,348
PROJECT NO. 4 COST TOTAL	\$265,108

TABLE 6
COST SUMMARY
NO. 5 TASS-PATCH-MCPHEE DITCH

		PVC - PIP PIPE (FEET)					GATE VALVE (14" VALVES AND REDUCERS)										
STA	TO STA	12"	15"	18"	24"	27"	VALVE 14" PIPE 15"	14" 18"	14" 24"	INLET/OUTLET (ENERGY DISSIP) STRCTR	ALFALFA VALVE DELIVERY	SPRINKLER DELIVERY	WASTEWAY	CONCRETE LINED CANAL (FEET)	MEMBRANE LINED CANAL (FEET)	RECLAIM/ CLEAN EXISTING CANAL (HR)	RESEEDING (AC)
0+00	14+00															100	
14+00	22+10		0		810					1			1				
22+10	59+85									1					3375		
59+85	64+85									1					500		
64+85	88+85		400							1		1					
88+85	70+00									1					115		
70+00	102+85									2					3285		
OLD ALIGNMENT																40	0.5
TOTAL		0	400	0	810	0	0	0	0	7	0	0	2	0	7275	140	0.5
UNIT COST		\$10	\$12	\$15	\$25	\$30	\$ 2,500	\$2,900	\$0	\$2,000	\$200	\$400	\$2,000	\$20	\$10	\$65	\$930
TOTAL COST		\$ 0	\$4,800	\$ 0	\$20,250	\$0	\$0	\$ 0	\$0	\$14,000	\$0	\$0	\$4,000	\$0	\$72,750	\$8,100	\$485

Preparation of Final Design & Specifications:	\$ 10,029
Permitting and Mitigation	\$ 2,500
Cost of Project Components	\$125,385
Mobilization 10%	\$ 12,537
Construction Cost Sub-total #1	\$137,902
Engineering Costs = CCS#1x10%	\$ 13,790
Sub-Total #2	\$151,692
Contingency = Sub-total #2x15%	\$ 22,754
Construction Cost Total	<u>\$174,446</u>
PROJECT NO. 5 COST TOTAL	<u>\$186,976</u>

TABLE 7
COST SUMMARY
NO. 6 41 RANCH-BAUER DITCH

STA	TO STA	PVC - PIP PIPE (FEET)					GATE VALVE (14" VALVES AND REDUCERS)			INLET/OUTLET (ENERGY DISSIP) STRCTR	ALFALFA VALVE DELIVERY	SPRINKLER DELIVERY	WASTEWAY	CONCRETE LINED CANAL (FEET)	MEMBRANE LINED CANAL (FEET)	RECLAIM/ CLEAN EXISTING CANAL (HR)	RESEEDING (AC)
		12'	15'	18'	24'	27'	VALVE 14" PIPE 15"	14" 18"	14" 24"								
0+008	5+00					1000				1			1				
0+00A	5+00					500				1			1				
5+00	25+00		2000				1				1						
25+00	47+00		2200				1				1						
47+00							1			1							
OLD ALIGNMENT																80	4.8
TOTAL		0	4200	0	0	1500	3	0	0	3	0	2	2	0	0	80	4.8
UNIT COST		\$10	\$12	\$15	\$25	\$30	\$ 2,500	\$2,900	\$0	\$2,000	\$200	\$400	\$2,000	\$20	\$10	\$85	\$930
TOTAL COST		\$ 0	\$50,400	\$ 0	\$0	\$45,000	\$ 7,500	\$ 0	\$0	\$8,000	\$0	\$800	\$4,000	\$0	\$0	\$5,200	\$4,278

Preparation of Final Design & Specifications:	\$ 9,864
Permitting and Mitigation	\$ 0
Cost of Project Components	\$123,178
Mobilization 10%	\$ 12,318
Construction Cost Sub-total #1	\$135,498
Engineering Costs = CCS#1x10%	\$ 13,550
Sub-Total #2	\$149,048
Contingency = Sub-total #2x15%	\$ 22,357
Construction Cost Total	\$171,403
PROJECT NO. 6 COST TOTAL	\$181,267

TABLE 8
COST SUMMARY
NO. 7 RIPRAP REPAIR MUDDY GUARD RESERVOIR

ITEM	UNITS	QUANTITY	UNIT PRICE	TOTAL PRICE
ROCK RIPRAP	CY	1000	\$25	\$25000

Preparation of Final Design & Specifications:	\$ 2,000
Permitting and Mitigation	\$ 500
Cost of Project Components	\$ 25,000
Mobilization 10%	\$ 2,500
Construction Cost Sub-total #1	\$ 27,500
Engineering Costs = CCS#1x10%	\$ 2,750
Sub-Total #2	\$ 30,250
Contingency = Sub-total #2x15%	<u>\$ 4,538</u>
Construction Cost Total	<u>\$ 34,788</u>
PROJECT NO. 7 COST TOTAL	<u>\$ 37,288</u>

TABLE 9
COST SUMMARY
NO. 8 REPLACE HEADGATE AND DIVERSION DAM ON NO. 9 DITCH

ITEM	UNITS	QUANTITY	UNIT PRICE	TOTAL PRICE
WING WALLS				
WALLS	CY	6.2	\$ 350	\$ 2,177
FOOTINGS	CY	1.2	\$ 350	\$ 410
PIPE INLET				
FLOOR	CY	1.4	\$ 350	\$ 499
HEADWALL	CY	1.2	\$ 350	\$ 434
SIDES	CY	0.3	\$ 350	\$ 105
WINGWALLS	CY	0.3	\$ 350	\$ 81
GATES, 36" SLID	EA	3.0	\$2,000	\$ 6,000
TRASHRACK	EA	3.0	\$ 500	\$ 1,500
PIPE, 36" RCP	FT	120.0	\$ 55	\$ 6,800
DAM				
SHEET PILING, 3/8" GAL. T-115 OR ZP-21 MATERIAL/	SF	360.0	\$ 18	\$ 6,480
GABIONS	CY	40.0	\$ 240	\$ 9,600
CONCRETE CAP	CY	5.2	\$ 350	\$ 1,820
ANCHORS	EA	6.0	\$1,000	\$ 6,000
DEMOLITION, EXIST. DAM	LS	1.0	\$5,000	\$ 5,000
EXCAVATION	CY	1000.0	\$ 10	\$10,000
EMBANKMENT & FUSE PLUG		1		\$ 4,000
SEEDING	AC	0.2	\$ 930	\$ 186
				\$80,901

Preparation of Final Design & Specification:	\$ 4,872
Permitting and Mitigation	\$ 1,200
Cost of Project Components	\$ 80,901
Mobilization 10%	\$ 8,090
Construction Cost Sub-total #1	\$ 88,991
Engineering Costs = CCS#1x10%	\$ 8,899
Sub-Total #2	\$ 73,890
Contingency = Sub-total #2x15%	\$ 11,054
Construction Cost Total	\$ 84,744
PROJECT NO. 8 COST TOTAL	\$ 90,818

TABLE 10
COST SUMMARY
NO. 10 NIMICK - FRALEY PIPELINE

		PVC-PIP PIPE (FEET)					GATE VALVES			MEMBRANE LINED CANAL (FEET)		
STA	TO STA	12"	15"	18"	24"	27"	12"	14" 18"	14" 24"		PUMP MOTOR INLET STRUC.	ELECT. POWER SOURCE (MI.)
0+00										2,000		
0+00	18+00	1800					1				1	1
TOTAL		1800	0	0	0	0	1	0	0	2,000	1	1
UNIT COST		\$10	\$0	\$0	\$0	\$0	\$2,500	\$0	\$0	\$10	\$15,000	\$4,000
TOTAL COST		\$18,000	\$0	\$0	\$0	\$0	\$2,500	\$0	\$0	\$20,000	\$15,000	\$4,000

Preparation of Final Design & Specifications:	\$ 4,780
Permitting and Mitigation	\$ 0
Cost of Project Components	\$ 59,600
Mobilization 10%	\$ 5,950
Construction Cost Sub-total #1	\$ 65,450
Engineering Costs = CCS#1x10%	\$ 6,545
Sub-Total #2	\$ 71,995
Contingency = Sub-total #2x15%	<u>\$ 10,799</u>
Construction Cost Total	<u>\$ 82,704</u>
PROJECT NO. 10 COST TOTAL	\$ 87,564

PERMITTING

The improvements recommended for the Crazy Woman Watershed Project will require permitting tasks in the Level III design stage.

The following assumptions have been made regarding permits:

- It is assumed that access and right-of-way will be provided by the Crazy Woman Watershed Improvement District members at no cost to the project.
- It is assumed that all construction related permits will be obtained by the Contractor.
- It is assumed that the Crazy Woman Watershed Improvement District will procure all EPA permits through the SCS work associated with the 319 Water Quality Program.
- It is assumed that the construction associated with this project will avoid the disturbance of major wetland areas.
- It is assumed that mitigation of minor wetland disturbances can be completed under a nationwide Army Corps of Engineers permit. (This applies to crossings and reclamation of minor areas.)

Permits anticipated for the Level III Design Stage are shown on Table 11. The permit work will require filing for a new appropriation for supplemental supply and original supply from North Fork Crazy Woman Creek to lands in the Muddy Creek drainage as described in Project No. 3. A NPDES permit will probably be required for the Project No. 3 discharge to Muddy Creek.

Three petitions to the State Board of Control will be required for a change in point of diversion for a portion of Crazy Woman Court Decree Priority No. 3 permit 6556 Enlargement and 6730 Enlargement presently diverted into the Crazy Woman Ditch. The petitions would allow all of the Project No. 4 water to be diverted into the Cook Ditch and into the Project No. 4 pipeline.

Project No. 5 will require a petition to the State Board of Control

for a change in point of diversion and mean of conveyance for the Mitten Ditch Permit 17669. A permit enlargement might be required for the Bash's PX Ditch and a new filing from Muddy Creek might be required on portions of the lands to be irrigated.

Two water right related items which HKM Associates recommends to be considered, include: (1) accurate mapping of the project area irrigated lands, and (2) filing of a diversion tie for the Cook Ditch point of diversion to clarify the State Engineer's records. These items were not included in the Cost Estimate because the mapping work was previously deleted by the WWDC and the clarification needs consideration by an attorney.

TABLE 11

PERMITS REQUIRED IN THE LEVEL III DESIGN STAGE
 CRAZY WOMAN WATERSHED REHABILITATION PROJECT

PROJECT NO.	PROJECT NAME	NPDES	WETLAND MITIGATION (MINOR)	STATE ENGINEER PERMITS	STATE BOARD OF CONTROL PETITIONS
NO. 1	ROGER-FRALEY-BENSON	----	----	----	----
NO. 2	ELSOM-ESPY-BENSON	----	----	----	----
NO. 3	DALEY-PATCH-TASS-MCPHEE	1	----	1	----
NO. 4	NIMICK-FRALEY-41 RANCH	----	1	----	3
NO. 5	TASS-PATCH-MCPHEE	----	1	2	1
NO. 6	41 RANCH - BAUER	----	----	----	----
NO. 7	RIPRAP REPAIR - MUDDY GUARD	----	----	1*	----
NO. 8	REPLACE H.G. & DIV. DAM	----	1	1*	----
NO. 9	JENSEN-MCPHEE-CLOW	----	----	----	----
NO. 10	NIMICK-FRALEY PIPELINE	----	----	----	----

* Notification only.

PROJECT SUMMARY

The Crazy Woman Watershed Rehabilitation Project will correct severe erosion problems and provide for more efficient use of a water supply which is already short. The proposed WWDC participation will only be on mainlines which serve more than one landowner. The project will be coordinated with other improvements under consideration through the EPA 319 Water Quality Project. It is recommended that the WWDC withhold funds on this project until such time as the EPA 319 funding is assured. In some areas, the modifications proposed in this study were developed assuming that the most efficient means of irrigation will be utilized.

The cost estimates for this Level II projects are provided in the section titled Cost Estimates. A cost summary is included in this section in Table 12.

Table 13 is an amortization schedule for a 20 year, 4% loan in an amount of one-half of the total estimated project cost. It is assumed that the other one-half of the project cost will be provided from grant funds.

