ENVIRONMENTAL ANALYSIS RECORD

for the

Proposed Westside Irrigation Project

Prepared by the

Worland, Wyoming District Office

Bureau of Land Management

TOPICAL INDEX

INDEX OF TABLES, CHARTS, MAPS AND ILLUSTRATIONS

INTRODUCTION

The Big Horn Basin Irrigation and Development Association, a private group, applied to the state engineer in May 1974 for the right to divert 1,114 c.f.s. (cubic feet per second) of water from the Big Horn River. Such a right, if "perfected" by actual, beneficial use, would allow for irrigation of as many as 78,000 acres. Under state law, water can be appropriated at a maximum rate of one cubic foot per second for each 70 acres to be irrigated.

Most Association members are farmers and businessmen living in or near Worland and Greybull. It is their intent to take water from the Big Horn River, convey it through a series of pumping stations, pipelines and canals, and irrigate land along the west side of the river between the two communities.

Since most of the area proposed for irrigation is national resource lands administered by the BLM -- about 92 percent -- most of the development would be on public land converted to private ownership under the Desert Land Act.

Purpose of Environmental Analysis

The purpose of the environmental analysis is to assure consideration of environmental values at all levels of Bureau planning and decision making. This is in response to the National Environmental Policy Act of 1969 which directs federal agencies to use a systematic, inter-disciplinary approach to ensure the use of natural and social sciences, and the design arts, in planning and decision making affecting man's environment.

Analysis is needed to ensure that environmental values are considered in decisions regarding conversion of national resource lands to private agricultural use. It is Bureau of Land Management policy that an environmental analysis be conducted for every Bureau action.

The purpose of this analysis is to:

-- Identify probable impacts from the intensive agricultural development of national resource lands;

-- Assess public controversy over such development;

-- Provide a basis for determining whether an environmental impact statement is required;

-- Document the analysis.

Background

Renewed interest in desert-land irrigation results from a combination of recent economic, political and social developments.

One factor is an apparent surplus of unappropriated water in the Wind, Big Horn, and Clarks Fork River drainage. The average annual volume of runoff water in the Basin is about 4.3 million acre-feet.

Of the above, about 1.04-million acre-feet are used in Wyoming for irrigation and crop production. The estimated net volume of unused water, therefore, is 3.2-million acre-feet. (USDA, 1974) This water leaves Wyoming annually and a portion has been appropriated by users in other states. In addition, water is increasingly being appropriated within the state for industrial use. The slogan "Use it or lose it" reflects the attitude of many Wyoming residents concerned to reserve this water for agriculture. Also, appropriation for agricultural development would reserve much of this water for use in Wyoming.

Economic factors which have contributed to increased interest in desert-land irrigation are the availability of development capital and high commodity prices. State government has appropriated money for low-interest loans (4.5%) for development of new agricultural lands. This is a permanent fund, currently at $15 million. The availability of such low-interest financing comes at an optimum time for growers in the Basin, since prices are high for their major crops such as malt baley and sugar beets.

Another factor is irrigation technology. Modern sprinkler-irrigation systems have made possible the development of desert lands which could not previously be reached, using the older gravity and flood methods. Generally, lands in the Basin susceptible to flood irrigation have already been developed and are now privately owned.

The Association's application for water rights alerted the BLM to this growing interest in desert-land development, and the probability of a large number of desert-land applications.

None of the lands considered in this project were classified for multiple use under the Classification and Multiple Use Act of 1964. The project boundaries are within the Gooseberry-Tatman Mountain planning unit and the Management Framework Plan (MFP) was completed in 1973. The MFP decision for this area states, "Some of the public lands are such that they may be suitable for commercial, industrial or agricultural development in the future." Where land use planning so indicates, and the land's highest and best use is for agricultural purposes, transfers can be made.

To ensure full consideration of all resource values, proper classification, equitable and orderly disposition and planned development with a minumum of administrative cost, the BLM requested that the

Secretary of the Interior temporarily withdraw these lands from appropriation and disposal under the public land laws.

The application for withdrawal precludes the filing of scattered and conflicting applications, thereby eliminating the need to investigate and classify the lands on such applications on an individual basis. It allows time for environmental assessment, identification of all the lands suitable for such development, and proper classification of them. This withdrawal action also provides an opportunity to control development in accordance with the principles of sound land-use planning.

Federal Action Involved

General

The BLM proposes to examine and classify approximately 29,000 acres of national resource land identified in the private feasibility study as being suitable for irrigation as to its suitability for disposal under the Desert Land Act. (Appendix) This analysis will provide a description of the probable development of these lands as a result of classifying lands as suitable for agricultural entry and outline the impacts on the environment. A discussion of alternatives to the action will also be discussed.

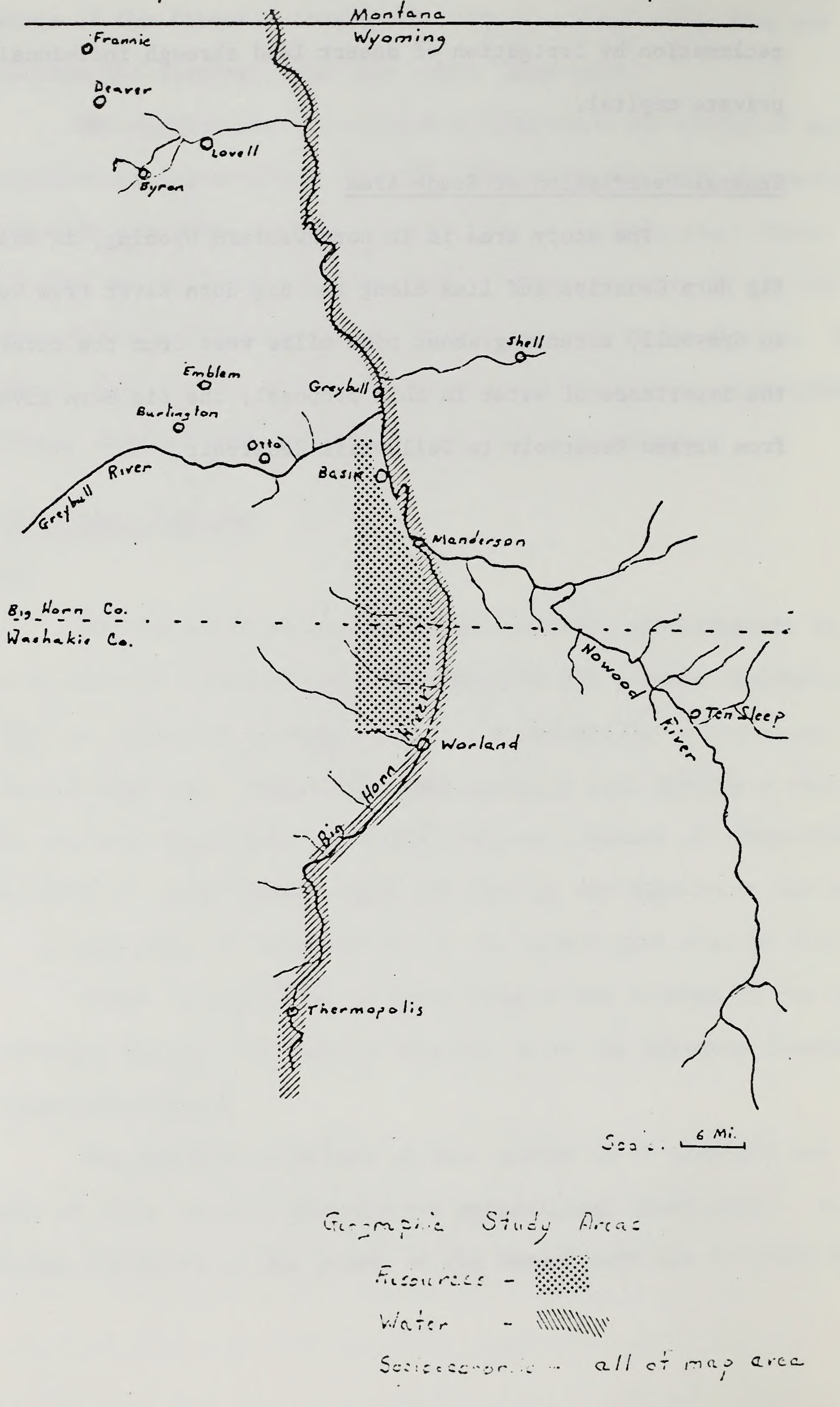
Based on evaluation of these impacts and studies of the land, the district manager will make a decision as to the ultimate disposition of these public lands.

The specific objective of this action is to identify and dispose of lands chiefly valuable for agricultural development. As was mentioned above, it is the intent of the Desert Land Act to allow the reclamation by irrigation of desert land through individual effort and private capital.

General Description of Study Area

The study area is in northwestern Wyoming, in Washakie and Big Horn Counties and lies along the Big Horn River from Worland north to Greybull, extending about nine miles west from the river. Due to the importance of water in this proposal, the Big Horn River is studied from Boysen Reservoir to Yellowtail Reservoir.

Study Area Map



Map I

Some potential impacts of agricultural development would extend beyond the study area. Probable socio-cultural, air quality, climate and wildlife impacts have therefore been analyzed for Washakie and Big Horn Counties. See study area Map I for scope of project.

Assumptions

The feasibility report

The development association hired the consulting firm of Clyde-Criddle-Woodward Inc., Salt Lake City, to study the engineering and economic feasibility of irrigating the higher lying benchlands west of the Big Horn River between Worland and Greybull.

This consulting firm's finding (reported June 1975) is that irrigation of these public lands is feasible. (Appendix) The BLM study team used the consultant's report as a basis for developing a "proposed action" to be analyzed in the present study. The report is not sufficiently detailed for this purpose, however, and so further assumptions have been made by the team.

Below is a description of the type of data from the Clyde-Criddle-Woodward feasibility report used in this study.

Farmable acreages

The feasibility study assumed development of 25,000 acres. Examination of a map submitted with the report reveals a total of 28,540 acres actually outlined as the project area. This acreage is the figure used for our discussion of the proposal.

Exemptions

Areas of more than 10 percent slope and areas with soils classified by SCS as "unirrigable" were subtracted from the total to determine irrigable acreage. Further reduction was made for improvements which would remove land from production.

Table 1

Acreage Data - Westside Project

	NRL	Private	Total
Acres in Project Area	26,140	2,400	28,540
Not arable due to terrain	4,873	380	5,253
Not arable due to poor soils (otherwise arable)	753	15	768
Not farmable due to improvements (roads, buildings, fences, etc.)	1,641	160	1,801
Acres to be farmed	18,873	1,845	20,718

Water supply and delivery

The BLM study team used information from the feasibility study without modification for discussion of the water supply and delivery system.

Probable timeframe

If a full environmental impact statement is not required, following the present analysis, classification procedures could begin in the fall of 1976. If it is determined that an environmental impact statement is required, this process would take BLM an additional 18 months.

After favorable classification, the BLM would lift the present "withdrawal," opening the lands to application under the Desert Land

Act. It is probable that a period would be allowed for filing applications for tracts classified for agricultural development. A drawing would then be held to determine successful applicants.

Following determination of successful applicants, development would begin. After entry is allowed, the applicant has four years in which to "prove up" by completing the irrigation system and actually farming the land.

The proposed project is of such magnitude that it would probably be developed in three parts. Development would begin in the northern portion and proceed southward toward Worland. Water would be delivered on the first portion a year after entry is allowed, with additional areas developed each succeeding year.

All lands would not be "proved up" and transferred to private ownership until at least 1983.

The Proposal

The study team predicts the following stages of implementation if development is allowed: project development, farming operation, and site occupation.

These stages are not exclusive, of course, and will overlap. In this report they will be discussed separately, however, to aid full understanding of the proposal.

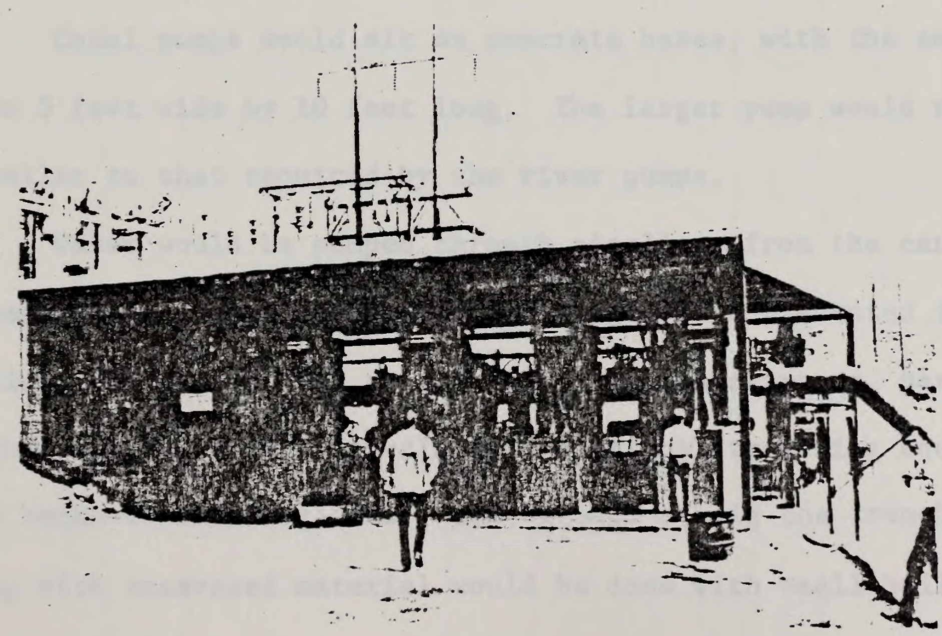
Project development

Water

Water to irrigate approximately 20,700 acres, 18,900 acres of national resource land and 1,800 private, would come from the Big Horn

River. The development association has applied for a permit from the state engineer, and if the permit is issued and the water is put to beneficial use, this would become a water right. The association believes that water for this project is available in the return flow from other irrigation projects already taking water from the river. This water would be pumped from the river into the existing Big Horn Canal with high volume pumps. The canal would serve as a regulatory and exchange facility. From the canal, the water would be pumped under pressure to the fields.