TABLE 12

COST SUMMARY

TOTAL PROJECT COST ESTIMATE

Preparation of Final Design & Specifications:		\$ 69,157
Permitting and Mitigation	:	\$ 9,000
Legal Fees	:	\$ 0
Acquisition of Access and Right-of-Way	:	\$ 0

Cost of Project Components

No. 1 Rogers-Espy-Benson Ditch	:	\$ 117,665	
No. 2 Elsom-Espy-Benson Ditch	:	\$ 138,123	
No. 3 Daley-Patch-Tass-McPhee Ditch:	\$	72,588	
No. 4 Nimick-Fraley-41 Ranch Ditch	:	\$ 189,208	
No. 5 Tass-Patch-McPhee Ditch	:	\$ 120,599	
No. 6 41 Ranch-Bauer Ditch	:	\$ 135,496	
No. 7 Riprap Repair Muddy Guard Res.	\$	27,500	
No. 8 Replace H.G. & Div. Dam Cook (No. 9) Ditch	:	\$ 66,991	
No. 9 Jensen-McPhee-Clow Drop Pipe	:	\$ 0	
No. 10 Nimick-Fraley Pipeline	:	<u>\$ 65,450</u>	
Construction Cost Sub-total # 1	:	\$ 950,923	
Engineering Costs = CCS # 1 x 10%	:	\$ 95,092	
Sub-total # 2	:	\$1,046,015	
Contingency=Sub-total #2 x 15%	:	<u>\$ 156,902</u>	
Construction Cost Total	:		<u>\$1,202,917</u>
Project Cost Total	:		\$1,281,074

TABLE 13**LOAN AMORTIZATION SCHEDULE**

TOTAL PROJECT ESTIMATED COST: \$1,281,074
 ASSUMED GRANT AMOUNT: \$ 640,537
 ASSUMED LOAN AMOUNT: \$ 640,537
 ASSUMED LOAN TERMS: 20 YEARS, 4% API
 ANNUAL PAYMENT AMOUNT: \$ 47,130.71
 FINAL PAYMENT AMOUNT: \$ 47,164.10

LOAN REPAYMENT SCHEDULE

		PAYMENT		
YEAR	LOAN AMOUNT	INTEREST	PRINCIPAL	BALANCE
1	\$ 640,537.00	\$ 25,621.48	\$ 21,509.23	\$ 619,027.77
2		\$ 24,761.11	\$ 22,369.60	\$ 596,658.17
3		\$ 23,866.33	\$ 23,264.39	\$ 573,393.78
4		\$ 22,935.75	\$ 24,194.96	\$ 549,198.82
5		\$ 21,967.95	\$ 25,162.76	\$ 524,036.06
6		\$ 20,961.44	\$ 26,169.27	\$ 497,866.79
7		\$ 19,914.67	\$ 27,216.04	\$ 470,650.75
8		\$ 18,826.03	\$ 28,304.68	\$ 442,346.07
9		\$ 17,693.84	\$ 29,436.87	\$ 412,909.20
10		\$ 16,516.37	\$ 30,614.34	\$ 382,294.85
11		\$ 15,291.79	\$ 31,838.92	\$ 350,455.93
12		\$ 14,018.24	\$ 33,112.48	\$ 317,343.46
13		\$ 12,693.74	\$ 34,436.97	\$ 282,906.49
14		\$ 11,316.26	\$ 35,814.45	\$ 247,092.03
15		\$ 9,883.68	\$ 37,247.03	\$ 209,845.00
16		\$ 8,393.80	\$ 38,736.91	\$ 171,108.09
17		\$ 6,844.32	\$ 40,086.39	\$ 130,821.70
18		\$ 5,232.87	\$ 41,897.84	\$ 88,923.86
19		\$ 3,556.95	\$ 43,573.76	\$ 45,350.10
20		\$ 1,814.00	\$ 45,350.10	\$ 0.00

REFERENCES

1. State of Wyoming, "Annual Report Data-Draft Records", 1988, 1989, 1990, Water Division No. 2.
2. State of Wyoming, "Tabulation of Adjudicated Water Rights," Water Division No. 2.
3. Lindeburg, 1989, "Civil Engineering Reference Manual."
4. Elwell, 1991, "Telephone Conversation with Northwest Pipe."
5. Yates, 1991, "Telephone Conversation with M.A. Nelson, Jr."
6. State of Wyoming, 1989, "Wyoming Nonpoint Source Management Plan", 305(b) Statewide Water Quality Assessment Report.
7. Lake DeSmet Conservation District, 1991, "North Fork of Crazy Woman Creek-319 Water Quality Project," Amended Proposal.
8. Lake DeSmet Conservation District, January 2, 1991, "Supplement to North Fork of Crazy Woman Creek - 319 Water Quality Project", Amended Proposal.
9. USDA Soil Conservation Service, November 1988, "Enterprise Cost Report for Irrigated Crops on Livestock Ranches", Buffalo, Wyoming.

APPENDICES

APPENDIX A

SCOPING MEETING MINUTES

MEMORANDUM
June 25, 1991

TO: File

FROM: Dick Talley/Bruce Yates *OutB*

SUBJECT: Scoping Meeting
Crazy Woman Irrigation Study
WWDC - 10M183.123

A meeting was held on June 25, 1991 at 7:30 p.m. at the Johnson County Soil Conservation District Office. Those in attendance were:

Evan Green - WWDC	Bruce Yates - HKM
Wayne Moore - WWDC	Dick Talley - HKM
Pete Baldwin	Kathleen McPhee
Glenn Colan Rogers	Rudy Anselmni
Dick Fraley	John Anselmni
Phil Gonzales - SCS	Earl Pust
Jim Purdy	Bill Paley

The meeting was called to order at 7:35 p.m. by Evan Green of the Wyoming Water Development Commission. Evan began with a short introduction to the concept of legislative funding water development projects. He stated that \$50 thousand was appropriated by the legislature to perform a feasibility study. He added that HKM Associates has been selected to perform the Level II evaluation. He then introduced Bruce Yates of HKM.

Bruce began by explaining HKM's role in this work is to primarily gather data to prepare a preliminary evaluation of the improvement district and to provide for some methods of economic analysis. Bruce advised all landowners that HKM field crews would be out in approximately two weeks. He added that all landowners will be contacted for permission for access prior to any trespass. He then handed out a form asking landowners for data needed to determine ditch flows.

Bruce then discussed the proposed areas to be evaluated were:

- 1.) Sketch of the #9 ditch
- 2.) Watkins lateral
- 3.) Diversion point above Richard Tass's place
- 4.) Lateral below Muddy Guard #2
- 5.) Madsen Ditch
- 6.) McPhee siphon
- 7.) Rip Rap on Muddy Guard
- 8.) Two possible extensions

Glen Rogers advised HKM to obtain copies of the ASCS crop reports for acreages and ditch layouts.

Bruce then added that the field work could be concluded in two weeks and then a preliminary report will be prepared. The report will summarize field investigation, recommendations and some cost estimate. HKM will then meet with the District again to review this draft form of the preliminary report.

Evan Green then interjected that HKM has been advised to perform preliminary design using these two criteria.

- (1) Assume minimum flow to be at least 2 cfs/70 acres
- (2) Assume maximum flow to be no longer than the historical diversion record.

He reminded everyone to be sure and review this preliminary report to avoid any conflicts later.

Bruce then continued with a preliminary discussion of the early assessment. He indicated that HKM will be evaluating channel linings natural vs. synthetic, possible use of pipe and pipe materials drop structures sediment basins and pipe installation methods to determine the best option of balancing effectiveness and cost.

Bruce stated that field work will also include some minor soil sampling to classify soils, determine conductivity and measure sulfate content. Surveying work will primarily consist of ditch profiles.

Continuing, Bruce advised that an economic study consisting of an amortization schedule and a loan repayment plan would be developed. Some investigation into permitting requirements will also be identified. He added that this would conclude HKM's work in this phase of the project.

Evan concluded the meeting with a brief time schedule stating the Preliminary Report would be complete by October 1, 1991, reviewed by both the District and the Water Development Commission and a final report complete by November 1, 1991.

APPENDIX B

**PRESENTATION MEETING
MINUTES**

MEETING MEMORANDUM

TO: Evan Green
Wyoming Water Development Commission

FROM: Bruce R. Yates
HKM Associates

SUBJECT: Crazy Woman Watershed Project-Level II
10M183.123
Meeting: September 6, 1991
Field Trip: September 7, 1991
Phone Calls: September 18, 1991
September 20, 1991

DATE: September 23, 1991

September 6, 1991 - 7:00 P.M. Buffalo, Wyoming

Meeting attended by:	Evan Green	Kathleen McPhee
	Bruce Yates	Rudy Anselmi
	Dick Talley	Ellis Elsom
	Dave Fraley	Jim Purdy
	Glen Rogers	Geffery Jensen
	Ron McPhee	Junior Herman

Evan Green explained that the purpose of the meeting was to explain where HKM was with the study and get landowner input before going into the Phase II conceptual design and cost estimates.

Bruce Yates indicated that there are areas where water rights are not clear. Some irrigation may be occurring on land that might not have a water right. In those cases, HKM can not recommend a project unless instructed further by the WWDC.

This meeting is to find out which projects the landowners want to proceed with. A map was presented showing HKM's understanding of the desired projects. Preliminary costs for several of the systems was presented. Considerable discussion ensued regarding each project.

A Landownership Map made from the Crazy Woman Watershed Improvement District Map was presented. One landowner identified a boundary change that has occurred since the district map was made. Bruce Yates explained that the Landownership Map was not intended for property line purposes, but intended to determine multiple ownership necessary for WWDC participation.

Ellis Elsom indicated that he would appose the cross over ditch on Project No. 2 if he could not get at least 25 cfs through the system.

MEMO - Evan Green, WWDC
September 23, 1991
Page 2

Each project was discussed in depth, and it was agreed that some changes would be considered which were not previously identified by the CWWID. It was concluded that Bruce Yates would meet with the following landowners on September 7, 1991 to look at their proposals:

Glen Rogers, Dave Fraley - Project No. 2
Ron McPhee - Project No. 5
Geffery Jensen - Project No. 9
Junior Herman - Project No. 6

HKM pointed out that Project No. 2, 5, and 9 are not currently recommended because multiple ownership is not apparent. It was agreed to take another look out at these projects as it was apparent from the meeting that the projects had not previously been well thought out by the CWWID.

On Project No. 5 Mrs. McPhee agreed to write a letter stating that they intend to file for a current priority water right from North Fork Crazy Woman Creek. Other landowners indicated that they would oppose this idea as it interferes with diversion of flood water.

September 7, 1991 - Site Visit

Project No. 2 - Bruce Yates pointed out that portions of the lands that landowners wanted to irrigate were not identified in the water right maps. After looking at the maps, the landowners (who are actually leases) agreed that portions of the land did not have water rights. The landowners requested that we make some changes to add one more user in at the lower end of the project.

Project No. 5 - A profile of the proposed siphon and ditch surveyed to determine if there is adequate drop. It was concluded that the project would work properly. The landowners preferred to work with the Muddy Creek siphon project and drop the Thompson Brothers Ditch alternative.

Project No. 9 - The pipeline as originally shown on the CWWID request for WWDC funding was not correct. The existing pipeline extended further south. A single landowner desires to extend the pipeline onto his land south of the existing pipeline.

Project No. 6 - The lower one-half of the Kennedy Ditch is eroding severely. The landowners to be served by the improvements did not appear to agree with the CWWID plan. We concluded that the best alternative was to install a gravity pipe system down the middle of the irrigated lands until it reaches the final (single) user. The landowner at the end of the system agreed with this concept. He was to get in touch with the other landowner and discuss the project with him.

MEMO - Evan Green, WWDC
September 23, 1991
Page 3

September 18, 1991

Rudy Anselmi called Dick Talley and indicated that he wants to include his No. 3 priority land located in the SE Sec. 27 T.49N., R.82W. in the Project No. 4. Dick advised that HKM would have to discuss it with Evan Green.

September 20, 1991

Dick Fraley called Bruce Yates to ask if HKM could consider including the Nimick-Fraley pipeline out of North Fork. I told him that it was one of the projects we were to consider (Project No. 10) but we had no input from CWWID on the project. He said the SCS had it designed and he would have Phil Gonzales send the design information to HKM.

I asked him if he was aware of Mr. Anselmi's plan to include his land in Project No. 4. he wasn't aware of it but did not oppose it. Dick was concerned about the increase pipe size. I told him it was already large, but if we could go to 1 cfs per 70 acres it would help. He said to go ahead and design for that on this Project No. 4.

BRY/dlwo

File: CWEGWWDC.MEM

MEMORANDUM

TO: File

FROM: Dick Talley/Bruce Yates *BTJ*

SUBJECT: Minutes of October 24, 1991 Final Meeting
Crazy Woman Irrigation Study
10M183.123

DATE: October 25, 1991

A meeting was held on October 25, 1991 at the law offices of Omohundro and Palmerlee, located in Buffalo, Wyoming. Those present at the meeting were: George Nimick, Bill Daley, Jim Purdy, Ellis Elsom, Ron and Cathleen McPhee, Dick Fraley, Junior Herman and his wife, Ruby Anselmi, Bruce Yates and Dick Talley. The purpose of the meeting was to discuss the final report as completed by HKM and offer any additional comments, changes or requests. The meeting began at 7:00 PM with Bruce Yates of HKM explaining the process of the Wyoming Water Development Commission Funding. Bruce explained the Level I, II and III and reminded everyone that this report is in Level II and serves as a preliminary design to determine feasibility and cost projections. Level III is for the final design plans and specifications. Bruce went on to summarize the report with its approach to all ten projects as identified by the Irrigation District. Next Bruce added that Evan Green of the Water Development Commission could not be present but added the following remarks per Evan's request:

- 1.) Evan requests that the District review and comment on all ten projects.
- 2.) Write a letter to the Wyoming Water Development Commission requesting which projects the District would like to continue with. This letter must be received by WWDC no later than November 1, 1991.
- 3.) The WWDC will fund a portion of the water right work as required for Level III funding. However, this work must be shown as an additional budget line item requested by the District.