Three pump stations with a combined capacity of about 500 c.f.s would be used between river and canal. Tentative sites are illustrated on Map 2. Capacity of the three stations would be about 225,280 gpm, with power requirements totaling 10,900 brake horsepower (BHP). Pumping rates, power requirements and acres served by each river pumping plant are displayed on Table 2. There will be from three to seven pumps at each station, resting on a concrete base approximately 25 feet wide and 50 feet long. (See Picture.)



Pumps at each plant will be of various sizes and capacities. These pumping plants will be on scour curves or cut banks along the river. Rip-rapping or bank stabilization will be necessary to protect the sites. The intake pipe would be placed in a bay dredged in the river. During periods of low flow, a temporary diversion dam of stream-bed material would be necessary to divert water to the intake pipe. This would be accomplished by use of a bulldozer on the riverbed.

From pumping plant to canal, water will be carried in 48 inch pipes at least two feet underground. Where this pipe enters the Big Horn Canal, a concrete-stilling basin would be constructed, to protect the bank from erosion by the turbulence. Dimensions and specifications are unknown.

Along the canal there would be 49 pumps. Location and size is displayed on Map 2 (Appendix) and in Table 2. Canal pumps would average 500 horsepower, although one would be larger than the river pumps. This pump would have a 5,000 brake horsepower capacity. Total power requirement of these pumps is 23,995 BHP.

Canal pumps would sit on concrete bases, with the smaller ones on bases 5 feet wide by 10 feet long. The larger pump would require a base similar to that required by the river pumps.

Water would be pumped through pipelines from the canal westward to project lands. Pipe dimensions and lengths are presented in Table 3. These lines would be buried at least two feet underground, parallel to each other at half-mile intervals. Conventional trenching equipment such as backhoes and draglines would be used to dig the trenches. Re-covering with excavated material would be done with small bulldozers. (See Map 2 for proposed system layout.)

Connections for sprinkler laterals would be at 60 foot intervals along each pipeline. These risers would extend a foot above land surface. Sprinkler heads would be mounted on the laterals for irrigation.

To supply adequate irrigation pressure, a total of 35 in-line booster pumps would be required. Such pumps average 250 horsepower. Water pressure at the sprinkler heads would be maintained at 35-50 pounds per square inch.

Table 2 presents pumping rates and power requirements, and Map 2 shows proposed locations. These pumps would also be placed on a concrete base.

Gravel access roads would be constructed to river pumping stations, along the canal and to the booster pumps. The roads would be constructed with conventional earthmoving equipment. No blasting is anticipated. These roads would be used for construction, operation and maintenance and would be of gravel. They would also be used for farming operations.

Power

Total pumping power required is estimated in the feasibility study to be 39,335 brake horsepower requiring 29,344 KW of electric power. All pumps in the system would be electric.

Only a portion of this requirement can be supplied by existing facilities: the northermost third of the project can be supplied from the Basin substation.

The remainder of the requirement would have to be supplied from another source. Thermopolis is the nearest distribution point with sufficient capacity.

Table 2

Pumping Plant Requirements

WESTSIDE IRRIGATION PROJECT

Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift H. Friction	H. Elevation	H. Pressure	TDH	Power required	Misc. notes
Tun. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
47N								
1	120	900	15	120	140	275	80	
2	280	2100	30	170	140	340	230	
3	240	1800	25	190	140	355	200	
4	320	2400	30	220	140	390	300	
5	480	3600	25	160	140	325	390	
6	480	3600	25	165	140	330	400	
7	640	4800	30	175	140	345	550	
8	640	4800	30	165	140	335	530	
Boosters								
1B	(160)	1200	10	60	-	70	25	
2B	(160)	1200	10	60	-	70	25	
3B	(320)	2400	30	70	-	100	80	
4B	(320)	2400	30	100	-	130	100	
Total	3200						2910	

Table 2

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT.
Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift: H. Friction	H. Elevation	H. Pressure	TDH	Power required	Misc. notes
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
T48N								
9	240	1800	30	145	140	315	180	
10	520	3900	35	125	140	300	390	
11	760	5700	40	145	140	325	600	
12	960	7200	40	145	140	325	780	
13	1200	9000	40	150	140	330	990	
14	840	6300	50	170	140	360	750	
15	860	6450	50	190	140	380	800	
16	1020	7650	50	195	140	385	980	
17	1020	7650	50	175	140	365	930	
18	1000	7500	40	205	140	385	950	
19	1000	7500	40	195	140	375	925	
Boosters								
5B	(80)	600	10	50	-	60	10	
6B	(240)	1800	20	90	-	110	60	
7B	(400)	3000	35	80	-	115	115	
8B	(640)	4800	50	165	-	215	340	
9B	(240)	1800	50	160	-	210	125	
10B	(320)	2400	45	100	-	145	115	
11B	(480)	3600	45	100	-	145	175	
12B	(400)	3000	45	140	-	185	165	
13B	(440)	3300	45	130	-	175	190	
14B	(520)	3900	40	140	-	180	230	
Total	9420						9820	

Table 2

Pumping Plant Requirements

WESTSIDE IRRIGATION PROJECT

Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
			H. Friction	H. Elevation	H. Pressure	TDH		
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
T49N								
20	1140	8550	35	135	140	310	880	
21	80	600	10	45	140	195	40	
22	360	2700	35	105	140	280	250	
23	520	3900	30	105	140	275	350	
24	640	4800	30	145	140	315	500	
25	720	5400	20	105	140	265	475	
26	700	5250	20	110	140	270	470	
27	520	3900	15	75	140	230	300	
28	360	2700	10	155	140	305	275	
29	100	750	15	115	140	270	65	
30	800	6000	40	100	140	280	560	
31	240	1800	20	65	140	225	135	
Boosters								
15B	(640)	4800	65	100	-	165	260	
16B	(80)	600	10	40	-	50	10	
17B	(240)	1800	20	40	-	60	35	
18B	(400)	3000	30	100	-	130	130	
19B	(400)	3000	30	100	-	130	130	
20B	(280)	2100	20	100	-	120	85	
21B	(200)	1500	15	100	-	115	55	
22B	(320)	2400	15	50	-	65	50	
Total	6180						5055	

Table 2

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Land Served	Pumping rate	Pumping lift: H. Friction	Pumping lift: H. Elevation	Pumping lift: H. Pressure	Pumping lift: TDH	Power required	Misc. notes
Twp.	No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
50N									
	32	80	600	10	40	140	190	40	
	33	4480	33600	75	370	-	445	5000	
Booster	31B	(520)	3900	35	-	120	155	200	
	29B	(560)	4200	55	-	140	195	270	
	30B	(120)	900	25	-	140	165	50	
	27B	(440)	3300	60	-10	140	190	200	
	28B	(400)	3000	60	-100	140	100	100	
	25B	(320)	2400	100	-40	140	200	160	
	26B	(560)	4200	115	-140	140	115	160	
	23B	(200)	1500	90	-80	140	150	75	
	24B	(1040)	7800	175	-100	140	215	550	
	34	240	1800	15	30	140	185	100	
	35	280	2100	20	35	140	195	130	
	36	120	900	10	65	140	215	65	
	37	240	1800	20	10	140	170	100	
	38	160	1200	15	25	140	180	70	
	39	80	600	5	25	140	170	35	
	40	160	1200	10	90	140	240	90	
	41	80	600	5	115	140	260	50	
	42	240	1800	10	215	140	365	220	
Total		6160						7665	

Table 2

Pumping Plant Requirements

WESTSIDE IRRIGATION PROJECT

Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
			H. Friction	H. Elevation	H. Pressure	TDH		
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
51 N								
43	320	2400	25	130	140	295	230	
44	320	2400	25	135	140	300	240	
45	2240	16800	105	145	140	390	2200	
46	40	300	10	70	140	220	20	
Boosters								
32B	(360)	2700	35	50	-	85	75	
33B	(400)	3000	35	-	-	35	35	
34B	(230)	2100	25	-	-	25	15	
35B	(160)	1200	25	-	-	25	10	
Total	2920							
52 N								
47	80	600	10	70	140	220	40	
48	120	900	15	70	140	225	65	
49	80	600	10	75	140	225	45	
Total	280						150	
Total 51 & 52	3200							

Table 2

Pumping Plant Requirements

WESTSIDE IRRIGATION PROJECT

Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
			H. Friction	H. Elevation	H. Pressure	TDH		
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
River Pump								
R1	(12620)	100960	20	125	-	145	4900	
R2	(5040)	40320	30	150	-	180	2400	
R3	(10500)	84000	20	110	-	130	3600	
	28160						10,900	0.39 HP/AC

Table 2

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift: H. Friction	H. Elevation	H. Pressure	TDH	Power required	Misc. notes
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
47N	3200						2910	
48N	9420						9820	
49N	6180						5055	
50N	6160						7665	
51N	2920						2835	
52N	280						150	
(88 Entries)	28160						28,435	= 1.01 HP/AC
River								
R1	(12620)						4900	
R2	(5040)						2400	
R3	(10500)						3600	
Total	28160						10900	= 0.39 HP/AC
Gr. Total	28160						39,335	1.40 HP/AC

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Pipe diameter in inches														
		48	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Tp.	No.	Length of pipe - Feet														
T47N																
	1													3300	660	
	2											2440	1320	1320	1320	
	3											2300	1320	1320	660	
	4											2900	1320	1320	660	
	5										2920	1980	1320	1320	660	
	6										3120	1980	1320	1320	660	
	7									4060	2640	1980	1320	1980	1320	
	8									3760	2640	1980	1320	1980	1320	
										7[illegible]	11[illegible]	1[illegible]	9240	[illegible]60	7260	

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	52	42	36	30	26	24	22	20	18	16	14	12	10	8	6
[illegible]	Length of pipe - Feet														
[illegible]															
9											2080	1320	1980	1320	
10									1560	2640	1980	1320	1980	1320	
11								2520	2640	2640	1980	1320	1980	1320	
12							2220	3300	2640	2640	1980	1320	1980	1320	
13						1460	4620	3300	2640	2640	1980	1320	1320	660	
14								3540	2640	2640	5280	2640	2640	1320	
15								4160	2640	2640	7260	1320	1320	660	
16							3700	3300	2640	5280	1980	1320	1320	660	
17							3700	3300	2640	2640	2640	1320	2640	1320	
18							2760	3300	2640	2640	1980	1320	2640	1320	
19							3360	3300	3960	2640	1980	1320	1320	1320	
						1460	20360	30020	26640	29040	31120	15840	21120	12540	

Table 3.

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT.
Bighorn River Basin, Wyoming

Station		Pipe diameter in inches													
Twp.	No.	[illegible]	42	36	30	26	24	22	20	18	16	14	12	10	8	6
		Length of pipe - Feet														
49N																
	20							4400	3300	3960	2640	3960	1320	1320	1320	
	21													660	1980	
	22										940	1980	1320	2640	1320	
	23									660	2640	1980	1320	1320	660	
	24									2460	2640	1980	1320	1980	1320	
	25								1240	2640	2640	1980	1320	1320	660	
	26								940	2640	2640	1980	1320	1320	660	
	27									720	2640	1980	1320	1320	1320	
	28										560	1980	1320	1320	1320	
	29													2080	1320	
	30-N								2400							
	K-North													660	660	
	K-O									1320						
	O- 22B									2640	2640					
	22B North													1320	1320	
	22B -P											2640				
	P North											660	1320	1320	660	
	31											4840	1980	1320	660	
								4400	7880	17040	19980	25960	13860	19900	15180	

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

(Cont.)