With no further questions, the discussion shifted to the explanation of each project. The following is a condensed narration of each project showing only the changes or deviations required for each.

Project No. 1: Remove the Espy Name.

- Project No. 2:** Add in the costs of a wasteway to the Cost Summary. Additionally Ellis Elsom remarked that this project does not benefit him unless the reservoir water can be carried in the system.
- Project No. 3:** Landowners indicate that there is not a Thompson and Mathew Extension. Bill Daly stated that Muddy Guard Storage Water is not used on the 30 and 50 acre parcels as shown. Mr. Daley indicated that this land is irrigated under the Thompson and Mathews Crazy Woman County Decree Priority No. 25. Bill also advised that the outlet from Muddy Guard No. 2 is a 30" CMP. Bill asked to include an additional 104 acres in the final design to accommodate the new filings that he and McPhee are making. Additionally McPhees' requested an additional 130 acres. This will most likely increase the pipe size from 12" to 15", maybe 18". Daley also requested a riser at Station 36+00 to allow for diversion of water into Muddy Creek at a high point to serve the Thompson Brothers Ditch.
- Project No. 4:** George Nimick stated that this project would not give any benefit to the Nimick property. Additionally George requested that the acreage of 199 acres be double checked. George feels that we show about 100 acres more than we should. Dick Fraley did not agree with Mr. Nimick. Dick Fraley asked to add a tee at Station 66+00 and an additional 25 acres right of that Station for the hay meadows located south of the line. Rudy Anselmi requested if the pressure will be adequate at the end of the line for the 41 Ranch's existing 140 acre center pivot. Rudy stated that he thought that the center pivot is on an existing 8" line with 80 psi at the existing pump pressure. Rudy was going to call HKM to give the capacity of the center point.
- Project No. 5:** Ron McPhee is concerned with regard to draining the siphon and the build up of sediment within the pipe. He also asked to include a flume on this system. Bruce explained he has found that siphons are generally not drained and that the proposed siphon was designated with a velocity of 4 fps which is greater than the assumed settling velocity of the sediment, hence allowing for the siphon to be self-cleaning.

Memo - File
October 25, 1991
Page 3

Ron McPhee requested that the acreage of the No. 5 Project be increased by about 80 acres.

Project No. 6: HKM explained that the proposed design in the report will be amended to include a pipe from the east ditch to connect at the proposed trunkline location at Station 5+00. Landowners requested that a flume be added to the system. It was explained to Mr. Anselmi that he will be able to flood irrigate with alfalfa risers.

Project No. 7: No Comments

Project No. 8: Ellis Elsom requested that an additional headgate be added below the two headgates to allow for return flow to the creek.

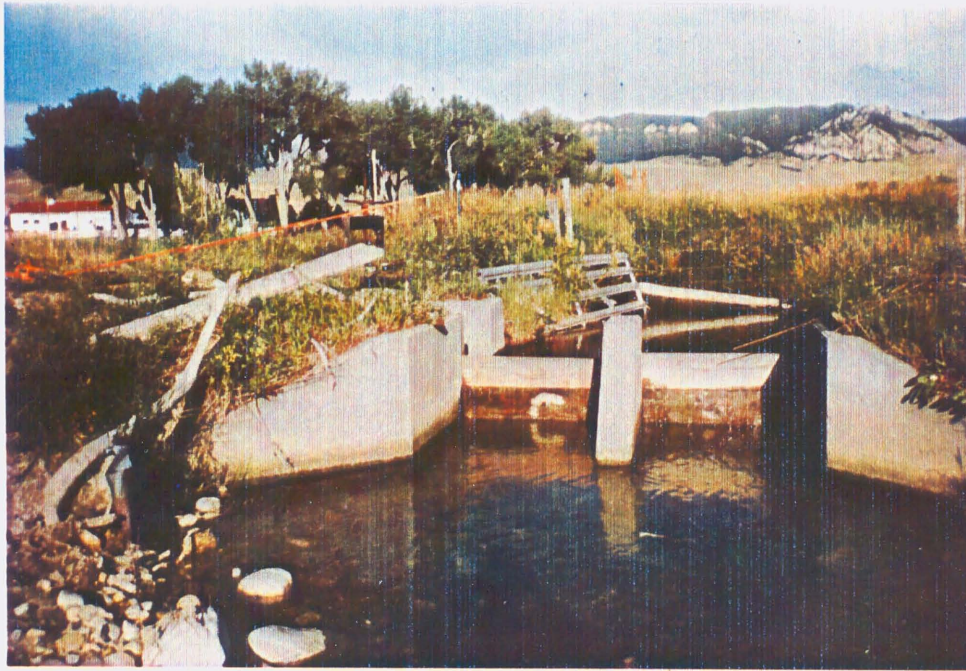
Project No. 9: No Comments

Project No. 10: George Nimick requested that the ditch from Muddy Guard #2 be enlarged from the outlet to the pump site. It is only a small lateral at present.

The meeting concluded with the Crazy Woman Irrigation District approving all projects as recommended by HKM and modified by this meeting and to proceed into Level III with all nine projects identified. Additionally they requested for HKM to identify the costs and work required for water rights as requested. This will be an additional budget item in Level IV. Bruce then concluded the meeting by re-iterating the requirements of the District to write the request in a letter to the Water Development Commission by November 1st. Additionally, a letter indicating the District's intent to pursue water rights for Project No. 3 needs to accompany the letter of request. With no further discussions the meeting adjourned at 12:00 PM.

File: FMTG1024.CW

APPENDIX C
PHOTOGRAPHS



WEIR: ROGERS-ESPY-FRALEY-BENSON DITCH
PROJECT NO.1 - STA 0+00



EROSION: ROGERS-ESPY-FRALEY-BENSON DITCH
PROJECT NO. 1 - STA 45+12



EROSION: ROGERS-ESPY-FRALEY-BENSON DITCH
PROJECT NO. 1 - STA 45+12



EROSION: HEADGATE WASHED OUT ON
NIMICK-FRALEY 41 RANCH
PROJECT NO. 4 - STA 101+07



EROSION: NIMICK-FRALEY 41 RANCH
PROJECT NO. 4 - STA 103+66



EROSION: NIMICK-FRALEY 41 RANCH
PROJECT NO. 4 - STA 103+96



EROSION: 41 RANCH
BAUER DITCH
PROJECT NO. 6 - STA 61+46 THRU 64+05



EROSION: 41 RANCH
BAUER DITCH
PROJECT NO. 6 - STA 67+24 THRU 69+87



LEFT (EAST) ABUTMENT RIPRAP - SOUTH EMBANKMENT
MUDDY GUARD NO. 2 RESERVOIR
PROJECT NO. 7



SECOND PHOTO



SPILLWAY CHANNEL AT NO. 9 HEADGATE
LITTLE NORTH FORK CRAZY WOMAN CREEK
PROJECT NO. 8

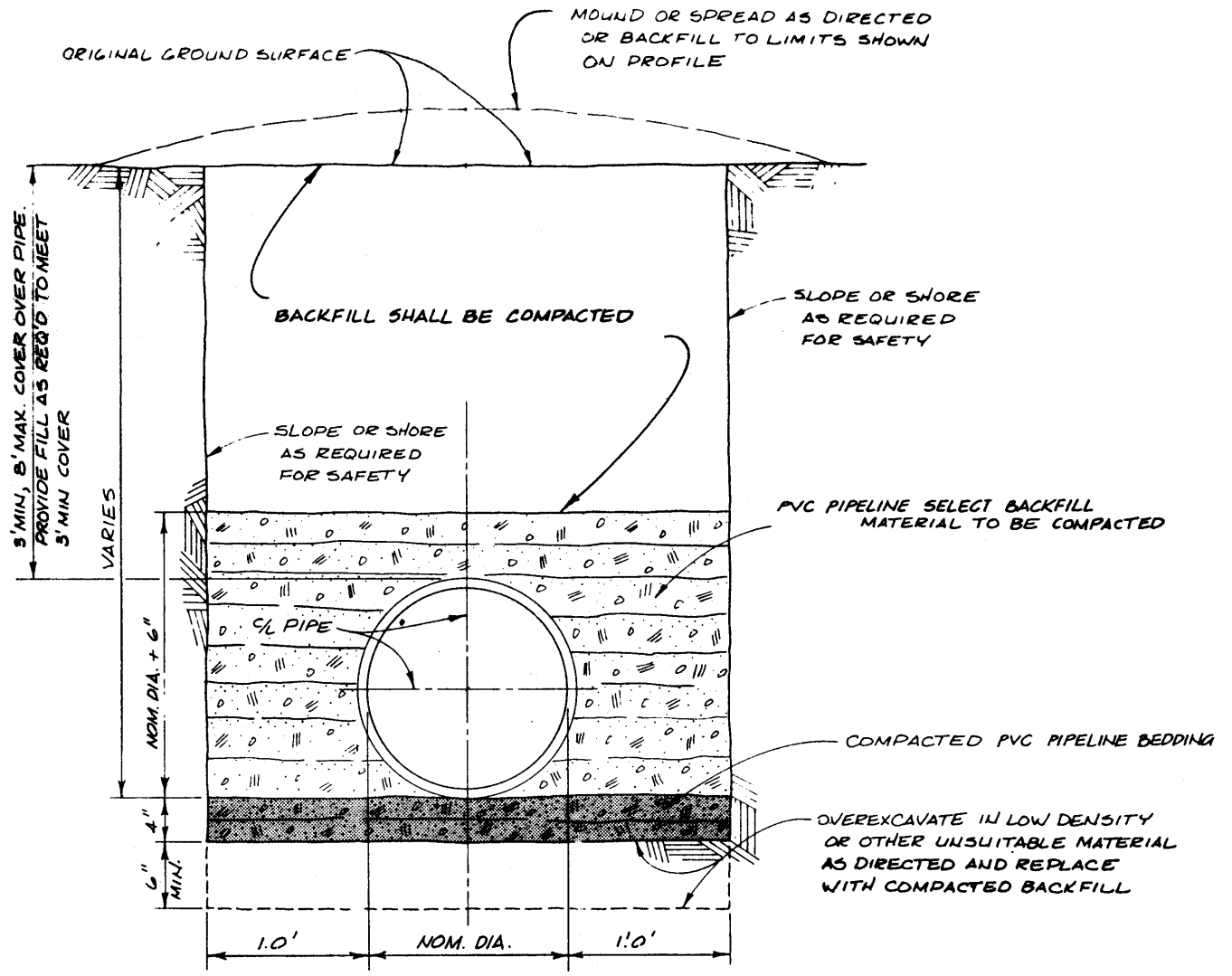


HEADGATES ON NO. 9 DITCH
LITTLE NORTH FORK CRAZY WOMAN DITCH
PROJECT NO. 8

APPENDIX D

TYPICAL DETAILS

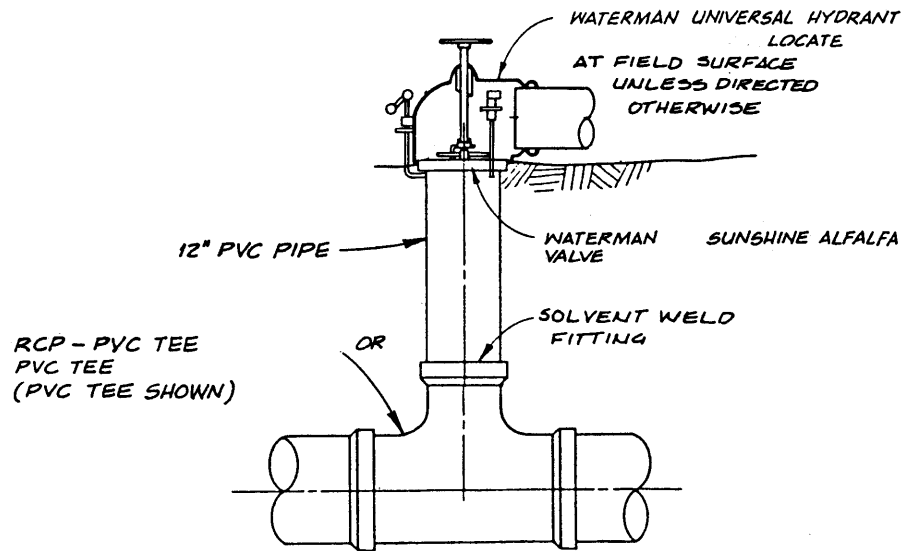
**WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 TYPICAL TRENCH DETAIL FOR
 PVC PIPE INSTALLATION**