Station	Pipe diameter in inches: 54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. | No.	Length of pipe - Feet														
T 50 N															
32													1320	1320	
33-M		1700													
M (North)												660	1320	660	
M - L		3800													
L (South)												660	1320	660	
L - A		7600													
A - J									660	1980					
J North										1320	1980	1320	1320	660	
J K													1320		
K North													1320	1320	
A - B			2640												
B North									1320	2640	1980	1320	1320	660	
B South													1320	1320	
B - C			2640												
C North									1320	2640	1980	1320	1320	1320	
C South										1320	1980	1320	1980	1320	
C - D				2640											
D North											1980	1320	1320	660	
D South									1320	2640	1980	1320	1980	1320	
D - E						2640									
E North												1980	1320	660	
E - F							5280	1320							
F South											660	1320	1320	660	
F - G									2640						
G - H									1320						

(Continued)

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Pipe diameter in inches														
		54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp.	No.	Length of pipe - Feet														
T-50N(Cont)																
	H-South												660	1320	660	
	H-I											2640				
	I South											3300	1320	1320	660	
	34											1000	1320	1320	660	
	35											1300	1320	1320	660	
	36													2130	1320	
	37											2130	1320	3300	1320	
	38												1360	1320	1320	
	39													1630	1320	
	40												320	1320	660	
	41													1440	660	
	42											2640	1980	1320	660	
2 Sheets Total			13100	5280	2640		2640	5280	1320	8580	12540	25600	23140	37640	22440	

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Pipe diameter in inches													
	54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. No.	Length of pipe - Feet														
151E															
43											3300	1320	1320	660	
44											1320	1320	1930	1320	
45 -S				8400											
S-T							2640								
T-U							2640								
U-Z											6600	1320			
Z North												1320	2640	1320	
U-Y									1930	2640	660				
Y North											1320	1320	1320	1320	
S-V						1320	3960								
V-X									1320	1320					
X North										1320	1930	1930	1930	660	
V-W										2640					
W-Z										2640					
Z North										660	1930	2640	1320	1320	
46														[illegible]	
Total				8400		1320	6600	-	3300	11220	17660	11220	10560	8530	
T 52N															
47													740	660	
48													1640	660	
49													1040	660	

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Pipe diameter in inches														
	[illegible]	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. · No.	Length of pipe - Feet														
R-1	3300														
R-2		5500													
R-3	4500														

Table 3

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Summary (Pipe)

[illegible]	Pipe diameter in inches														
	60	42	36	30	26	24	22	20	18	16	14	12	10	8	6
	Length of pipe - Feet														
47N									7820	11320	15560	9240	13860	7260	
48N						1460	20360	30020	26640	29040	31120	15840	21120	12540	
49N							4400	7800	17040	19980	25960	13860	19900	15180	
50N		13100	5280	2640		2640	5280	1320	8580	12540	23600	23140	37640	22440	
51N				8400		1320	6600		3300	11220	17660	11220	10560	8580	
52N													3420	1980	
R1	3300														
R2		5500													
R3	4800														
Total	8100	18600	5280	11040	-	5420	36640	39220	63380	84100	115900	73300	106500	52800	

A 115-kv transmission line from Thermopolis would be constructed roughly 50 miles to a substation west of the canal, south of Manderson. From the substation, power would be transported on about 75 miles of 34.5-kv transmission lines north and south to canal, booster, and river pumps. Step down transformers would be necessary at each pump station to reduce voltage to 480 V.

The main line from Thermopolis would be supported on structures consisting of two 65-foot wooden poles joined by a 20-30-foot cross beam. Distribution lines would be carried on single poles with single cross beams.

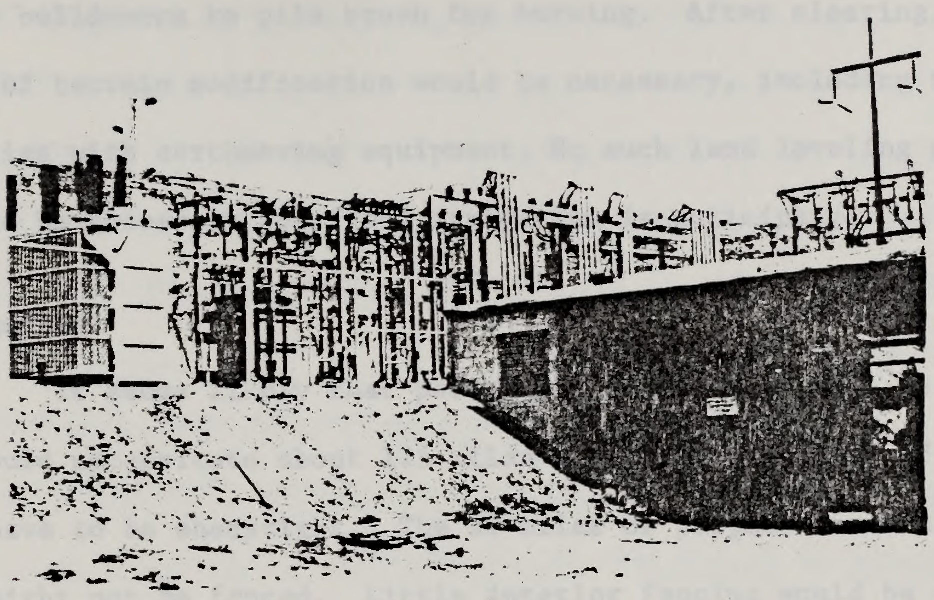
Transformers would be mounted on poles at each of the small booster and canal pumps. Pumps along the river would require large transformers similar to those shown in Picture 2.

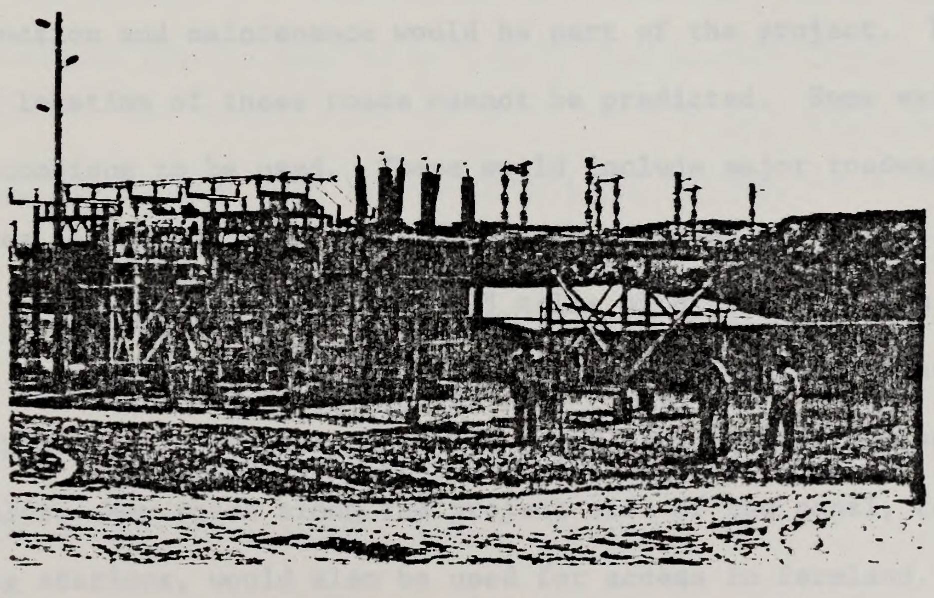
Construction work would include blasting, where the ground is too hard to use augers in making holes for transmission poles and guy-line anchors. A road would probably be pioneered along the powerline rights-of-way during construction. The power company might wish to maintain this road in a rough, "unimproved" condition to aid periodic inspections.

The BLM would require protection and rehabilitation of the environment. A copy of the usual stipulations for such rights-of-way is included as Appendix 1.

The substation would supply an estimated 8,131 kw to the river pumps, 17,900 kw to the canal pumps and 3,305 kw to the booster pumps. The substation would be about the size of the one now serving Worland.

PICTURE NO. 2





Land preparation

Preparation of land for farming would begin with removal of vegetation. On most of the land, this is sparse enough that clearing could be accomplished by large disc-type plows. Some clearing may require bulldozers to pile brush for burning. After clearing, a small amount of terrain modification would be necessary, including the filling of gullies with earthmoving equipment. No such land leveling and planing as would be necessary for flood irrigation is anticipated.

Fencing

It seems likely that perimeters of the area will be fenced. This would necessitate about 125 miles of fence, a portion of which might have to be sheeptight. The 25 miles of project lands along the canal might not be fenced. Little interior fencing would be done.

Roads

New access and farm roads would be necessary, and those for construction and maintenance would be part of the project. Length and actual location of these roads cannot be predicted. Some existing roads would continue to be used. These would include major roadways through the area, and roads on rights-of-way for pipe and powerlines.

An estimated total of 225 miles of access and farm roads now exists. An additional 150 to 175 miles would have to be constructed. These roads would probably be built along irrigation lines and on edges of fields. New roads along the project side of the canal, for access to pumping stations, would also be used for access to farmland.

Access and farm roads on private lands would be maintained by landowners. Owner-maintained roads would probably be less than 14 feet wide, unsurfaced and with few improvements. Total area covered by owner-maintained roads would be approximately 380 acres.

Some roads crossing areas of mixed ownership would require county maintenance. County regulations stipulate a 66-foot right-of-way. A rough estimate is that 27 miles of county road might have to be built on arable land in the project. County-maintained roadways would involve an area of 220 acres of arable land, and might have to be surfaced at a later date.

Within the project area are the canal and intermittent waterways. Bridges would have to be constructed over them to support loaded farm trucks of 30,000 lbs. G.V.W. or more.

Farming operations

Farming would be dependent on irrigation since normal rainfall here is not sufficient for agriculture. Irrigation will be by sprinkler. Sprinkler systems most likely to be used are the hand-moved lateral or side-roll line.

Farming would be on slopes less than 10 percent, and on soils classified by the SCS as IV or better.

The project area includes a total of 28,540 acres. Not all of this area will actually be farmed, due to unsuitable terrain or soils, or use for other improvements. We estimate that about 20,718 acres would actually be farmed. Table 1 summarizes the predicted acreage breakdown.

Actual farming methods are impossible to predict because of the large number of applicants expected, each with his own technique. It was assumed that the area would be farmed in the same manner as are surrounding irrigated lands.

Sugar beets and malting barley would be the major crops, with other possibilities being seed crops such as alfalfa and various grasses, pinto beans and silage corn. For study purposes it was assumed that about 7,500 acres of beets, 7,500 acres of malting barley and 5,000 acres of alfalfa would be grown, with the remaining 700 acres devoted to these other crops.

The 20,718 acres proposed for irrigation would need approximately 63,000 acre-feet of water annually. Average requirement for crops in this area is about two acre-feet per acre. Assuming 70 percent irrigation efficiency, the seasonal requirement would be 2.0 ÷ 0.70 = 2.86 acre-feet per acre. Assuming a six percent loss throughout the system, a total slightly over three acre-feet would be needed annually from the river. We estimated that about 20 percent (see feasibility study in Appendix) of that pumped from the river (12,600 acre-feet) would return to the river, mostly underground, making net stream depletion by the project 50,400 acre-feet.

Peak use on a farm using sprinkler irrigation is 7.5 gallons per minute (gpm) per acre. For the 20,718 acres, this would require 345 cubic feet a second (cfs). With six percent loss in the pumping system, the total river pump capacity must be eight gpm an acre, or about 370 c.f.s

The average grower sows beets in late March or early April. He begins irrigating April 14 and stops October 5. The beet crop requires

28.52 inches of water, 3.59 inches of which are supplied by precipitation and the remaining 24.93 inches of which are irrigation water. Heaviest water use is in July (7.89 inches) and August (7.37 inches). The average yield is 22 tons per acre.

The average barley grower sows in April and begins irrigating April 24. He stops irrigating August 6. The barley crop requires 17.18 inches of water, with precipitation supplying 3 inches and irrigation the remaining 14.18 inches. Heaviest water use is during May (4.24 inches) and June (6.45 inches). The average yield is 75 bushels per acre.

Alfalfa is planted in early spring and irrigation is begun by the average grower on April 20. The crop requires 29.4 inches of water, 3.5 inches of which are supplied by precipitation and the remaining 26.9 by irrigation. Irrigation is completed by October 5. Alfalfa is harvested two or three times during the summer, and if seed is the crop, it is harvested in late September or early August. The average yield is four tons per acre.

Table 4 presents the pesticides, insecticides and herbicides applied to sugar beet crops, their application rate, time of application and target. Table 5 presents similar information for chemicals used on malting barley. Table 6 shows the chemical fertilizers applied.

Table 4

Chemicals Used in Sugar Beet Production

Chemical	Control	Time of application	Rate
Ro-Neet	weeds & grass	planting time	10#/acre
Temik	nematode	planting time	40#/acre
Temik	root maggots	planting time	15#/acre
Treflan	weed control	1st cultivation	3 pints/acr
Pyramin & Betanal	weed control	2nd cultivation	5 pints/acre

Table 5

Chemicals Used in Malting Barley Production

Chemical	Control	Time of application	Rate
Parathion	aphids	when populations build up	1 pt./acre
Malathion	aphids	when populations build up	1 pt./acre
2, 4-D ester or amine	annual weeds	full tiller to boot stage	1/2 to 3/4 lbs/acre
2, 4-D ester or amine	perennial weeds	full tiller to boot stage	1½#/acre
Carbyne	wild oats	when oats are in 2-leaf stage	1/4 to 3/8#/acre
Avadex	wild oats	pre-emergent	1-1¼#/acre

Table 6

Chemical Fertilizers

Fertilizer	Sugarbeets	Barley
Nitrogen	125 lbs/ac.	40 lbs/ac.
Phosphate	100 lbs/ac.	40 lbs/ac.
Potassium	50 lbs/ac.	20 lbs/ac.