**TYPICAL TRENCH DETAIL FOR
 PVC PIPE INSTALLATION**
 NOT TO SCALE

FIGURE D-1

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
TYPICAL PIPELINE DELIVERY DETAIL



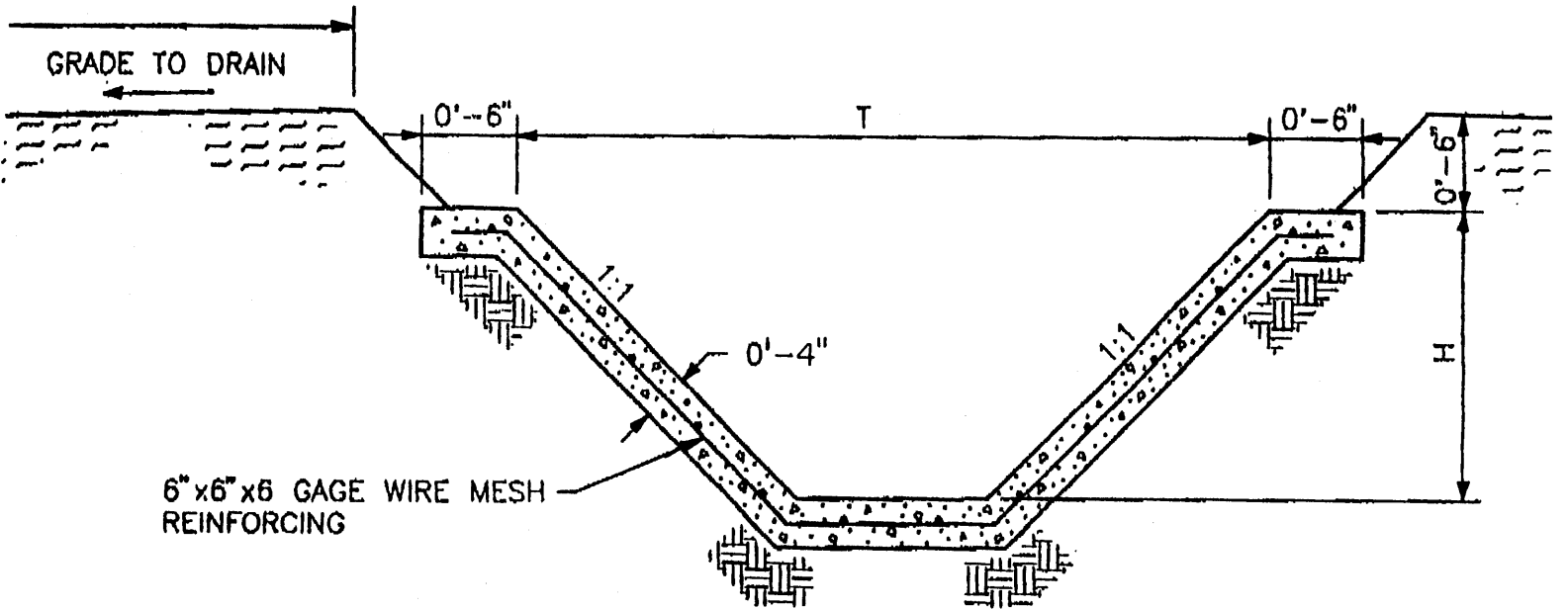
TYPICAL PIPELINE DELIVERY DETAIL

NOT TO SCALE

FIGURE D-2

HKA ASSOCIATES	
ENGINEERS • PLANNERS	
10M183.123	10/01/91

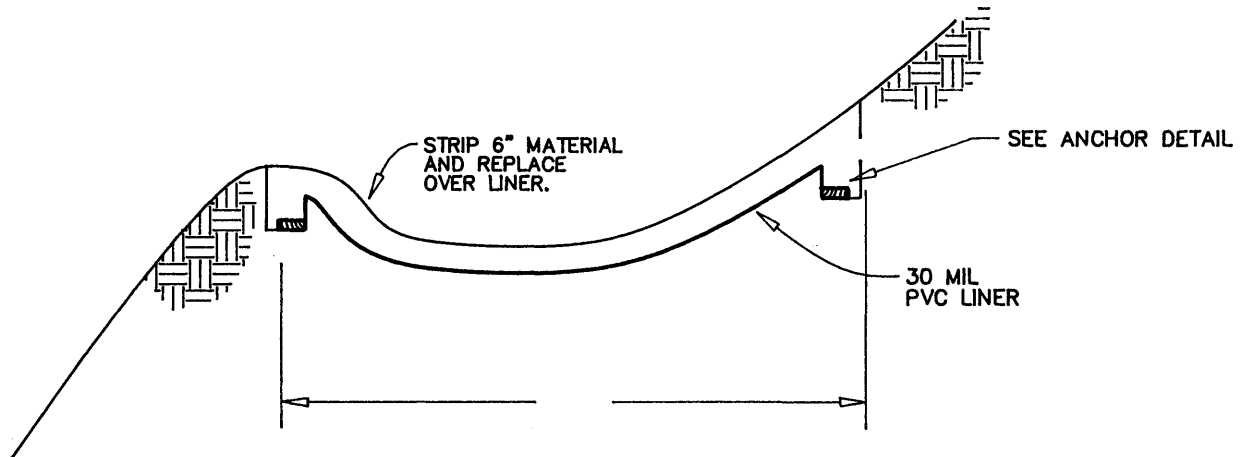
WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 TYPICAL CONCRETE LINED SECTION



TYPICAL CONCRETE LINED SECTION

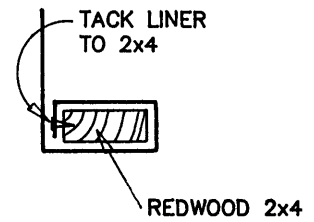
FIGURE D-3

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
TYPICAL MEMBRANE LINING OF EXISTING DITCH



TYPICAL
LINING OF EXISTING DITCH

NOT TO SCALE



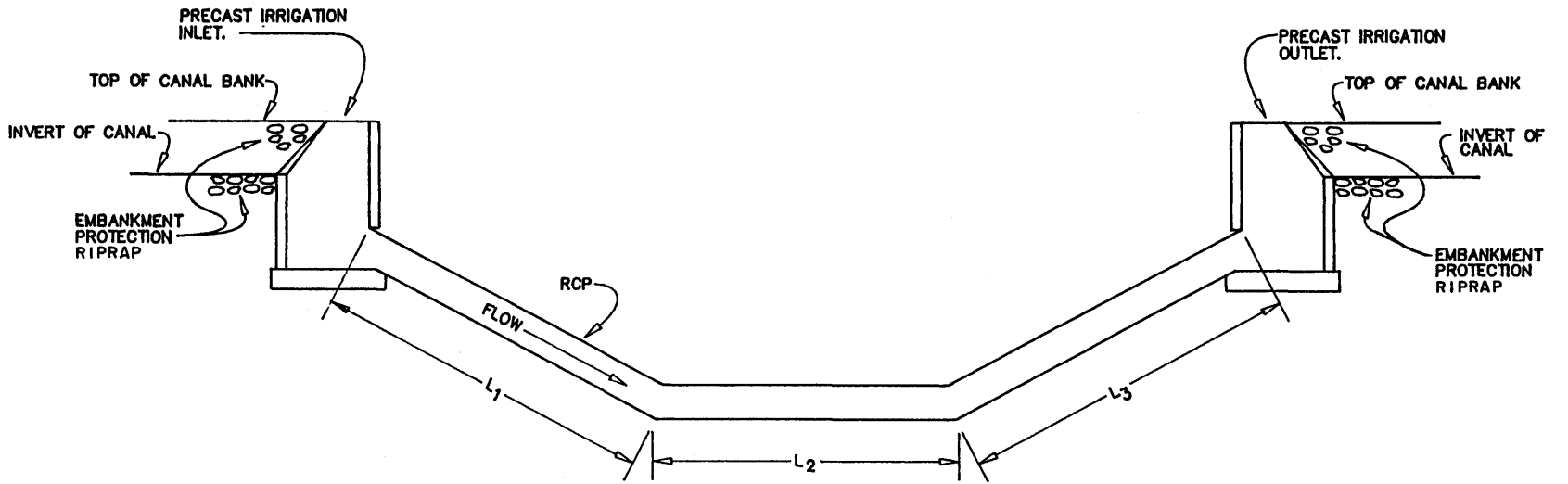
ANCHOR DETAIL

SDET-3.DWG

FIGURE D-4

K&A ASSOCIATES
ENGINEERS • PLANNERS
10M183.123 10/01/91

WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 TYPICAL INVERTED SIPHON



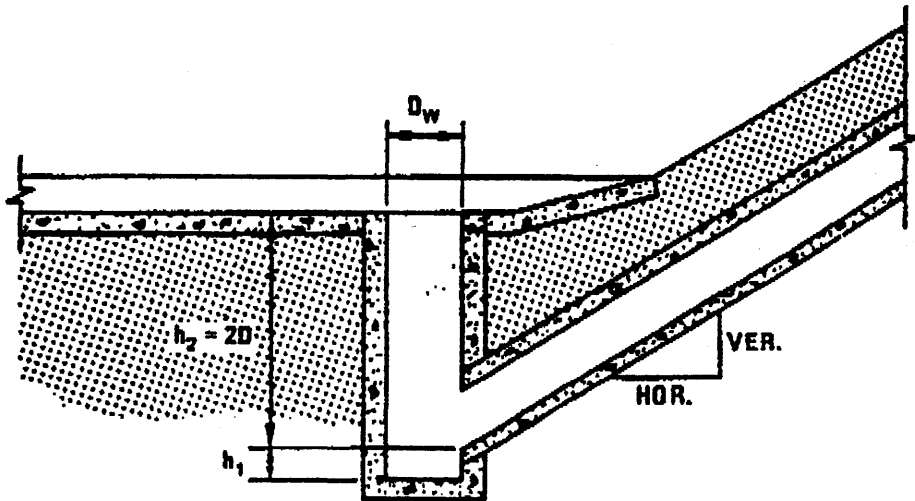
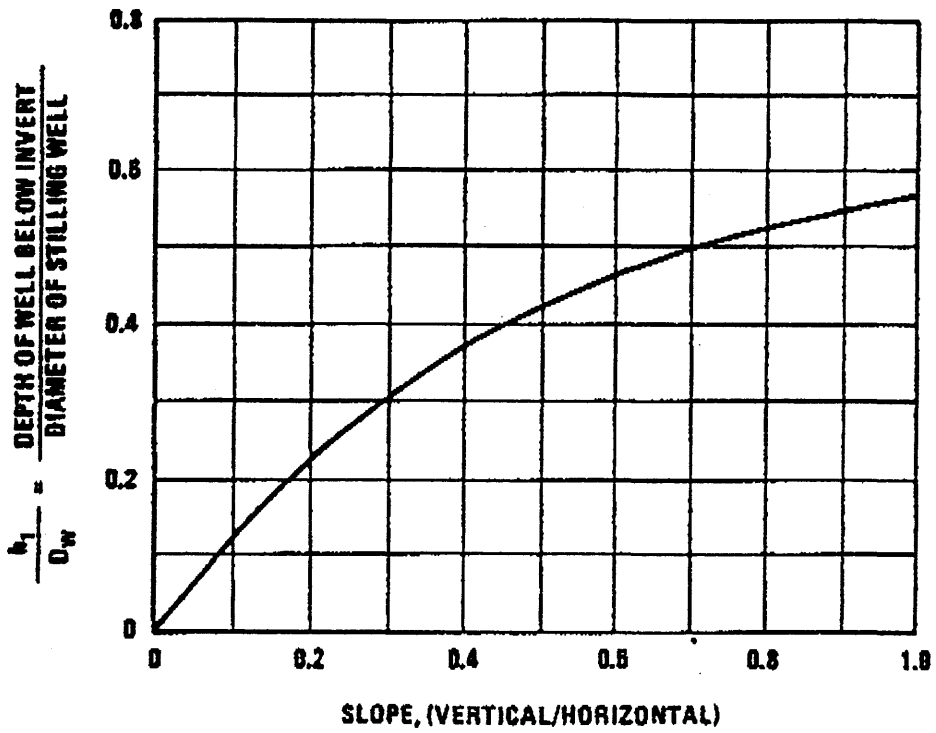
ELEVATION VIEW