Sugar beets require cultivation several times during the season, as well as thinning at least once. A portion of the cultivation and nearly all thinning is hand labor by migrant laborers. Beets are harvested in mid-October and trucked to market in Worland or to agreed-upon dumping areas. Some growers pasture livestock on the remaining tops for part of the winter. These fields are plowed again in the spring as soon as weather allows, usually in late March. Fields not pastured are plowed immediately after harvest, before the ground freezes.

Barley requires no mechanical cultivation during the growing season, but may be treated chemically to control weeds and pests.

Harvest of barley is in late August or early September. The straw may be baled and stored for later use or sale. It may also be plowed under or burned. Baling or burning is normally done a few days after harvesting. The land is plowed again as soon as possible, normally by early October.

Although few seed crops are now grown in the area, it was assumed that harvesting and fall plowing will be accomplished in the same manner as with barley, except that alfalfa is not planted every year.

Site occupation

There are 82 possible entries within the proposed project. It is very likely that a number of entrymen will take up residence in nearby communities or in established farmsteads on lands adjoining the project. Some entrymen will construct new residences on the project. It is assumed that 32 of these new residences will be built on project lands. Most permanent home construction on the project would be done after the entryman is assured his entry is successful. In the interim, mobile homes would be utilized.

All entries would have machine storage and maintenance buildings constructed on them.

Housing would have to be available for migrant workers on the project. Mobile homes would probably be used for the first few years and then replaced by simple bunkhouse-type buildings later.

Alternatives

The BLM could refuse to classify any of the land as suitable for agricultural entry.

Other development alternatives were considered and found to be unreasonable:

-- Use of irrigation water from wells. This is not technically feasible because the water-bearing strata is 7,000-10,000 feet deep. The economics of pumping from this depth make use of this water for irrigation purposes unfeasible.

-- Enlargement of the Big Horn Canal in lieu of pumping from river. Based on Bureau of Reclamation studies, there is insufficient water available in the river at the point of diversion to the canal to use this alternative.

THE EXISTING ENVIRONMENT

Non-Living Components

Air

Although air quality data for the study area is scarce, the Wyoming Department of Environmental Quality has furnished 1973 sampling data for Riverton, some 100 miles to the south, and Meadowlark Ski Area in the Big Horn Mountains, about 60 miles southeast of the project.

The average concentration of particulate matter at Riverton is 56 milligrams per cubic meter and at Meadowlark, 14 milligrams. We may assume that concentrations in the study area are somewhere in this rather wide range, though probably nearer to the Riverton level since it is more similar to the study area than is Meadowlark.

Observation reveals that the air is clear although vision is noticeably impaired by dust for short periods, usually in the spring when winds are stronger and fields are fallow prior to irrigation. We estimate that this condition occurs about 10 times from late February through April, with each period lasting from one to three days. The condition also occurs several times in the summer for periods of a few hours, caused by high winds in thunderstorms passing through the area.

There is a definite odor of natural gas near the Union Oil Refinery on Hwy. 20 north of Worland. We do not know the area affected by this odor.

Climatological records at Worland for the past ten years reveal an average annual temperature of 44.4 degrees, with an average of 132 days between days with temperatures 32 degrees or lower. Worland has an average daily temperature of 70 degrees during June, July and August, though often reaching daytime temperatures above 100 degrees. Nighttime temperatures typically are 20 to 25 degrees cooler. The climate is good for growing the proposed crops.

During November, December and January average daily temperature is 22 degrees. Temperatures often drop below zero during these months and lows under -50 degrees have been recorded.

Prevailing winds are from the southwest, but frontal movements are generally from the northwest.

Land

Geologic structure

The land form is of gentle to moderate terrace slopes cut by dry washes and associate gullies. Elevation varies from 3,920 to 4,400 feet. Drainage is eastward toward the Big Horn River, which flows north.

The geologic history extends from the terrace deposits of Quaternary Age to the Mesaverde Formation of the Upper Cretaceous. All formations are sedimentary.

Most of the surface is terraced alluvium deposits of silt, sand and gravel. These deposits probably reach 15 to 20 feet in thickness. Immediately below most of them lies the Willwood Formation, mainly of varicolored clay, sandstone and shale.

From Manderson to Greybull, in the eastern portion of the area, the terrace deposits are underlain by the Fort Union, Lance, Meeteetse and Mesaverde Formations below the Willwood. The Fort Union is of

Tertiary Age while the Lance, Meeteetse and Mesaverde are of Upper Cretaceous. These last four formations become progressively more sandy in composition, the Mesaverde being essentially all sandstone. Generally the formations dip less than 3 degrees to the southwest; however, the eastern portion from Basin to Greybull dips as much as 45 degrees to the southwest.

None of the formations are known to contain valuable locatable minerals. Terrace deposits are sources of sand and gravel, in plentiful supply along the Big Horn River. All the lands are potentially valuable for oil and gas; and the Fort Union, Meeteetse and Mesaverde Formations are known to contain coal.

Soils

The Soil Conservation Service surveyed the project area in 1974 and determined soils types and associations. This survey included a description of each soil type, its production capability, and its suitability for irrigation. This survey, entitled "The Big Horn Irrigation Development Report," is in the appendix, and the soil-type map may be inspected at the BLM office in Worland. The SCS, in identifying their potential for agricultural use, classifies soils into eight major classes.

Classes I and II are the most desirable soils and are suitable for row-crop production; Class III is suitable for two to three years of row crop production in rotation with an equal period of hay and pasture use; Class IV is marginal for row-crop production and is better suited for hay, pasturage or small grains; Class V soils and higher are unsuitable for crop production. Class VI and higher are nonarable and are not a part of the farmable acreage. Less than 100 acres are Class III or better and about 6,000 acres are Class VI or poorer. The remainder of the project, 14,600 acres, is Class IV.

Summary

Soils in the study area are generally marginal to fair for production under irrigation. They are typically alkaline, high in sodium, with some soils having layers of gypsum salts, and rather shallow and poorly developed. Some of the soils can produce good crops; most of them require fall plowing to improve tillage and water intake through the addition of organic matter. Subsurface drainage is a problem on many of the soils, due to the shallow depth to an impermeable layer. Following are the major soil associations in the study area.

Rairdent-Uffens

This soil complex accounts for 34.5 percent of the project area, or about 9,800 acres, and is made up of the following percentages of soils: Rairdent - 40; Uffens - 20; Griffy - 15; Avalon - 15; Kinnear - 5; and Clifterson - 5.

Soils of this association are deep, medium textured and found on slopes from 0 to 10 percent. Rairdent soils have a layer of gypsum that will dissolve and cause some subsidence and saline spots when irrigation water is applied. The Uffens is alkaline and from 5 to 15 percent of the area will have slick spots or other areas of low production. These soils are primarily sandy or silty clay loams.

This association, when found on slopes zero to three percent, is suitable for three to four years of row-cropping in rotation with hay and pasture use. Fall plowing is important to incorporate organic matter and enhance water intake.

On three to six percent slopes this soil is suitable for two or three years of row-cropping, in rotation with hay and pasture use. Fall plowing is desirable. Soils on 6 to 10 percent slopes are not generally suitable for row crops, although they could be used for hay or pasture, and small grains.

Rairdent soils have slow-to-medium runoff, and water erosion hazard is slight-to-moderate.

Greybull-Persayo

This association accounts for 12.0 percent, or about 3,427 acres, of the project area, and includes the following percentages of soil types Greybull - 50; Persayo - 30; Chipeta - 20.

The soils of this association are moderately fine textured and found on slopes varying from 0 to 30 percent. The association is about 50 percent moderately deep soil, 45 shallow soil and about 5 shale. They are on nearly-level to steep, rolling shale hills with Persayo on the ridge tops and Greybull on the sideslopes. Five to fifteen percent of the area will have saline spots or shale. The underlying shale will weather with the application of water, so that plants will be able to extract moisture from the area in a few years. Runoff is slight to rapid. The water-and-wind-erosion potential is slight-to-severe.

The Greybull soils in this association are suitable for one or two years of row-cropping rotation with hay and pasture use. However, corn, beans and potatoes do not adapt to this soil. Fall plowing is desirable and important to incorporate organic matter and enhance water intake.

The Persayo soils are suitable for hay, pasturage and small grain. They are not generally suited to row crops.

Preatorson-Persayo

This soil association accounts for 10.3 percent of the project area, or about 2,940 acres. It includes the following percentages of soil types: Preatorson -30; Persayo - 25; Willwood - 20; and Apron-Greybull or Rockland - 25. Soils in this association are found on 3 to 45 percent slopes and are deep, very gravelly soils at the top of escarpments, and are shallow, gravelly soils at the bottom of escarpments. They have slow-to-medium runoff and the water-erosion hazard is slight to moderate.

Willwood soils are cobbly and stony, with a very low water-holding capacity. They are not suited to regular cultivation and are suitable only for permanent pasture.

Apron soils are suitable for row-crop production on zero-to-six percent slopes. On 6-to-10 percent slopes they are best maintained in perennial vegetation but can be cultivated occasionally. They are subject to moderate-to-severe wind and water erosion.

The Greybull soils on slopes of zero to three percent are very fine, sandy loam to silty-clay loam underlain by slowly permeable bedrock at depths of more than 20 inches. They have poor subsurface drainage and tend to seep when irrigated. This soils is best adapted, on these slopes, to small grains, hay or pasture. On slopes of from 3 to 10 percent they are subject to severe water erosion and are best adapted to permanent hay or pasture, but they can occasionally be cultivated.

Uffens-Rairdent

This soils association accounts for 6.6 percent of the project area, or about 1,885 acres, and is made up of the following percentages of soils types: Uffens - 45; Rairdent - 30; Emblem - 10; Griffy - 10, Kinnear - 5.

Soils in this association are deep and medium textured, with about 35 percent of the area alkaline and about 30 percent having a layer of gypsum salts. From 5 to 35 percent of the area will be slick or saline spots. This association occurs on nearly-level to sloping alluvial fans and terraces.

The Uffens soil is a silty clay loam and is in the more-level bottomland areas. On zero-to-three percent slopes the Uffens soils take water rather slowly and have good water-holding capacity. With fall plowing to improve the cultivability, these soils can produce good yields of crops on such slopes. On three-to-six percent slopes the soils are subject to moderate water erosion and proper irrigation management is necessary to prevent seepage. On these slopes, such soils can produce good yields. On 6-to-10 percent slopes they are subject to severe water erosion; for this reason they are best adapted to permanent vegetation. However, these soils on such slopes can be cultivated occasionally, with good management and conservation practices.

Rairdent soil is a medium-textured loam with a depth of more than 60 inches. Areas covered with this soil have 5 to 15 percent slick spots. However, it takes water readily and has good water-holding capacity. It is subject to slight wind erosion when left unprotected. On slopes of three to six percent these soils are subject to moderate water erosion. Proper irrigation management is necessary to prevent seepage to lower lying lands. This soil produces good yields of all adapted crops. On 6-to-10 percent slopes that Rairdent is subject to moderate water erosion and is best suited for a permanent cover of hay of pasture vegetation. It can be cultivated occasionally.

The Emblem soil has a very gravelly, sand texture and is 24 to 40 inches deep. On slopes of zero to three percent this soil takes water readily. It has a limited water-holding capacity and provides good subsurface drainage. This is good soil and can produce good crop yields. On slopes of three to six percent this soil is subject to moderate water erosion, and proper irrigation management is needed to prevent seepage to lower lying lands. On this slope, Emblem soil produces good yields of all crops. On 6-to-10 percent slopes this soil is subject to moderate-to-severe water erosion, and proper water management is needed to prevent erosion. On this slope, Emblem soil is best adapted to permanent hay or pasture use, but can be cultivated occasionally.

Griffy soil is a medium texture, sandy clay loam and is more than 60 inches deep. On slopes of zero to three percent this soil takes water readily and has good water-holding capacity. This soil is subject to slight wind erosion if left unprotected. It is capable of producing good yields of all adapted crops. On slopes of three to six percent these soils are subject to moderate water erosion. They absorb water easily and have good holding capacity. However, proper irrigation management is needed to prevent seepage to lower lying lands. This soil produces good crop yields. On 6-to-10 percent slopes this soil is subject to moderate-to-severe water erosion. It is adapted to permanent hay or pasture use, but can be cultivated occasionally.

The Kinnear soil is a medium-textured clay loam deeper than 60 inches. Production and erosion potentials are the same as described for the Griffy soil.

Uffens-Chipeta

This association makes up 5.5 percent of the project area or about 1,570 acres. It occurs on 0-to-30 percent slopes, and has about 65 percent deep, alkaline soils, 30 percent shallow, fine textured soils over shale and 5 percent exposures of shale. From 10 to 25 percent of the area will be slick spots or areas of low production. This association includes the following percentages of soils: Uffens - 60; Chipeta - 30; Rockland (shale) - 10.

The Uffens soil type is described under other Uffens associations.

Chipeta soil is shallow, from 8 to 20 inches, and is a very fine-textured silty clay from shale parent material which is highly alkaline. This soil takes water very slowly and is prone to seep in low lying areas. It is subject to wind erosion when unprotected and moderate-to-severe water erosion on slopes of more than three percent. This soil is suitable for only limited cultivation of shallowed rooted crops. Surface shale is not suited for crops.