TYPICAL
 INVERTED SIPHON
 NOT TO SCALE

SDEL-8.DWG

FIGURE D-5

HKA ASSOCIATES
 ENGINEERS • PLANNERS
 10M183.123 10/01/91



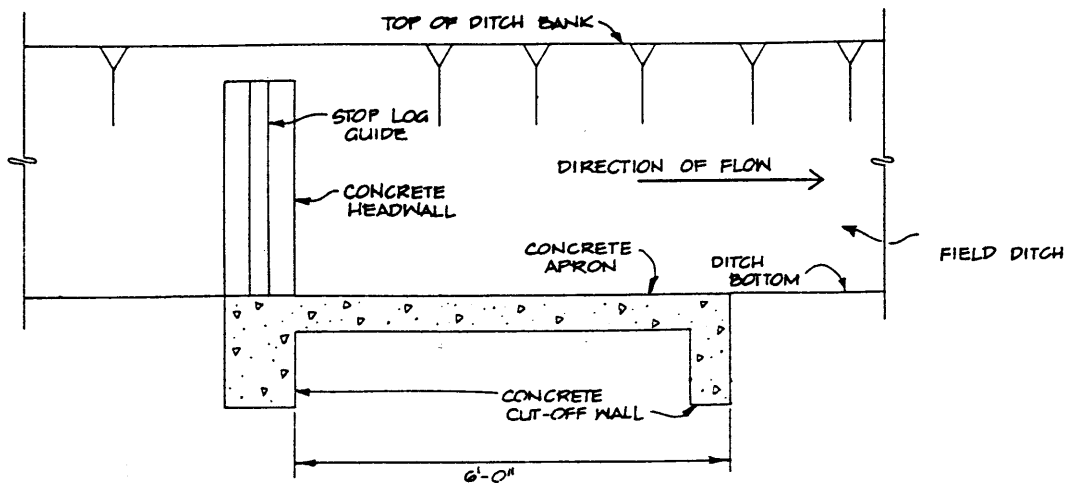
WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
ENERGY DISSIPATING STILL WELL

FIGURE D-6

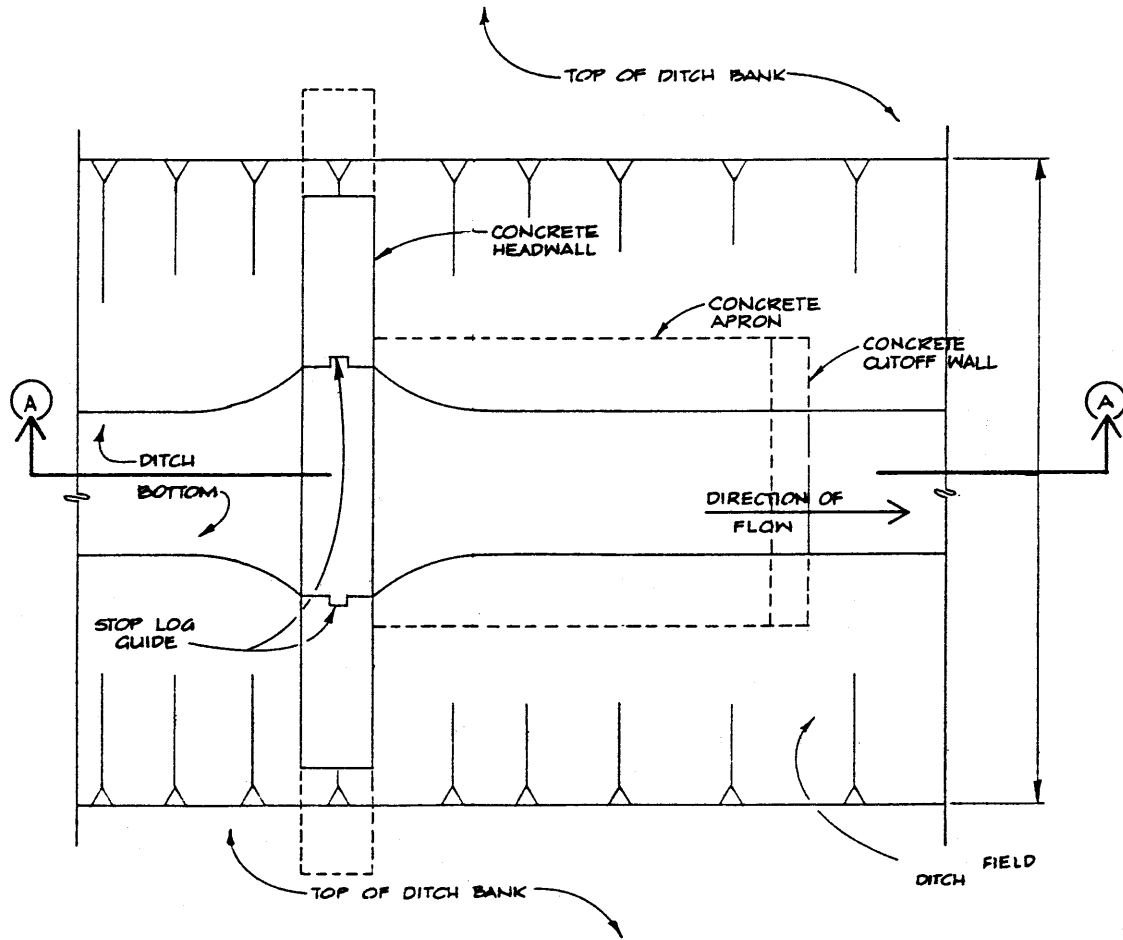
HKA ASSOCIATES
ENGINEERS • PLANNERS

10M183.123

10/01/91



SECTION A - A

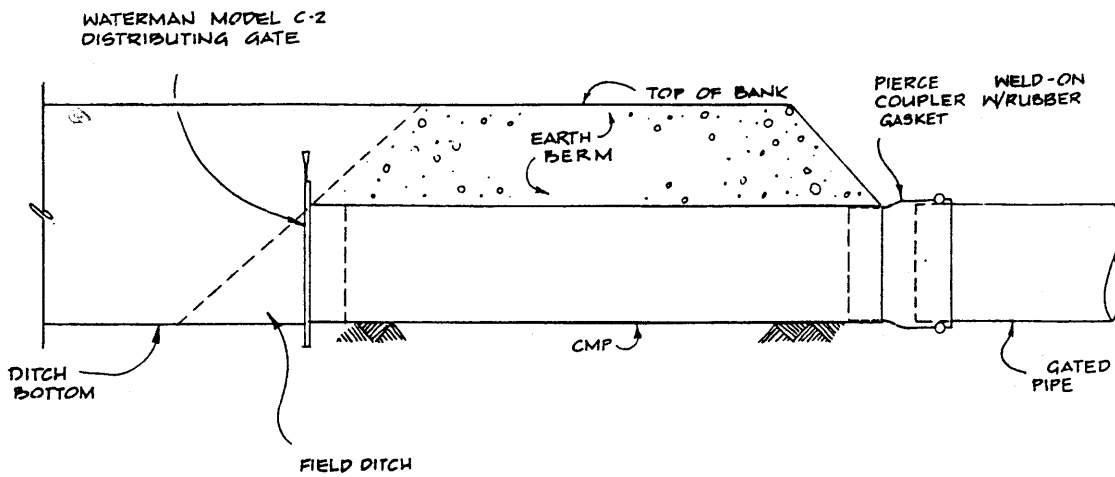


FIELD DITCH CHECK STRUCTURE

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
TYPICAL FIELD DITCH CHECK STRUCTURE

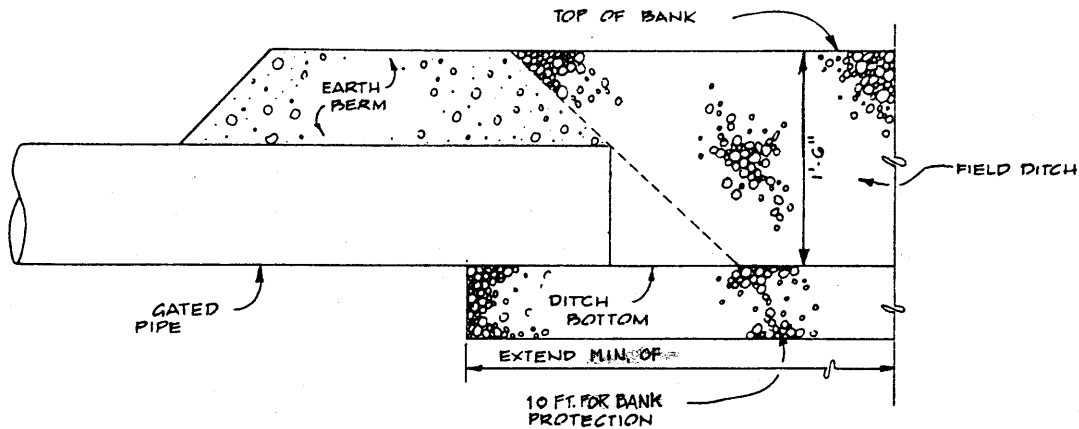
FIGURE D-7

HKA ASSOCIATES
ENGINEERS • PLANNERS
10M183.123 | 10/01/91



INLET TO GATED PIPE

NOT TO SCALE



OUTLET TO OPEN DITCH

NOT TO SCALE

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II

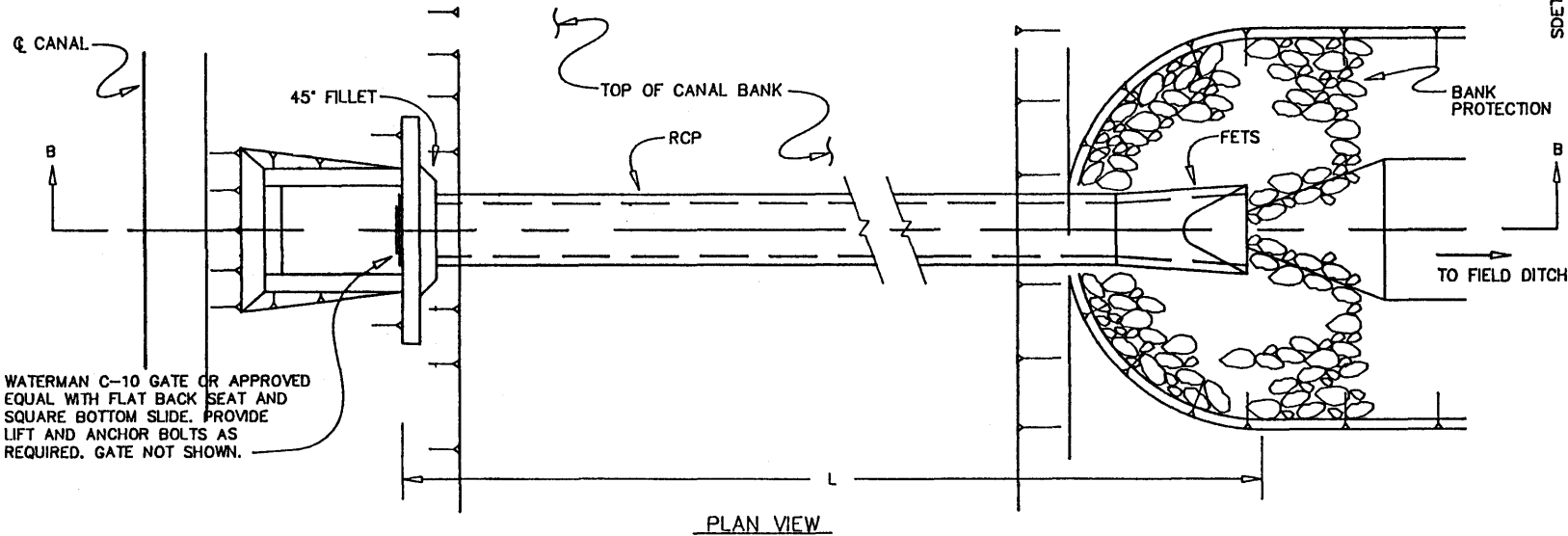
TYPICAL OUTLET TO OPEN DITCH & GATED PIPE

FIGURE D-8

HKA ASSOCIATES
ENGINEERS • PLANNERS

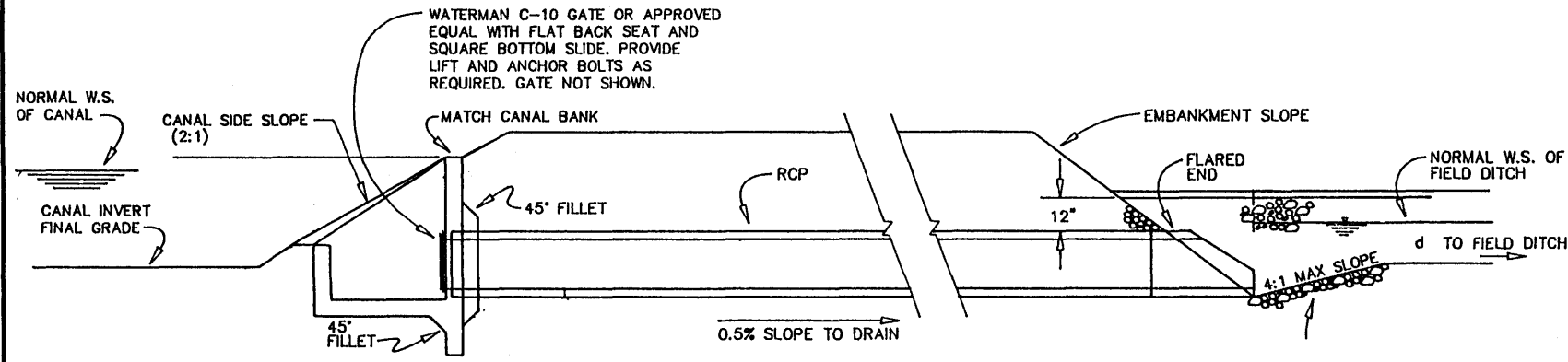
10183.123

10/01/91



WATERMAN C-10 GATE OR APPROVED
EQUAL WITH FLAT BACK SEAT AND
SQUARE BOTTOM SLIDE. PROVIDE
LIFT AND ANCHOR BOLTS AS
REQUIRED. GATE NOT SHOWN.

PLAN VIEW



WATERMAN C-10 GATE OR APPROVED
EQUAL WITH FLAT BACK SEAT AND
SQUARE BOTTOM SLIDE. PROVIDE
LIFT AND ANCHOR BOLTS AS
REQUIRED. GATE NOT SHOWN.

SECTION "B-B"

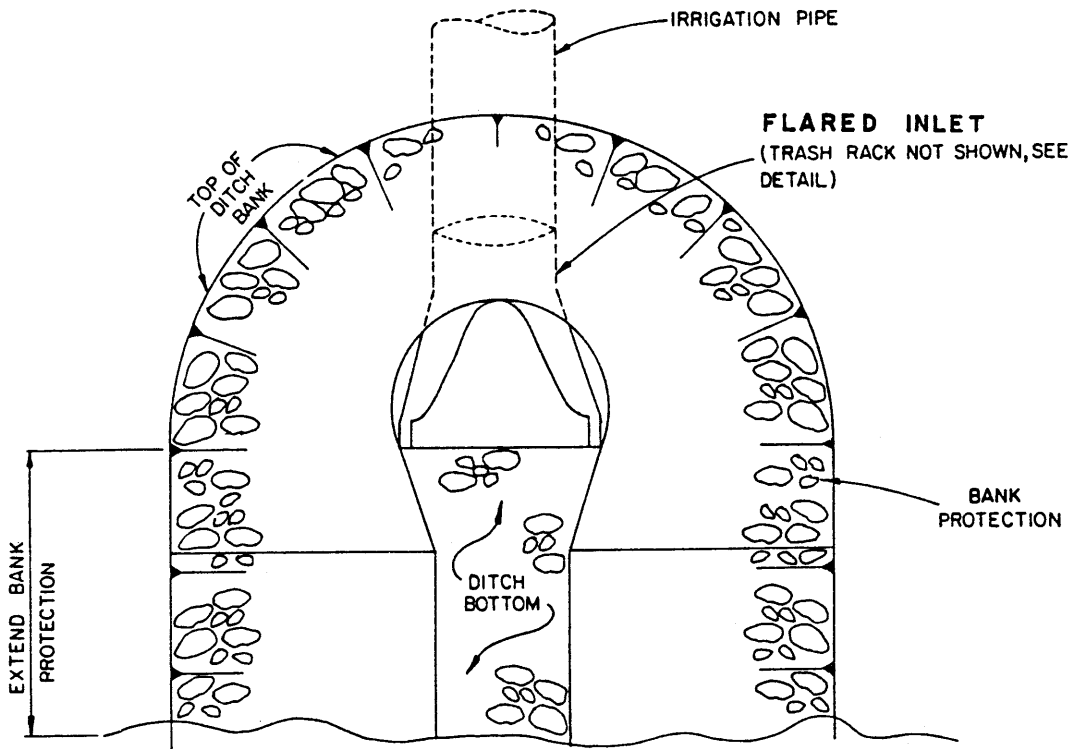
BANK
PROTECTION RIPRAP
(1' THICK)

**TYPICAL
CANAL DELIVERY**
NOT TO SCALE

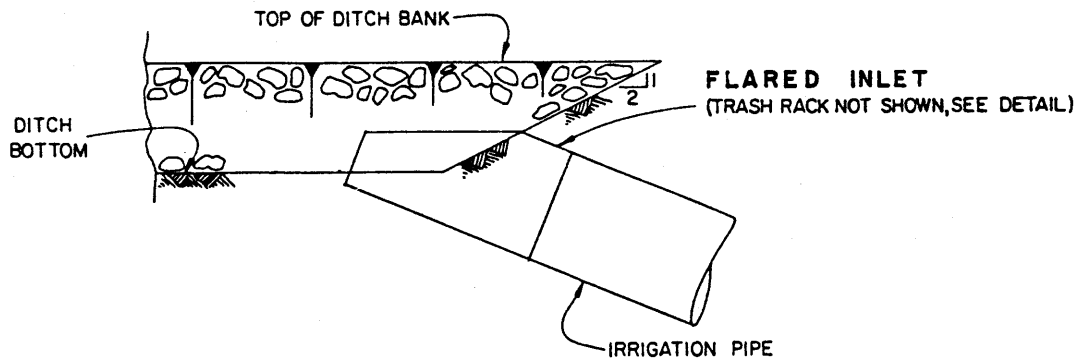
**WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II**
TYPICAL CANAL DELIVERY

FIGURE D-9

HKA ASSOCIATES
ENGINEERS & PLANNERS
10M183.123 10/01/91



PLAN VIEW



ELEVATION

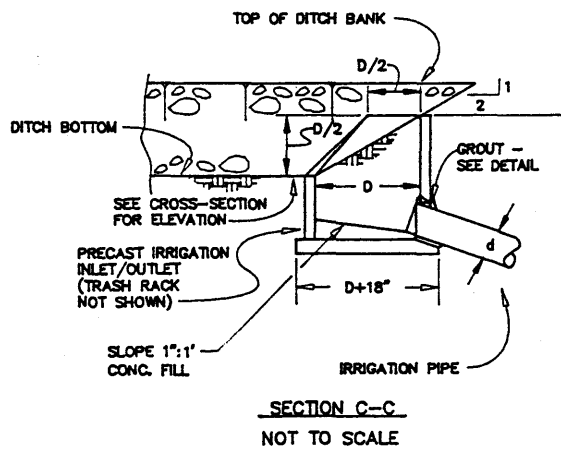
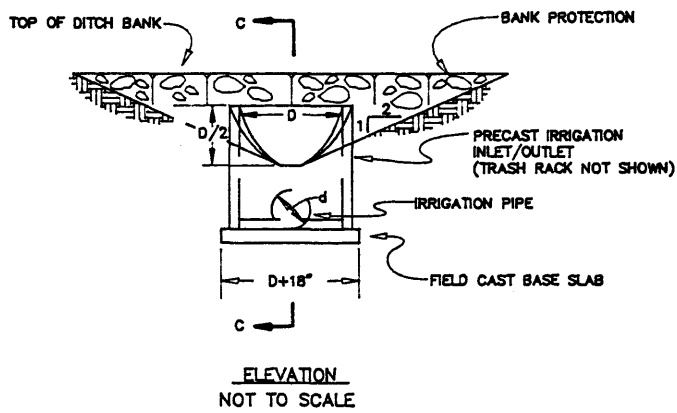
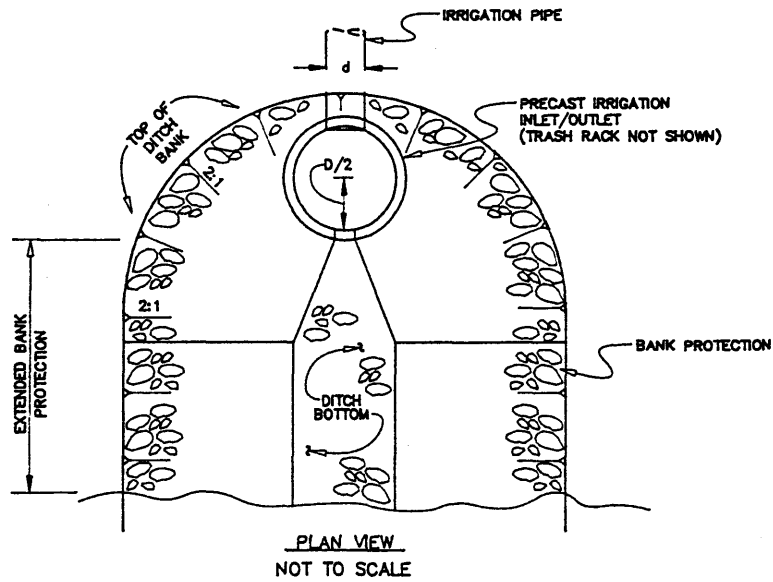
WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
TYPICAL FLARED END IRRIGATION
INLET OR OUTLET

FIGURE D-10

HKA ASSOCIATES
ENGINEERS • PLANNERS

10M183.123

10/01/91



SD-12.DWG

WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II

TYPICAL PRECAST IRRIGATION INLET OR OUTLET

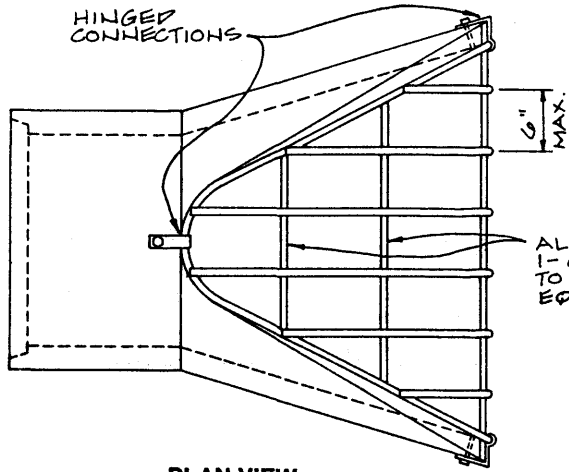
FIGURE D-11

HKA ASSOCIATES
ENGINEERS • PLANNERS

10M183.123

10/01/91

**WWDC CRAZY WOMAN WATERSHED
PROJECT - LEVEL II
TYPICAL TRASH GUARD FOR PIPE INLETS**

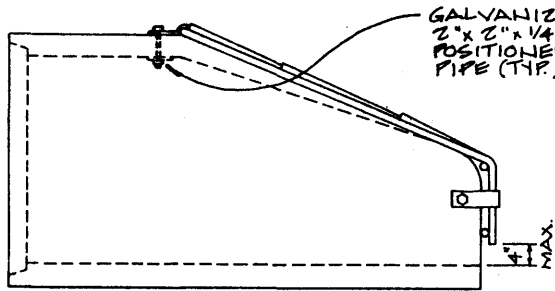


PLAN VIEW

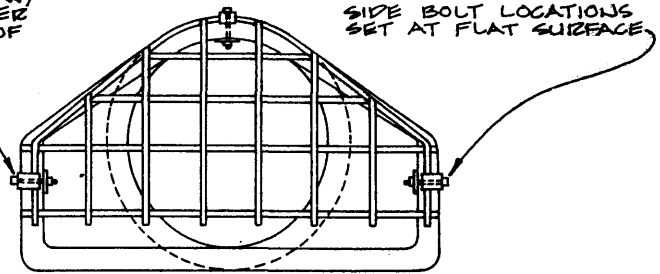
ALL GUARDS TO HAVE 1- CROSS BAR - 60" & UP TO HAVE 2- CROSS BARS EQUALLY SPACED

	PIPE SIZE	HOLE DIA. REQ'D	BOLT DIA.	BAR SIZE
ROUND	12"-24"	5/4"	5/8"	5/8"
	27"-48"	7/8"	3/4"	3/4"
	54"-90"	1 1/8"	1"	1"
RECT	22"-29"	3/4"	5/8"	5/8"
	36"-59"	7/8"	3/4"	3/4"
	65"-88"	1 1/8"	1"	1"

BOLT LENGTH = PIPE WALL THK. + 2 1/2"