Uffens

The Uffens association makes up 4.7 percent of the project area or about 1,340 acres. It is a deep, moderately fine-textured alkaline soil. Five to 25 percent of the area in this association will have low production. Soils by percentage are as follows: Uffens - 70; Kinnear - 10; Lost Wells - 10; Griffy - 5; Rairdent - 5.

The Kinnear, Griffy, and Rairdent types were discussed above.

Lost Wells soils is a fine-textured clay loam more than 60 inches deep. This soil has a clay or heavy, silty clay-loam surface with loamy subsoils. It take water rather slowly and has good water-holding capacity. This soil tends to form a hard surface crust when it dries out after wetting, and tends to form clods if worked when set. It will produce good crop yields. On slopes of three to six percent this soil is subject to moderate water erosion, and proper irrigation management is necessary to prevent seepage to lower lying lands. On these slopes the soil is moderately good, and can produce good crop yields. On 6-to-10 percent slopes this soil is subject to moderate-to-severe water erosion, and close growing, permanent vegetation is necessary. Therefore, this soil is best adapted to permanent hay or pasture vegetation, but can be cultivated occasionally.

Enos-Wallson

This association makes up 3.3 percent of the project area, or about 940 acres. It includes the following percentages of soil types: Enos - 40; Wallson - 40; Worland - 20.

Soils in this association have slow to medium runoff. Water erosion potential is slight to moderate, and that for wind erosion is moderate. These soils are generally on rolling uplands, with Worland and Enos soils on the steeper slopes and Wallson on the broader, undulating slopes. The association is sandy loam and is moderately deep over sandstone. Enos soil is a fine, sandy loam 20 to 40 inches deep. On zero-to-three percent slopes these soils take water readily, but have poor subsurface drainage and tend to seep when irrigated. They are best suited to small grains or pasture vegetation. On 3-to-10 percent slopes this soil has good water holding capacity. However, the wind and water erosion potential is moderate to severe. This soil should be maintained in perennial vegetation with only occasional cultivation.

Wallson soil is a fine, sandy loam more than 40 inches deep. On slopes of zero to three percent these soils take water readily and have good holding capacity. The sandy topsoils are subject to wind erosion and vegetative cover is necessary. This soil produces good crop yields on slopes of three to six percent. It is subject to erosion and vegetative cover is necessary.

On 6-to-10 percent slopes this soil should be maintained in perennial vegetation such as hay or pasturage, with only occasional cultivation.

Worland soil is a sandy loam 20 to 40 inches deep, from a sandstone parent material. On slopes of zero to three percent this soil takes water readily but has poor subsurface drainage and tends to seep when irrigated. Therefore, proper irrigation management is necessary to prevent seepage through this and nearby soils. This soil is best suited for small grains, hay and pasturage. On steeper slopes from 3 to 10 percent, this soil has good water holding capacity, but also has a moderate-to-severe wind and water erosion potential. For this reason, Worland soil is best maintained in close-cover crops and perennial vegetation. It can be cultivated occasionally, using good conservation practices.

Lost Wells-Youngston

This association makes up 2.7 percent of the project area or about 771 acres. It is of deep, moderately-fine textured soils. From 5 to 10 percent of the area will be slock or saline spots. This association includes the following percentages of soils types: Lost Wells - 50; Youngston - 20; Uffens - 10; and Persayo-Worland-Enos-Oceanet - 20.

The Lost Wells soil type was discussed above.

Younston soil is a clay loam more than 60 inches deep. This soil is deep with clay or heavy-silty clay-loam surface layers and loamy subsoils. It takes water rather slowly and has good holding capacity. It tends to form hard surface crusts when dried. Fall plowing, incorporating manure or crop residues, is necessary to enhance soil production and water intake. This soil produces good crop yields. On slopes of zero to three percent it has good water-holding capacity, but is subject to moderate water erosion. Proper irrigation management is necessary to prevent seepage to lower lands. This soil is moderately good on such slopes and produces good yields of adapted crops. On 6-to-10 percent slopes this soils is subject to moderate-to-severe water erosion. Therefore, proper irrigation and close-growing, permanent vegetation are necessary. This soil is adapted to permanent hay or pasture use but can be cultivated occasionally with good conservation practices.

Oceanet soil is a fine, sandy loam 8 to 20 inches deep. It is formed from sandstone. On zero-to-three percent slopes this soil takes water readily but has poor subsurface drainage and tends to seep when irrigated. Proper irrigation management is therefore necessary. This land is best adapted to grains, hay or pasturage. On 3-to-10 percent slopes this soil is subject to moderate-to-severe water erosion, and permanent vegetation is necessary. It is therefore best adapted to permanent hay or pasture use, but can be cultivated occasionally with good conservation practices.

Youngston-Uffens

This complex makes up 2.4 percent of the project area or about 685 acres. It is composed of deep, moderately fine-textured soils with about 35 percent of the area alkaline soils. The area will have from 5 to 15 percent slick or saline spots. These soils occur in an intermingled pattern on nearly-level-to-sloping alluvial fans, flood plains and valley fills. Runoff is slow to rapid and the water-erosion potential is slight to severe. The wind-erosion hazard is slight to moderate.

This complex is composed of the following soils types: Youngston - 45 percent; Uffens -35 percent; Stuzman-Lost Wells-Greybull - 20 percent.

Stuzman soil is a well-drained, silty clay loam of fine-textured alluvium, and is about 40 inches deep. It has a high pH (8.4-8.9) and a slow permeability rate. Water-erosion potential on slopes of 3 to 10 percent is high. This soil is suited to row cropping on slopes of zero to three percent. On steeper slopes of 3 to 10 percent they are best maintained in permanent hay or pasturage, but can be cultivated occasionally. Fall plowing is desirable to increase water intake.

Greybull soil is a clay loam 20 to 40 inches deep. On zero-to-three percent slopes these soils take water readily but have poor subsurface drainage and tend to seep when irrigated. Proper irrigation management is necessary to avoid seeping to soils nearby. This soil is best adapted to small grains, hay or pasture. On 3-to-10 percent slopes these soils are subjet to moderate-to-severe water erosion, and permanent vegetative cover is therefore desirable. This soils is best adapted to hay or pasture use. However, it can be cultivated occasionally.

Bibutte-Persayo

This association makes up 2.3 percent of the project area or about 656 acres. It is composed of the following percentages of soils: Bibutte - 35; Persayo - 30; shale - 15; Chipeta and Deaver - 20.

This association occurs on 6-60 percent slopes, with shallow, fine textured soils and shale outcrops. About 15 to 30 percent of the area will be slick spots. Runoff is rapid and the water-erosion potential is severe. Bibutte soil is not suitable for irrigation because of the slopes and erosion potential. Persayo soil has been discussed previously, as have the shale, Chipeta and Deaver soils.

The remaining 10.5 percent of the study area, about 3,000 acres, is composed of a number of soil associations. They are the Shailand, Badland, Lost Wells complex, Binton-Youngston, Chipeta, Pavillion-Kinnear, Chipeta-Deaver, Emblem-Griffy, Persayo-Saddle and Persayo-Badland. These associations include soils previously discussed. Because of their relatively small size and slight significance to the project, they will not be discussed at length.

Land use compatibility

Present use of the land includes: licenses for 1,842 AUMs of sheep and cattle, wildlife habitat, oil and gas exploration with three producing oil wells, miles of attendant pipelines, six permits for gravel production, and low-intensity recreation such as hunting and rockhounding. Fewer than a dozen free-roaming horses have been observed in the area. These uses are generally compatible although there are some limited conflicts. Examples of these include elimination of forage for livestock and wildlife by oil exploration and gravel production; competition for forage between livestock and wildlife and coyote predation on sheep.

Land-use suitability

Because of the poor soils and low rainfall there is sparse vegetation and forage production is low. There is no great scenic or recreation value nor are there large human populations in the area which would create a demand for dwelling sites.

Although the intensity of some uses, most notably grazing, may be excessive, the land is well suited for the present type of use.

Water

Average annual precipitation for Worland and Basin is 7.76 and 7.31 inches respectively. (See Table 7.) (Commerce, 1974) More than half of this occurs in scattered spring and summer thunderstorms (Agriculture, April 1974). However, this is not a dependable source of water.

Table 7

Average Monthly Precipitation for Worland (in inches)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.25	0.22	0.37	0.99	1.34	1.45	0.74	0.41	0.72	0.64	0.41	0.22

Average Monthly Precipitation for Basin (in inches)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.24	0.19	0.33	0.72	1.03	1.14	0.55	0.30	0.65	0.48	0.36	0.22

Between 80 and 90 percent of the precipitation falling on the study area returns to the atmosphere through evapotranspiration. Much of this occurs directly after thunderstorms and through the sublimation of light winter snows. Between one and three percent infiltrates the soil and eventually recharges the ground water supplies (Agriculture, 1974). Much of this water follows the topographic slope underground and recharges the Big Horn River valley alluvium. Some recharges the permeable strata of the Willwood Formation.

The remaining water leaves the area as runoff. This runs over the land surface in drainages to the Big Horn River. Approximately 50 percent of the runoff is produced from April through July.

Ground water

The largest source of shallow ground water is the Big Horn River valley alluvium. During the irrigation season, water levels range from surface to 40 feet deep. For the remainder of the year, water levels drop an additional few feet. Ground water in the valley is used for domestic purposes, livestock, and, to a small extent, irrigation.

The study area is 20 to 400 feet above the valley floor. Ground-water levels in the study area are estimated to vary from 40 to 250 feet below the surface. Water quality from these shallow wells is fair to poor. Calcium (Ca), magnesium (Mg) and sulfate (SO_4) are all present in large quantities, making the water very "hard." Fluoride concentrations are fairly high. Some sites have recorded as high as 5.4 mg/L. Dissolved solids are high, generally greater than 800 mg/L (USGS 1966-1970).

Potability is marginal. In some cases potable water must be brought in from other sources. Some wells have recorded 3,000 mg/L dissolved solids or higher. These waters are generally suitable for livestock but not for human consumption.

Underlying most of the project area is the Willwood Formation. Because of the high clay content of this formation, permeability is low except along the few sandstone beds. Wells that penetrate this formation, therefore, do not yield large quantities of water. Generally, yields are from 5 to 15 gallons a minute.

Ground water does exist in deep formation. The Ten Sleep, Madison, Big Horn, Dolomite and Flathead are all water and oil producing formations. The depth of these formations in the study area is in excess of 7,000 feet. Water quality is generally fair. The use of these waters for irrigation is economically impractical.

Surface water

The study area is part of Five Mile-Elk Creek Watershed. This watershed includes 187,400 acres in four principal drainages: Antelope, Elk, Five Mile and Ten Mile Creeks. These intermittent drainages carry a high sediment load eastward to the Big Horn River. Between 0.2 and 0.5 acre-feet of sediments is removed per square mile annually (Agriculture, 1974). More than half of this erosion occurs in the spring and summer, when the soil is not frozen. Thunderstorms during this period are the main cause. The lack of adequate vegetation and ground cover promotes sheet as well as gully erosion.

Big Horn River

The Big Horn Basin is one of the principle drainages in Wyoming, encompassing about 11 percent of the state. The river makes up 55 percent of the Wind-Big Horn-Clarks Fork River system, an important tributary of the Missouri River. More than 7.0-million acres are drained by the Big Horn River (Agriculture, 1974).

The Wind River is the major source of water for Boysen Reservoir. Its headwaters are on Wind River Indian Reservation.

Development of irrigable land on the reservation is anticipated. This would reduce the water supply in Boysen and, downstream, the Big

Horn River, but is not expected to seriously affect existing irrigation. The issue of how much water in the Wind River is owned by the Indians is not settled. Litigation may be necessary to determine how much water the reservation is entitled to.

Boysen Reservoir, built in 1951, at the southern end of Wind River Canyon, initially controls the flow of the Big Horn River to the north. Maximum storage capacity in this reservoir is 802,000 acre-feet. During dry periods Boysen water may be released to supplement natural river flow. This water is used for irrigation in the Basin, under contract from the Bureau of Reclamation. Industry also has options on Boysen water.

Sun Oil Co., for example, has an option for 35,000 acre-feet annually for industrial use. A similar reservation, of an additional 50,000 acre-feet of water annually by another major oil company, has been considered. No action has been taken, however, due to a moratorium established by the Secretary of the Interior.

The Sun Oil Co. option allows for the purchase of all or part of this by a third party. The third party could buy the water from the Bureau of Reclamation, if the water were purchased on a permanent basis and put to immediate, beneficial use. An annual rate of $11 an acre-foot would apply. Sun Oil Co., however, can continue its option by making annual payments at the annual rate of $11 an acre-foot.

Hydrologic evaluations indicate that this sale of 35,000 acre-feet would not be detrimental to present irrigation downstream. Limited future agricultural or industrial development could also take place. The environmental impact from such a sale cannot be evaluated until the exact use and point of diversion is known.

Boysen Reservoir is allowed to store only water in excess of appropriated downstream needs. The established determined "normal flow" moves through the reservoir continuously and is used for irrigation in the Basin. Generally, water from Boysen is used in the summer or early fall and replenished in late winter and spring. Average discharge for the 22 years of record is 1,412 c.f.s.