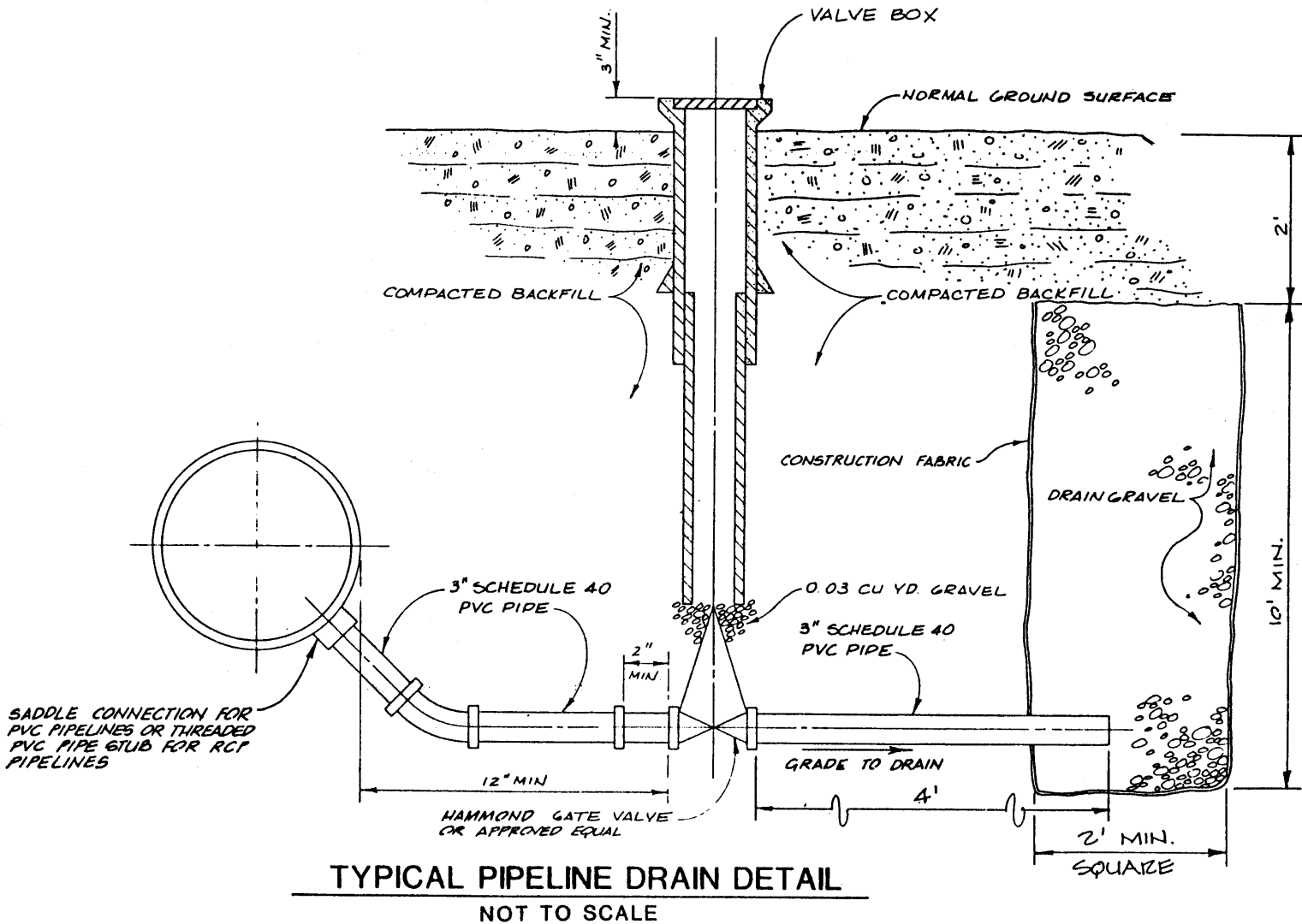
SIDE VIEW



FRONT VIEW

FIGURE D-12

WWDC CRAZY WOMAN WATERSHED
 PROJECT - LEVEL II
 TYPICAL PIPELINE DRAIN DETAIL



TYPICAL PIPELINE DRAIN DETAIL
 NOT TO SCALE

FIGURE D-13

APPENDIX E

MUDDY GUARD RESERVOIR #2 INSPECTION REPORT

Remarks to Accompany the Reports on the
Inspection of the Muddy Guard Reservoir #2

Permit No. 7598 Res.

Russell Dahlgren

Assistant Safety of Dams Engineer

April 28, 1989

Introduction

These remarks are meant to accompany the attached reports describing the conditions of the Muddy Guard Reservoir #2 North and South Dams. The reports describe the conditions of the dams which were seen during visual inspections of the facilities conducted on April 19, 1989.

We stress that no detailed engineering investigations were performed in conjunction with these visual inspections and defects in the dam, which could not be seen during the visual inspections, MAY BE present. We urge you to frequently inspect this facility and monitor the conditions of the dams. If any unusual conditions develop, promptly notify this office.

General Information

The top half of the inspection report outlines general information about the facility, including: location, size, uses, etc. Most of these items are self explanatory, however, the hazard rating classification does warrant explanation.

Dams are classified according to their hazard. A hazard classification reflects the amount of damage expected, if a dam were to fail. The hazard classification does not reflect the actual condition of the dam. Design standards, construction techniques, and operation and maintenance criteria will vary depending upon a dam's hazard rating.

The South Dam at Muddy Guard Reservoir #2 is classified as a Significant Hazard or Class II Dam. Loss of life would probably not occur, but significant damage would occur, if the dam were to fail. On top of the expected damage would be the cost of replacing the structure.

1

RECEIVED
OCT -7 1989

**HKM ASSOCIATES
SHERIDAN OFFICE**

The North Dam at Muddy Guard Reservoir #2 is classified as High Hazard or Class I Dam. Loss of life is probable and significant damage would occur, if the dam were to fail.

Be advised that future development below the reservoir may change the hazard classification of either dam.

Since there is only one spillway and only one outlet at Muddy Guard #2 Reservoir, conditions in each of these appurtenances will be described first. Conditions in each of the dams will then be described separately.

Condition of the Outlet

The outlet is located near the left abutment of the North Dam. The control for the outlet is located on the dam crest.

Item 12 - There is some deterioration in the concrete in the outlet stilling basin and more significant deterioration is present in the concrete in the outlet ditch below the stilling basin. The wire repair mesh in the floor of the outlet ditch is exposed. Only minor spalls of concrete are present in the floor, lower walls, and "lip" of the stilling basin structure itself.

Item 13 - The operation of the outlet was not checked, because no hand wheel or crank was present. The outlet control appears to be in good condition, however.

Item 14 - The outlet control is easy to get to.

Item 15 - The water released through the outlet is not causing significant erosion, other than of the concrete in the floor of the outlet ditch.

Item 20 - No crawl through inspection of the outlet pipe was conducted. Conditions inside the pipe are unknown. No obvious problems were identified from the downstream end of the pipe. In light of the initial settlement of the pipe which occurred after construction, a thorough inspection of the pipe is warranted and should be conducted in the near future.

Condition of the Spillway

The spillway is located in the right abutment of the South Dam. See attached sketch of South Dam. The spillway structure serves two purposes: a by-pass for the Thomas and Mathews #25 Ditch and as the reservoir spillway. Water was flowing in the Thomas and Mathews Ditch during the inspection, obstructing the view of the floor of the spillway.

Item 16 - No erosion or other deterioration is present in the spillway channel. The spillway outlet consists of a 36" diameter pipe.

Item 17 - The spillway is not obstructed

Item 18 - The dam has not been overtopped.

Item 19 - All parts of the spillway appear to be in good condition.

Condition of the Dam Embankments

During the inspection the water level in the reservoir was 40' below the spillway crest. This meant that approximately the upper 45' of the upstream face of the North and South Embankments were visible.

North Dam

Items 2 and 3 - Vegetation - Several small willows and cottonwoods are growing on the upstream slope at the high water line. A lot of sage brush is growing on the downstream slope of the dam.

Item 4 - There were no cracks, slumps, or other indications of instability in the embankment. The old slump in the right abutment has been repaired and there are no signs of additional movement.

Item 5 - No rodents or other burrowing animals were noted during the inspection. No serious erosion gullies have formed on the dam, however, two areas show the first signs of erosion.

The area of a dam where the embankment meets the abutment is known as the groin of the dam. A cattle trail is present near the right groin of the dam and no vegetation is growing in this area. This situation has the potential to allow erosion to form. Minor erosion is occurring in the lower portion of the left groin. The road to the outlet ditch aggravates the potential erosion problems in this area.

Items 6 and 9 - Riprap - The riprap on the dam has been displaced and has broken down. Consequently several beached areas or benches have formed on the upstream face of the dam due to wave action. The worst displacement and wave erosion occur about 20' or more below the dam crest. Above the 20' level, some displacement of the riprap has occurred, but no major benches have formed, yet.

The riprap over the seepage blanket on the right abutment of the dam is in good condition with only minor displacement.

Other comments - The crest of the dam is 25'-27' wide, is level, and is in good condition. No vehicle caused ruts or other erosion is present.

North Dam Seepage

Items 7, 8, 10 and 11 - This dam has a history of seepage. During the inspection seepage was noted in the areas shown on the attached sketch, however, due to the low water level during the inspection the seepage was not as prevalent as in the past. Although a boggy area was noted below the dam, no actual seepage flow was seen. A drainage system was installed in the right groin and below the dam, as a remedial action to control seepage, however, the drain outfalls were not located during the inspection. Two piezometers were installed in the right abutment. The water level in the piezometers was not measured during the inspection.

There were no indications of piping or other seepage related problems seen during the inspection.

South Dam

Items 2 and 3 - Vegetation - There are several small trees and willows growing on the upstream face of the dam at the high water line. A lot of sagebrush is growing on the downstream slope of the dam.

Item 4 - There are no cracks, slumps, or other indications of embankment instability. Several benches are present in the upstream face of the dam, due to wave erosion not embankment movement. There are several breaks in the slope on the downstream face of the dam, which appear to be due to construction activity not movement in the embankment.

Item 5 - No rodents or other burrowing animals were noted. No erosion gullies are present.

Items 6 and 9 - Riprap - There has been significant displacement and consequent erosion of the upstream face of the dam due to wave action. The riprap below approximately 20' from the top of the dam is in generally poor condition. Several bare areas are present in this portion of the dam and several benches have formed on the face of the dam.

One of the most obvious benches is: approximately 30" high, 24' below the dam crest, starts near the right groin of the dam, and extends nearly 300' across the dam face.

Other comments - The dam crest is 17'-18' wide, level and is in good condition. No vehicle caused ruts or other erosion is present.

South Dam Seepage

Items 7, 8, 10 and 11 - This dam has a history of seepage. During the inspection, seepage was noted in the areas shown on the attached sketch, however, due to the low water level during the inspection, the seepage was not as prevalent as in the past.

Although several wet and boggy areas were present, the only actual seepage flow which was seen was located below the large boggy area left of the maximum section of the dam. The flow was very slight and was not measured.

A drainage system was installed as a remedial measure to control seepage. Two drain outfalls, consisting of white PVC pipe were located. The PVC pipe in these drain outfalls is broken and should be repaired.

No indications of piping or other seepage related problems were seen during the inspection

Name of Dam North Dam Muddy Guard #2 Reservoir Date 4-19-89
 Permit Nos. 7598 Water Division Number 2 District # 2
 County: Johnson Location: 1/4 Section, Lot, Tract: NUSW
 Section 29 Township 49N Range 82W
 Type of Dam (circle) (EARTHFILL) ROCKFILL, CONCRETE, OTHER Zoned
 Hazard Rating: I
 Estimated Capacity: 1930 AF Capacity - From Plans: 1934.40 AF
 Estimated Height (Hand Levelled): 96' Height - From Plans: 102'
 Source (Stream Dam located on and/or supplied from - including downstream tributaries): OSE Channel

Water Level - (Circle which one) Feet Below Principal Spillway 40'
 or (Emergency Spillway)
 Estimate Spillway Width: 10' wide Weir 36" ø CMP
 Estimate Freeboard (Spillway to Top of Dam): 6'
 Size and Type of Outlet Pipe (Metal or Concrete): 27" ø Concrete

Use: (IRRIGATION), MUNICIPAL, (circle), (OTHER), (Specify) Fishing

DIRECTIONS: Mark an "x" in the Yes or No column and circle the word or phrase which applies. Use back of form to completely describe or explain condition as warranted from the responses below. Fill in all blanks, if unknown - enter unknown; or not applicable - enter N/A; if none - enter none.