Between Boysen and Worland are three major irrigation diversions: Upper Hanover Canal, Big Horn Canal and Lower Hanover Canal. These diversions all have concrete weirs extending across the river to divert water into the canals. During periods of low flow, the entire river is sometimes diverted into the Big Horn or Lower Hanover Canals. Return flow from irrigated lands replenishes the river a few tenths of a mile downstream.

Flow at Worland is dependent upon many upstream variables, including: discharge from Boysen Reservoir, inflow from tributary streams, evaporation losses, irrigation diversion losses, and return flow from irrigated lands.

For the four years of record at Worland, minimum discharge was 50 cfs on June 2 and 3, 1969. Maximum discharge was 15,900 cfs on June 23, 1967. Average discharge from 1965 to 1969 was 1,359 cfs (USGS, 1966-1973).

Flow at Kane is dependent upon the same variables as affect flow at Worland. Three major tributaries -- the Nowood and Greybull Rivers and Shell Creek -- contribute to the flow at Kane. For the 45 years of record at Kane, maximum discharge was 25,200 cfs on June 16, 1935. Minimum discharge was 179 cfs on July 22, 1934. These discharges occurred before construction of the present Boysen Reservoir. Average discharge recorded since 1928 is 1,282 cfs. Annually about 3.2-million acre-feet of water leave Wyoming via the Big Horn River (Agriculture, 1974).

The Yellowstone River Compact, among Wyoming, Montana, and North Dakota, was approved on October 30, 1951. The compact confirms existing rights as of January 1, 1950, and apportions the waters of the Big Horn which were unappropriated on January 1, 1950. Wyoming is apportioned 80 percent and Montana 20 percent of the available water (Interior, 1975).

Water is used for municipal, agricultural and industrial purposes. A total of about 1,500 cfs is adjudicated (allocated by the state engineer) for these purposes.

Municipalities having water rights include Thermopolis, Worlands Basin and Greybull. A total of about 13 cfs is adjudicated for municipal use (Wyoming State Engineer, 1972).

Agriculture is the largest user of surface water in the basin. Over 1,200 cfs is adjudicated for irrigation. Most of this water is diverted above Worland. Less than 300 cfs is adjudicated for industry (Wyoming State Engineer, 1972).

Water quality is an important factor in all these uses, and certain minimum standards must be met. In general, quality diminishes as the water travels downstream from Boysen Reservoir. Concentrations of dissolved calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), bicarbonate (HCO_3) and sulfate (SO_4) are significantly greater at Kane than at Boysen Reservoir. (See Table 2.) This results in an increase in total dissolved solids, water hardness and specific conductance (USGS, 1966-1973).

TABLE 8

Water Year October 1971 to September 1972 (Kane)

Date	Dissolved Calcium (Ca) (MG/L)	Dissolved Magnesium (Mg) (MG/L)	Dissolved Sodium (Na) (MG/L)	Dissolved Potassium (K) (MG/L)	Bicarbonate (HCO_3) (MG/L)	Dissolved Sulfate (SO_4) (MG/L)
Oct 06	81	24	100	4.4	186	330
Nov 05	75	26	80	3.3	200	290
Nov 30	72	25	78	3.3	184	250
Jan 18	68	22	66	3.1	183	230
Feb 07	68	20	62	3.3	174	230
Mar 06	72	33	74	3.5	139	290
Apr 20	69	25	76	3.0	182	260
May 16	71	22	78	3.3	178	270
June 21	56	17	56	2.8	153	200
July 06	54	17	49	2.6	149	180
July 31	65	20	61	3.0	171	230
Sep 07	76	21	77	3.3	189	270

TABLE 8

Water Year October 1971 to September 1972 (Boysen)

Date	Dissolved Calcium (Ca) (MG/L)	Dissolved Magnesium (Mg) (MG/L)	Dissolved Sodium (Na) (MG/L)	Dissolved Potassium (K) (MG/L)	Bicarbonate (HCO_3) (MG/L)	Dissolved Sulfate (SO_4) (MG/L)
Oct 20	44	13	45	2.2	139	140
Nov 10	49	11	48	2.2	131	150
Dec 02	45	14	49	2.2	141	160
Jan 11	54	15	53	2.2	153	180
Feb 08	53	16	53	2.2	139	180
Mar 06	55	15	51	2.1	157	160
Apr 14	62	16	64	2.6	162	200
May 12	60	15	61	2.3	165	200
June 07	50	17	52	2.1	146	180
June 30	43	8.7	33	1.9	119	110
Aug 08	37	12	33	2.3	121	110
Sep 08	40	11	39	2.3	126	110

Water discharged from Boysen Reservoir encounters its first major chemical change at Thermopolis. Hot springs there add many minerals including calcium (Ca), magnesium (Mg), potassium (K), and Floride (F). Also bicarbonate and sufate are added. This results in an increase in hardness, dissolved solids and specific conductance (USGS, 1966-1973).

Downstream from Thermopolis, return flow from irrigation lands, natural runoff and waste water from oil wells add more minerals to the River. Suspended in the return flow are silt and clay particles. These suspended sediments cloud the River further downstream to Kane.

Living Components

Plants

Aquatic

Habitat for aquatic plants is limited to the Big Horn River, the Big Horn Canal, adjacent drainage ditches and wet, swampy areas along the river. The river and the canal are not suited to vascular and rooted plants because of gradient and rate of flow. Water bodies in the study area are a few, small stockwater reservoirs that are dry for extended periods and do not support true aquatic plants.

Intensive research data on aquatic plants of the Big Horn is apparently nonexistent: seven usually-informative sources were investigated with negative results.

Moss and algae are present in the river and the canal, and are particularly noticeable in the summertime. Moss has become such a problem that moss traps have been installed in canals and irrigation system. Phytoplankton undoubtedly exists but has not been identified. Neither of these forms has been identified as to species, and nothing is known of their morphology and physiology. Species such as water lilies and water cress have not been observed but may exist in ponds and swampy areas on private land along the river.

Vascular aquatic plants that occur in the bogs and swamps include: narrow-leaf cattail (Typha angustifolia), pondweed (Potamogeton spp.), rushes (Juncus spp.), bur-reed (Sparganium spp.) and arrowgrass (Triglochin spp.). Since most of the bogs and swamps are created by irrigation waste water, these plants are tolerant of salinity, alkalinity and a variety of fertilizer, herbicide and pesticide residues.

Terrestrial

Terrestrial vegetation is complex and diverse. There are two distinctly different areas in terms of vegetation supported: native rangeland above the canal and irrigated land, waste areas, and river bottom below. Vegetation will be discussed on the basis of this division.

Below the canal

Most of this is irrigated farmland and crops will not be discussed in this section. The remainder of the area is mostly "wasteland" and river bottom. A wide variety of plants is supported due to the favorable growth conditions. (See Appendix for a species list). These species are generally adapted to moist conditions, fertile soils and wide temperature extremes. Vegetation density is high. Where there are trees or shrubs, cover is usually tiered or multi-layered, consisting of understory grasses, forbs and so on, and overstory canopies of branches and leaves.

These plant communities are stable and probably near climax. This is because river flow is no longer subject to wide fluctuation and annual flooding, since construction of Boysen Dam. Too, a humid atmosphere and high water table are maintained by the irrigation of adjoining lands. These "wastelands" receive very little use during the growing season. Primary uses are by wildlife (yearlong) and domestic livestock. Livestock use is limited mostly to the fall and winter when the ground is frozen and no irrigation occurs.

Above the canal

This area includes the study area. This is semi-arid native rangeland typically classified as "winter sheep range" -- a description indicative of the vegetative cover (See Appendix for a species list). Generally, the area fits the description of the "intermountain shrub" region. It consists entirely of two grazing types: sagebrush (range type 4) and saltbush (type 13). Saltbush (Atriplex nuttallii) is the predominant species, occurring both in association with other plants and in pure stands.

Two species of sagebrush predominate: black sagebrush and big sagebrush. Forbs and weeds, many of them annuals, are found in association with the dominant shrubs, though second in density to them. A few grasses make up the rest of the vegetation complex.

Vegetation condition varies from poor to fair. Most of the area shows signs of heavy livestock use in the past. Only remnants of desirable grasses remain; less desireable species have replaced them. Vigor of desirable browse species (sage, saltbush, winterfat and hopsage) is less than optimum, also due to heavy use by livestock.

Animals

Fish and wildlife

Native wild animals of the study and adjacent areas which might be affected include species which can be expected in the desert, basin and river bottom vegetation zones as described by Porter (1962, p. 12). Some species are closely tied to particular vegetation types within these major zones, such as the sagebrush-grassland, Nuttall's saltbush association and aquatic habitats. Others range broadly over most of the area. A number of introduced species are also present. A list of known and probable species for the study area is found in the Appendix.

Threatened species

Those wildlife species determined by the Secretary of the Interior to be threatened with extinction and named on a list published in the Federal Register are officially "endangered species." Species categorized as "threatened" by the Fish and Wildlife Service (Fish and Wildlife Service, 1973) include all vertebrate species whose existence is considered threatened whether they are officially listed as "endangered" or not.

The American peregrine falcon and the black-footed ferret are the only "threatened" species which may exist in the study area. Sightings of peregrine falcons along the river have been reported though not confirmed. No nests have been reported in the study area, however, and it is probable that the sightings were of migrant birds.

There have been no confirmed sightings of the black-footed ferret in the study area, but its presence is possible since a recent survey revealed ferrets in nearby portions of the basin. Prairie dog colonies occur in the study area and ferret populations in the western United States are associated with prairie dog colonies. No reliable survey of prairie dog colonies in the study area has been made.

Some species, while not endangered throughout their range, are in danger of elimination in some areas. This has prompted development by the Wyoming Game and Fish Department of a state "rare and endangered" species list. Wyoming's list includes such species as the shovelnose sturgeon, sturgeon chub and western burrowing owl, which may occur in the study area.

The shovelnose sturgeon, considered "rare" by the state agency, has been reported in the Greybull and Big Horn Rivers. Its preferred habitat is in the current at or near the bottom of large rivers. Food consists largely of bottom dwelling insects, but also includes some vegetation and minnows.

The sturgeon chub, considered "rare and endangered" by the state, is a small minnow which lives over gravel in the current of the larger silty rivers. It is recorded in the Big Horn River but most of its habitat in this stream was eliminated by construction of Yellowtail Dam (Baxter and Simon, 1970).

The western burrowing owl occurs on the study area. These owls use the burrows of small animals such as kangaroo rats, ground squirrels and prairie dogs for most of their nesting. Burrow availability is the major controlling factor in burrowing owl populations. These owls usually prey on insects and rodents weighing less than 5 grams. No population estimate is available for the study area.

Big game animals

Mule deer use dry sagebrush and greasewood draws and slopes in the study area and brushy riparian habitat along the Big Horn River. (See Map 3.) The mule deer population is mostly non-migratory and is considered sparse. While the herd along the river between Worland and Greybull may number several hundred animals, probably no more than 75 to 100 make significant use of the study area. Summer use is reduced beyond a mile or so from the river and the canal, due to the scarcity of water.

Proposed project lands fall mostly in the Game and Fish Department's hunting area 125 (Fifteen Mile) with some in area 124 (Emblem). The total harvest of mule deer in these areas was 269 in 1973. Project lands would make up only two to three percent of the total acreage in these hunting areas, and probably provide no greater percentage of deer habitat than this. On this basis, it appears that the lands of the study area are producing approximately six to eight deer for the hunters' bag annually. (See Table 9.)

Big sagebrush and rabbitbrush are the most important browse species for deer in the project area. Browse conditions are generally fair to good considering growing conditions. The lack of dependable surface water seems to be an important factor responsible for the limited value of the study area as mule deer habitat.

Pronghorn antelope use the sagebrush-grassland, saltbush and greasewood types of vegetation in the area. This population is also relatively sparse and project lands would take up only a portion of the

Table 9

Estimated Populations, Harvest and Recreation Day Use of Some Wildlife Species Likely to be Affected by the Project

Species	Population	Harvest	Recreation Days
Burrowing Owl	10	--	--
Mule Deer	75-100	6-8	15-20
Pronghorn Antelope	50	5	10-15
Cottontail	unknown	50	50
Prairie Dog	200-300	unknown	10
Sage Grouse	80	20	16
Mourning Dove	unknown	30	12
Fish	unknown	unknown	100
Ducks	153[1]	1,600-1,800[3]	1,200-1,500
Geese	43[2]	75-100	500-600

1) Breeding season count on Big Horn River between Worland and Greybull (Wyo. Game & Fish Dept.)

2) Breeding season count on Big Horn River between Worland and Greybull. Includes an average of 18 breeding pairs (Wyo. Game & Fish Dept.)

3) Migrating waterfowl provide much of the harvest

range used by any one herd observed in the area. The area is yearlong antelope range, but observation over several years indicates that it may be dependent on the availability of snow as a water supply.

Although it has reportedly increased slightly in recent years, the smallness of the antelope population is characteristic of this central portion of the Basin. Antelope habitat is marginal. Limiting factors have not been well defined. Forage plants such as sagebrush, saltbush, winterfat and rabbitbrush appear to be in more than adequate supply for the present herd. The study area is entirely in the Game and Fish Department's antelope hunting area 77 (Fifteen Mile Creek). The 1973 harvest totaled only 90 antelope in an area of more than 700,000 acres. Project lands would take up only about three percent of this antelope area. In December 1974 three different groups of antelope numbering 19, 15 and 7 were observed on or immediately adjacent to proposed project lands. Other small bunches were reported within a few miles. At present harvest levels in hunt area 77, proposed project lands can realistically be credited with producing only about five antelope for this annual harvest. (See Table 9.)

Predatory and furbearing mammals

Coyotes and red fox, the most common predators, range over most of the area. Bobcats and long-tailed weasels are less common but may be encountered. Cottontail rabbits, Ord's kangaroo rats and other small rodents appear to be the major prey species for these predators. Badger diggings are found throughout the upland areas, so these animals are apparently present in considerable numbers.

Bottomlands along the river, agricultural drainage and waste areas, and well-vegetated canal banks provide habitat for striped skunks, raccoons and mink. These animals have varied diets which include aquatic and semi-aquatic animals.

The river, the canal and associated marshes, and some permanent stock-water ponds support muskrat populations. Beaver are found along the river. These species must have the proper riparian vegetation and water bodies to survive.

Small mammals

The most noticeable small mammal inhabiting the study area is the desert cottontail whose population is cyclic. The cottontail is important both as a small game animal and as prey for coyotes, foxes, bobcats, golden eagles, rough-legged hawks and other predators. Broken topography, rocks and dry washes, along with sagebrush and other shrubs, provide necessary protection from harsh winters and predators.

Sagebrush, rabbitbrush, snakeweed and saltbush provide most of their feed, especially in winter. There is no information available concerning population densities in this area.

White-tailed jackrabbits occur in limited numbers throughout the sagebrush-grassland and saltbush types of vegetation. They are also cyclic and are food for predators, especially coyotes.

Several white-tailed prairie dog colonies have been found on project lands. (See Map 3.) As mentioned previously, prairie dog towns are potential black-footed ferret habitat. Prairie dog burrows and those of other rodents provide cover and nesting habitat for various other wildlife species such as burrowing owls, snakes, rabbits and weasels.

The Ord kangaroo rat is found throughout the upland portions of the area although they are most abundant in areas of sandy soils.

Porcupines are also present in the willow and shrub vegetation along the river. Also, there are northern pocket gophers, bushy-tailed woodrats, deer mice, and least chipmunks in suitable sites throughout the area. Other species of small rodents undoubtedly occur but have not been confirmed.

Non-game birds

Information concerning such factors as population and nesting densities and even documented occurrences and seasons of use is almost totally lacking for most non-game birds in the study area.

Raptors in the area include golden eagles, rough-legged hawks, great horned owls, and, along the river, bald eagles. Eagle and rough-legged hawk populations increase in the winter since many migrants of these species "overwinter" in the region. Marsh hawks, red-tailed hawks, American kestrel and burrowing owls are known summer residents. Nesting density of all raptors is low. One golden eagle nest site has been reported in Section 17, T. 50 N., R. 93 W., immediately adjacent to one of the proposed project tracts. It is unlikely that there are any bald eagles nesting in the study area. Marsh hawk and red-tailed hawk nesting would be expected primarily on riparian lands where agricultural fields and cottonwood trees are abundant. Major prey species for raptors include cottontail rabbits, chipmunks, kangaroo rats, deer mice and, along the agricultural lands, various voles. A few stock ponds, the canal and the river provide shoreline nesting and feeding habitat necessary for shore birds. Great blue herons, gulls, grebes, snipe, willets, avocets, spotted sandpipers and killdeer all migrate through the Basin and use the limited habitat found on proposed project lands and along water courses.

Other birds commonly found near agricultural lands along the river are crows, Brewer's and yellow-headed blackbirds, and black-billed magpies. Small birds such as the horned lark, savannah sparrow, Brewer's sparrow, vesper sparrow and lark bunting are found on the proposed project lands, as are the largely-insectivorous birds such as the western meadowlark, loggerhead shrike and common nighthawk. These birds are summer residents, with the exception of the horned lark which remains during the winter. The gray-crowned rosey finch migrates into the area during the winter.

Upland game birds

Sage grouse are present on proposed project lands although the population appears to be sparse. (See Map 3.) A strutting ground probably exists on or near Section 19, T. 49 N., R. 93 W., but has not yet been confirmed. The lack of dependable surface water and succulent vegetation supports a belief that project lands are marginal sage grouse habitat. Although the area is open to sage grouse hunting during the season, very little hunting or harvest takes place (Burns, 1974).

A rating scale for population density of sage grouse in eastern Wyoming was decided upon by Game and Fish Dept. biologists as part of the Northern Great Plains Resource Program. Densities of two to five birds per square mile are considered "light," five to eight birds per square mile "medium," and more than eight birds per square mile "high." We estimate that population density in the study area is "light." (See Table 9.) Sage grouse are dependent upon the sagebrush type of vegetation for food and cover.

Mourning doves use proposed project lands from spring through early fall. They tend to concentrate near the river and canal. We have no information about populations here. These birds depend heavily on weed seeds and grain for food. A harvest estimate based on countywide surveys is shown in Table 9.

Chukar partridge have been introduced into the area south of the study area but have been only marginally successful. Extensive investigations on proposed project lands in December 1974 failed to reveal any evidence of chukars. Hungarian partridge are present near the agricultural and riparian lands, but populations are cyclically "low to very low." Ringneck pheasants are found in the same areas but populations are low. Present populations of chukars, "huns" and pheasants support little harvest in the study area.

Waterfowl

Information provided by the Game and Fish Dept. is that 12 to 27 breeding pairs of Canada geese use the river annually between Worland and Greybull. The average for the last four years is 18 breeding pairs and 7 grouped geese for a total of 43. The breeding pairs are estimated to produce between 60 and 135 goslings annually.

Canada geese generally arrive in March, prior to runoff. Nest sites are selected and nesting is usually underway by early April. Most nest sites are on islands or along the river banks fairly close to the water's edge. Any large increases in flow, from either runoff or releases from upstream impoundments, result in nest losses. The later in the incubation period these losses occur, the less chance there is that renesting will take place. Young geese are quite vulnerable to predators until June or July.

Table 10 presents a four-year-average duck census on the River between Worland and Greybull, taken during May breeding-ground surveys. This number has varied between 111 and 183 birds, producing between 300 and 500 ducklings annually. Duck nesting periods and requirements vary considerably between species. Some ducks nest close to water, others considerable distances away. Generally, mallards and pintails will nest from April into June. Gadwall, shoveller and teal nest from May into June. Ducks have a greater tendency to renest than do geese. Fall and winter census data for the Worland-to-Greybull portion of the river shows the influence of migratory birds. (See Table 11.) During October and November numerous species migrate through, but it is not until late November that large concentrations gather on the river. This is due largely to the freeze-up of ponds, lakes and reservoirs.

Harvest data in Table 9 is largely creditable to the Worland to Greybull portion of the river (Serdiuk, 1975).

Table 10
Duck Breeding Ground Survey
Big Horn River, Worland to Greybull
(four-year average)

Species	No. of Ducks
Mallard	88
Gadwall	4
Teal	17
Merganser	13
Pintail	6
Widgeon	8
Shoveller	2
Unknown	10
Coot	5
	153

Table 11
Average Waterfowl Population, Fall and Winter
Big Horn River, Worland to Greybull

	Oct.	Nov.	Dec.	Jan.
Ducks	250-500	1500-3000	200-500	100
Canada Geese	100-150	200-250	50-100	20-50

Fish

The River provides the only fish habitat in the area which might be affected by the project. While a sizeable fish population exists in the stretch between Worland and Greybull, it is primarily of non-game species. According to Louis Pechacek, area fisheries biologist for the Game and Fish Dept., very few game fish have been taken in this stretch of the river during department operations and studies, and these have been limited to walleye. The department has planted catfish on several occasions, however, and there are a number of reports of catfish catches made by anglers on the River near the mouth of the Nowood River.

From a game-fish standpoint, the stretch of the Big Horn between Worland and Greybull is the poorest. This stretch has had a history of industrial pollution and also sediment loading from the Fifteen Mile and other drainges. Upstream use periodically nearly de-waters the river between Worland and Manderson during low-runoff years. Low summer flows and high temperatures cause high water temperature, often making conditions intolerable for many game fish species.

Spot studies by the Game and Fish Dept. over several decades reveal generally poorer aquatic invertebrate production in the project portion of the river south of Worland. Counts of such invertebrate species important as fish food as caddisfly larvae, mayfly nymphs, dragonfly nymphs and aquatic beetle larvae are commonly low. This is especially true in pool and shoal areas where sand and silt cover the bottom.

Species most commonly taken during studies by the Game and Fish Dept. in the study portion of the river are the white sucker, stonecat, flathead chub and river carpsucker. Species sometimes taken are carp, creek chub, black bullhead, northern redhorse and longnose sucker. A rainbow trout, catfish, walleye, burbot or sauger may be taken, but probably not often. Past records suggest that the shovelnose sturgeon, sturgeon chub, silvery minnow, longnose dace and mountain sucker may occur in this part of the Big Horn also.

Reptiles and amphibians

Reports have been made of amphibians on proposed project lands. The majority of these lands, of course, do not provide suitable habitat. However, some amphibians can be expected in small numbers.

The blotched tiger salamander can probably be found around small temporary ponds and reservoirs, especially during wet periods. It can certainly be found in suitable areas along the river. The plains spadefoot toad and the Great Plains toad probably occur also, at least along the river. Frogs which probably occur include the boreal chorus frog and the leopard frog.

Reptiles known in the study area include the sagebrush lizard, eastern short-horned lizard, prairie rattlesnake, bullsnake and wandering garter snake. The eastern yellow-bellied racer and red-sided garter snake probably occur near the river. Snapping turtles and western softshell turtles have been collected along the project section of the river (Pechacek, 1975).

Invertebrates

Information is lacking on invertebrate life in the study area. Fautin, in 1946, studied animal life in the shadscale and sagebrush association in Utah. In these associations two strata occur: the ground and the shrub. Certain arachnids (spiders and mites), leafhoppers, fulgorid planthoppers, scale insects, leaf beetles and plant bugs were most numerous in the shrub strata. Other arachnids, tenebrionid beetles and ants were the most conspicious ground invertebrates. Grasshoppers commonly used both strata.

Limited observation of these associations in the study area reveals invertebrate life very similar to that found in Utah by Fautin. Within the sagebrush associations of the proposed project lands, obvious vegetation patterns have evolved as a direct result of harvester ant activity. Denuded rings ten to twenty feet across surround ant hills numbering one to several per acre. A ring of larger, more vigorous sagebrush plants several feet wide surrounds the denuded area. Bare soil areas around the ant hills are commonly of an erosion-pavement nature. Runoff from the bare area maintained by the ants apparently increases soil moisture on the edge of this bare area, accounting for increased vigor of the sagebrush and understory vegetation around its edge. On close inspection, one finds evidence that rodent, rabbit, small bird, insect, predator and ungulate activity is increased in these "sagebrush rings," as compared to that in the surrounding area. It is apparent that activities of the harvester ant have far-reaching effects on other members of the community.

Invertebrate populations in the riparian and aquatic habitats associated with the river undoubtedly include a wide variety of insects. However, only limited information is available. Numerous aquatic forms of insects and small crustaceans are present in the river. Some were mentioned in the fish section. Information is spotty, however, and of a cursory nature. Snails are present. Freshwater clams and crayfish may be present but no confirming information has been found.

Domestic livestock

Eleven ranching operations graze domestic livestock on national resource land in the study area. The percentage of each grazing allotment proposed to be included in the project is shown in Table 12. Annually, from 6,000 to 10,000 sheep and 700 to 1,000 cattle graze on project lands during some part of the year. Maximum authorized grazing on allotments which are partially in the project area amounts to 8,566 active animal unit months.* (See Table 12 and Map 4.) Grazing records indicate that actual cattle and sheep use varies from year to year below this maximum.

In 1974 grazing users applied for only 4,932 AUMs in these allotments and an estimated 1842 AUMs of this use was on project lands. The annual variation in surface water for livestock controls use that can be made in these allotments.

Sheep use is mostly in winter and spring. Major native forage species include Nutall's saltbush, blue gramma grass, big sagebrush, western wheatgrass and Indian ricegrass. Cheatgrass-brome and squirrel-tail are abundant on many sites and used in the spring. Cattle use is primarily in the spring when more water is available.