	Yes	No
1. Are the roads to the dam adequate to allow ACCESS by EMERGENCY EQUIPMENT and TRAVEL ACROSS the DAM (i.e., TRUCKS, AMBULANCES)?	X	
*2. Is there DEBRIS, <u>(TREES)</u> , or <u>(BRUSH)</u> on the upstream slope that prevent seeing the entire surface of the slope?	X	
3. Are there TREES or BRUSH on the CREST, or on the DOWNSTREAM SLOPE that prevent seeing the entire surface?		X
4. Are there CRACKS, SLIDES, SLUMPS, BOILS, SETTLEMENT or OTHER on the UPSTREAM SLOPE, CREST, or DOWNSTREAM SLOPE?		X
5. Are there RODENT HOLES or ERODED GULLIES on the UPSTREAM or DOWNSTREAM SLOPE?		X
*6. Is the upstream slope eroded from wave action?	X	
*7. Is there FLOWING WATER or LARGE BOGGY SPOTS at the toe of the dam?	X	
8. Are there FLOWS of WATER or WET SPOTS above the toe of the dam?		X
*9. Is the riprap <u>(DISPLACED)</u> , <u>(BROKEN DOWN)</u> or MISSING?	X	
10. Are there toe drains?	X	
11. Is the water from the TOE DRAINS or LEAKS found to be MUDDY, SANDY, or carrying any material.		X
12. Are any of the concrete portions excessively CRACKED or SPALLED?		
13. Is the OUTLET CONTROL or GATE found to be STUCK, BROKEN, or EXCESSIVELY CORRODED?		
14. Is the outlet control easy to get to?		
15. Is released water UNDERCUTTING the OUTLET or ERODING the EMBANKMENT.		
16. Does the spillway channel show significant EROSION, BACKCUTTING or DETERIORATION?		X
17. Is the spillway obstructed with FLASHBOARDS, TREES, DEBRIS, BRUSH or OTHER material?		X
18. Is there evidence that the dam has been overtopped?		X
19. Are spillway WALLS, FLOOR, CONTROL SECTION, and ENERGY DISSIPATOR in POOR condition?		X

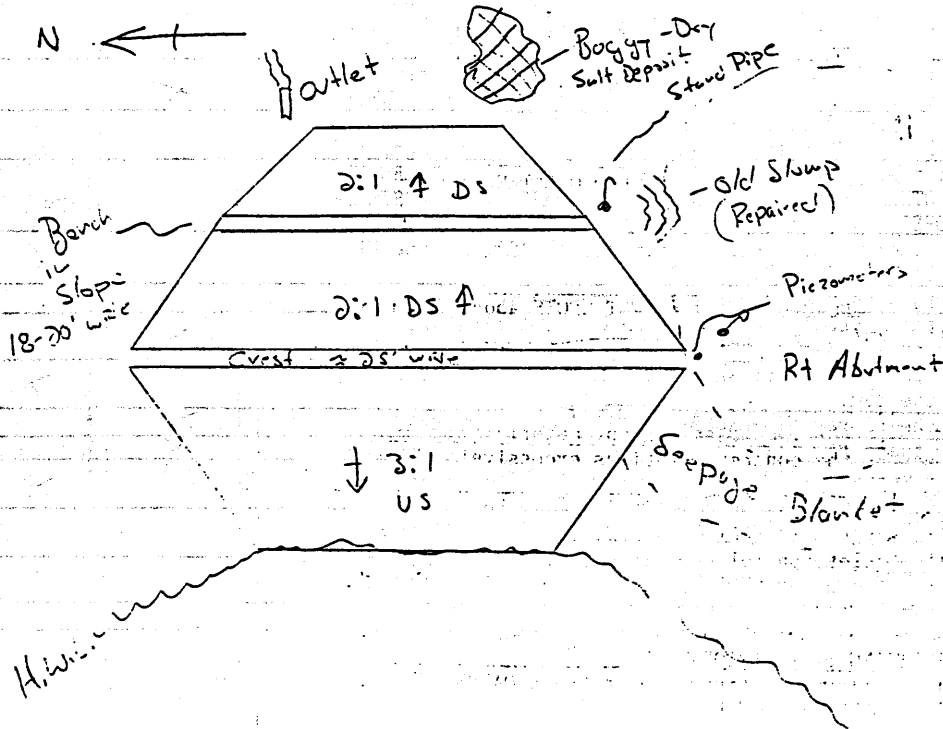
See Remarks

See Remarks	20. Is the outlet pipe BLOCKED, EXCESSIVELY CORRODED or in any other poor condition?	?	
	21. Is the reservoir usually full YEAR ROUND, OVER 1/2 OF YEAR, or LESS THAN 1/2 OF YEAR?		
	22. Should this dam be promptly inspected by a field engineer? (Explain why below)		X
	23. Were photographs taken and forwarded to Cheyenne - State Engineer's Office?	X	
24. Additional Comments and Detailed Narrative Description of Problem Areas and follow-up Activities:			

See Attached Remarks

SKETCH (Use to show problem areas with dam or related facilities):

Sketch of North Dam No Scale



Inspected By: Russell Dahlgren
 Title: Asst. Safety of Dams Engineer

Name of Dam South Dam
Muddy Guard #2 Res Date 4-19-89
 Permit Nos. 7598 Res Water Division Number 2 District # 2
 County: Johnson Location: 1/4 Section, Lot, Tract: NW SW
 Section 29 Township 49N Range 82W
 Type of Dam (circle) EARTHFILL ROCKFILL, CONCRETE, OTHER Zoned
 Hazard Rating: II
 Estimated Capacity: 1930 AF Capacity - From Plans: 1934,40
 Estimated Height (Hand Levelled): 68' Height - From Plans: 57'
 Source (Stream Dam located on and/or supplied from - including downstream tributaries): Off Channel

Water Level - (Circle which one) Feet Below Principal Spillway
 or Emergency Spillway 40'
 Estimate Spillway Width: 10' wide weir 36" ϕ CMP
 Estimate Freeboard (Spillway to Top of Dam): 6'
 Size and Type of Outlet Pipe (Metal or Concrete): 27" ϕ concrete

Use: IRRIGATION MUNICIPAL, (circle), OTHER (Specify) Fishing

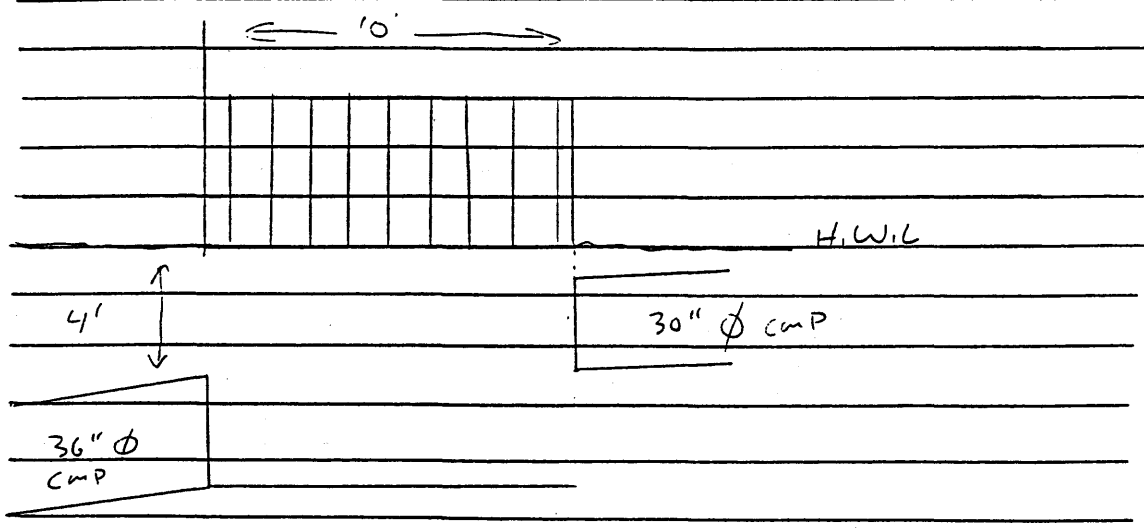
DIRECTIONS: Mark an "x" in the Yes or No column and circle the word or phrase which applies. Use back of form to completely describe or explain condition as warranted from the responses below. Fill in all blanks, if unknown - enter unknown; or not applicable - enter N/A; if none - enter none.

	Yes	No
1. Are the roads to the dam adequate to allow ACCESS by EMERGENCY EQUIPMENT and TRAVEL ACROSS the DAM (i.e., TRUCKS, AMBULANCES)?	X	
* 2. Is there DEBRIS, <u>TREES</u> or <u>BRUSH</u> on the upstream slope that prevent seeing the entire surface of the slope?	X	
3. Are there TREES or BRUSH on the CREST, or on the DOWNSTREAM SLOPE that prevent seeing the entire surface?		X
4. Are there CRACKS, SLIDES, SLUMPS, BOILS, SETTLEMENT or OTHER on the UPSTREAM SLOPE, CREST, or DOWNSTREAM SLOPE?		X
5. Are there RODENT HOLES or ERODED GULLIES on the UPSTREAM or DOWNSTREAM SLOPE?		X
* 6. Is the upstream slope eroded from wave action?	X	
* 7. Is there FLOWING WATER or LARGE BOGGY SPOTS at the toe of the dam?	X	
8. Are there FLOWS of WATER or WET SPOTS above the toe of the dam?		X
* 9. Is the riprap <u>DISPLACED</u> , <u>BROKEN DOWN</u> or MISSING?	X	
10. Are there toe drains?	X	
11. Is the water from the TOE DRAINS or LEAKS found to be MUDDY, SANDY, or carrying any material.		X
12. Are any of the concrete portions excessively CRACKED or SPALLED? <u>See Remarks on outlet</u>		X
13. Is the OUTLET CONTROL or GATE found to be STUCK, BROKEN, or EXCESSIVELY CORRODED?		
14. Is the outlet control easy to get to?		
15. Is released water UNDERCUTTING the OUTLET or ERODING the EMBANKMENT.		
16. Does the spillway channel show significant EROSION, BACKCUTTING or DETERIORATION?		X
17. Is the spillway obstructed with FLASHBOARDS, TREES, DEBRIS, BRUSH or OTHER material?		X
18. Is there evidence that the dam has been overtopped?		X
19. Are spillway WALLS, FLOOR, CONTROL SECTION, and ENERGY DISSIPATOR in POOR condition?		X

See Remarks

		Yes	No
See Remarks X	20. Is the outlet pipe BLOCKED, EXCESSIVELY CORRODED or in any other poor condition?	?	
	21. Is the reservoir usually full YEAR ROUND, OVER 1/2 OF YEAR, or LESS THAN 1/2 OF YEAR?		
	22. Should this dam be promptly inspected by a field engineer? (Explain why below)		X
	23. Were photographs taken and forwarded to Cheyenne - State Engineer's Office?	X	
24. Additional Comments and Detailed Narrative Description of Problem Areas and follow-up Activities:			

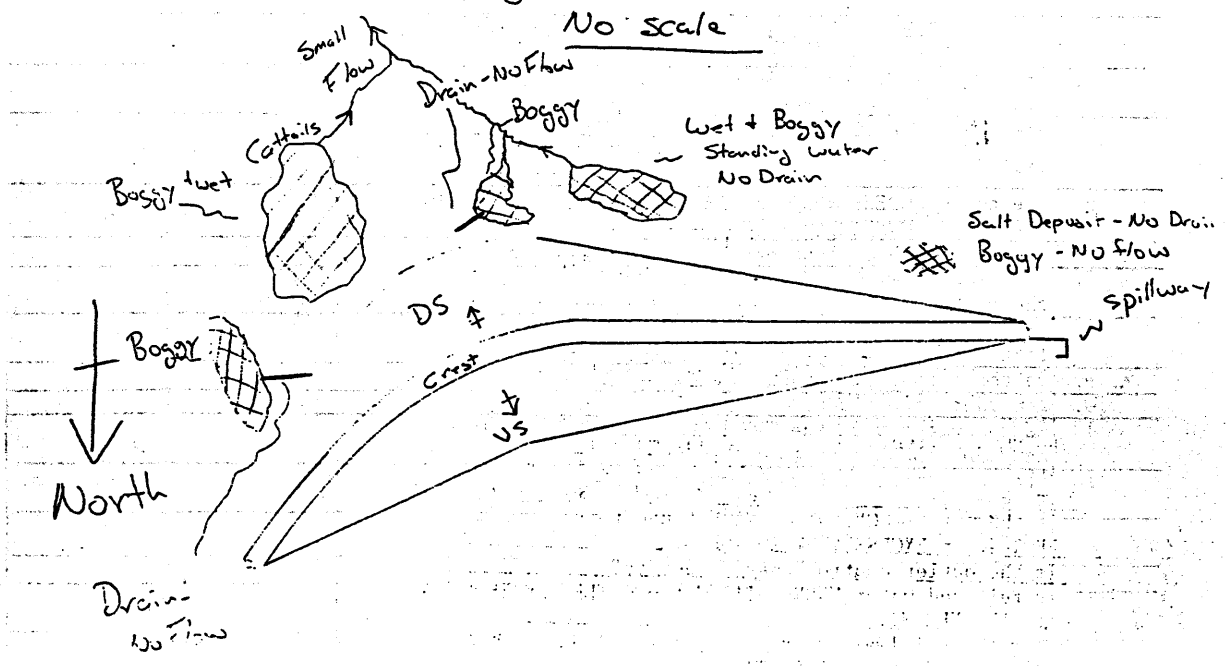
See Attached Remarks



SKETCH (Use to show problem areas with dam or related facilities):

Sketch of Seepage Areas Below South Dam

No scale



Inspected By: Russell Dahlgren
 Title: Asst. Society of Dam Engineer