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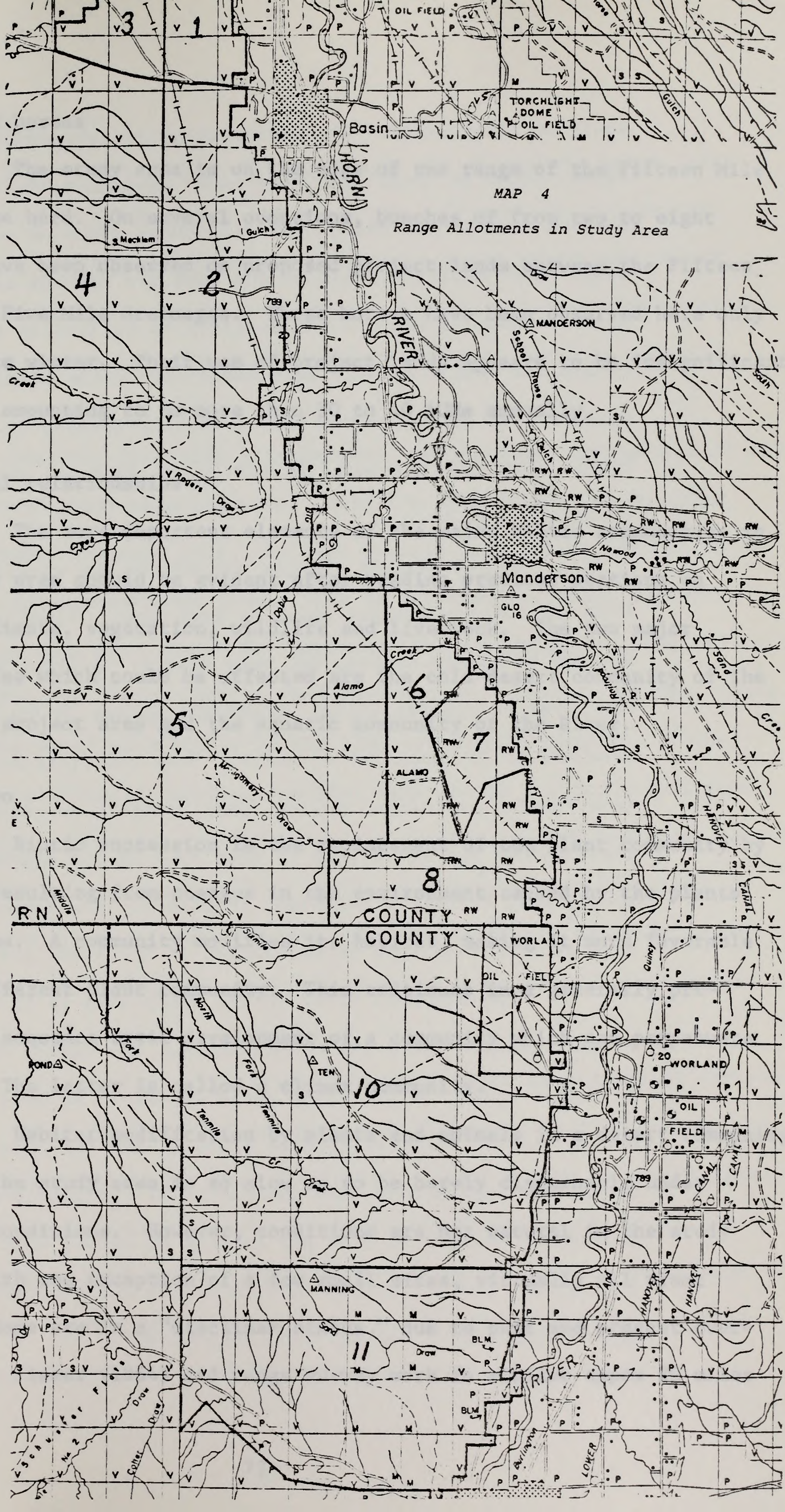
* An animal unit month (AUM) is the amount of forage required to feed a mature cow with calf, or equivalent, for a month.

Table 12

Livestock Use in Allotments in the Study Area

Allotment (see map)	% of Allot. in Study Area	Active AUMS Authorized in Allotment	Type of Livestock	1974 Actual AUM Use	Season Used in 1974
1. Basin (north)	20%	200	Sheep	0	--
2. Basin (south)	10%	870	Sheep	293	Spring
3. Dooley (Indiv.)	17%	150	Cattle	150	Spring
4. Elk Creek	10%	1438	Sheep	1224	Spring-Fall
5. Five Mile	14%	2785	Cattle	1712	Winter-Sprir
6. Alamo Creek	50%	25	Cattle	26	Spring
7. Buchanan (Indiv.)	100%	125	Cattle	125	Spring
8. Euler (5-Mile)	50%	400	Cattle	401	Spring-Summe
9. Six Mile	95%	134	Sheep	134	Winter
10. Ten Mile	28%	1651	Sheep	517	Winter
11. Fifteen Mile	29%	788	Sheep	350	Spring
Totals		8566		4932	



MAP 4

Range Allotments in Study Area

Wild horses

The study area is on the edge of the range of the Fifteen Mile wild horse herd. On several occasions, bunches of from two to eight horses have been observed on proposed project lands between the Fifteen Mile and Five Mile drainages. These horses have been observed here only during the winter. Their use of project lands appears to be insignificant, probably amounting to no more than 30 to 40 AUMs annually.

Ecological relationships

The more important elements of the major biotic communities in the study area should be evident after reading previous sections on soils, climate, vegetation, wildlife and livestock. The two major communities which could be affected are the cold desert community of the proposed-project area and the aquatic community of the River.

Succession

Biotic succession is the replacement of one plant community by another resulting from changes in the environment caused by the plants themselves. A community modifies its habitat, making it more favorable for a different plant community. This continues in a generally predictable sequence until development of a community which can perpetuate itself. The latter is called a climax community.

Habitat modification by plants and animals in a desert community such as the study area is so slow as to be barely discernable under natural conditions. However, conditions are not natural in the study area. With the exception of a few small sites, virtually all plant associations are in a "disclimax status," due to past and present overgrazing. Fisser (1964) did range survey work in similar types 20 miles south on Kirby Creek. The sagebrush-grass, greasewood and saltbush types, rated in "poor" to "very poor" condition in Fisser's work, exhibited most of the characteristics these types do now in the study area. Most native animals of the area are members of the general cold desert community and are not specific to particular plant associations within it. These animals were described in the wildlife section. It appears that the long-term effect of this grazing on animals in the biotic community has been, primarily, to decrease populations more than to change species.

Physiographic changes can modify the environment quite apart from the changes brought about by organisms. Flood plains become better drained as stream courses cut more deeply. Silting in low places raises the level of mineral soils. Chemical changes in the soil result from leaching or accumulation of salts. Such modifications of habitat produce vegetation changes called "physiographic succession." Those plant associations and variations of them such as big sagebrush-bluebunch wheatgrass, Nuttall's saltbush, greasewood, greasewood-saltbush, and bud sage exhibit this type of succession in the study area.

The Big Horn River in the study area is in the middle stages of succession. There are no waterfalls, and rapids are mostly reduced to ripple areas. Sand-bottom pools appear to be more common than mud-bottom pools. The fish species present, and the apparent status of invertebrate populations, are indicative of the middle stage of succession. Man-caused changes in flow and quality of water, with dams, irrigation diversions, and pollution, have certainly altered natural stream processes, but to what degree has not been determined.

Food relationships

Major producers in the study area are cheatgrass brome, blue grama, Nuttall's saltbush and big sagebrush. Greasewood, halogenton, rabbitbrush, western and bluebunch wheatgrasses and needle and thread grass are major producers on some sites. Most of the food manufactured by plant producers is taken at the primary-consumer level by domestic sheep and cattle.

Insects, primarily grasshoppers, undoubtedly consume significant quantities of plant material also. Wildlife species such as antelope, deer, rabbits, kangaroo rats, mice and prairie dogs make up the third important primary-consumer group. Man is the most important secondary consumer in this ecosystem. He "harvests" the livestock for food, as well as some antelope, deer, rabbits, and sage grouse. Coyotes, eagles, foxes, badgers and other wild predators are also secondary consumers. These predators take mostly rabbits, rodents, sage grouse and occasional fawns. Coyotes take some sheep. Species such as coyotes, eagles and great horned owls sometimes assume the role of tertiary consumers when they take smaller carnivores and insectivores. In some instances one species may be extremely dependent upon another. Such is the case with sage grouse upon sagebrush.

The study area is naturally arid, subject to periods of extreme drought. "Wet" and "dry" years cause wide fluctuations in the amount of plant material produced. This fluctuation, coupled with excessive livestock use not necessarily based on changes in forage availability, is largely responsible for the depleted production potential. Relatively little dead organic matter accumulates in this environment and, correspondingly, the activities of "transformer" organisms are limited.

Man's efforts to increase livestock production have included surface-water development. This has resulted in severe overuse of vegetation near these water developments by livestock and wildlife. Such development has enabled consuming elements to make increased use of the energy "fixed" by the producing elements.

Food relationships in the biotic community on the River are complex. Some food chains are strictly aquatic, such as filamentous algae - caddisfly larva - flathead chub; some are terrestrial in the riparian zone, such as cattail - muskrat - mink; and others are both, such as algae - snail - mallard - fox.

Community relationships

Most of the obvious cases of interdependency of one species on another are food-related. The wintering golden eagle population is almost totally dependent upon cottontail rabbits for food during winter months when prairie dogs and other rodents spend little time above ground. Some prairie dog colonies appear to be almost totally dependent upon Nuttall's saltbush for food. In such situations there is little other vegetation over large areas. Some situations of species interdependence are related to nesting sites and cover. Burrowing owls depend upon burrowing rodents, usually prairie dogs, for their burrows. Brewer's sparrows are dependent primarily upon sagebrush for nest sites.

A wide variety of species interactions involve lesser organisms throughout the cold desert, riparian and aquatic communities, but it is not possible or productive to attempt to describe them all here.

Human Values

Landscape

Proposed project land

Acreages in the proposed project possess a common character, determined by vegetation, climate, geology, animal occurrences, and m a-made modifications.

The basin climate -- infrequent cloud cover, low rainfall, extreme temperature variation, and normally-still air -- provides usually-clean air, shadow contrast (competing with color contrast), limited variety and color of vegetation, absence of ephemeral conditions (such as cloud displays), and scarcity of visible water.

Vegetation interest in the area is lessened because of the general absence of trees. This is further reduced by the lack of vegetation diversity. Except for the rare cottonwoods and willows along stream bottoms, sagebrush, cactus and short grasses dominate the scene.

The area's geology is exhibited in the low, rolling benchlands, stream flood plains, and dry basins above which rise ridges, buttes and eroded escarpments. Muted color banding of sedimentary beds show up on eroded slopes, which are frequently overlain by alluvial cobbles on the flats.

Ephemeral or short-term effects are added by occasionally-seen deer, antelope, birds of prey and rabbits. Other species of animals are less frequently seen.

Among the man-made changes are numerous jeep roads and trails, and fences. Flocks of sheep and the ever present herder's wagon parked on a high point can also occasionally be seen, in season.

Summarized, the aesthetic values include these:

Scale

Typically the scale is large; this feature is an outstanding one and enhances the aesthetic resource. Panoramic views take in a background of mountains some fifty miles distant. Rolling terrain rarely presents a view of less than half a mile, thus allowing many good middle-ground views. Vertical relief of from 30 to 150 feet complements scale without distracting one's attention.

Form

Flat and moderate-to-high rolling terrain exhibits "uninteresting-to-good" contour distinction and some interesting surface variations, except where bench escarpments block views.

Texture

Surface rock, vegetation, and eroded slopes generally dominate the texture of the landscape. Interest is typically "moderate" at best.

Line

This is usually seen in the gradually curving silhouette of surface contours against or below the horizon. Like texture, the lines of the landscape are not dominant and present a "moderate" value at best.

Color

Low color contrast is the rule in the area. Muted tones of tan and grey blend into the grey-greens of sagebrush and the browns of some exposed rock. Where sedimentary layers are exposed by erosion, subtle color bandings of red, tan, brown, and grey give added color interest. During a short spring, vegetation displays such as greening and blooming plants may add substantial interest. Values added to the landscape by color are easily the least substantial of those described here.

A dominant scenic element of this area is the great harmony resulting from uninterrupted form, line, texture and color. Combined with the large scale of the landscape, this lack of variety makes the landscape very vulnerable to scenic intrusions.

Among the scenic deviations already present are oil field structures, pipelines, power lines, roads and trails, fences and flocks of sheep. These deviations are aesthetically intrusive.*

From many vantage points in the study area the irrigated bench-land along the river can be seen. When these cultivated areas are in the foreground, and to a lesser degree when in the middle ground, they are intrusions and represent scenic disharmony. In other instances, the separation of these areas from the foreground and their reinforcement of line and form lend scenic variety to the landscape.

Adjacent land

The riverbottom agricultural land lies outside the proposed project area but within the potential influence zone between the canal

*This is true despite the various values they may possess for cultural sightseeing. Such features are held to be values by some and intrusions by others, depending upon acquired senses of taste. Whether or not they are valuable for cultural sightseeing, they are not a natural attribute of the landscape.

and the River. These lands are mainly converted to agriculture and related human activities, except for marshes and other unusable riverside lands, many of which remain in a visually unmodified condition.

Other cultural influences are communities, oil processing plants, the Burlington Northern Inc. railroad, and commercial and industrial developments around the communities.

Groups of trees and large shrubs harmonize with terrain form in some places and elsewhere give contrast and variety. Along the river, smaller areas of open space are generally visible with greater restrictions of view caused by structures, trees, and other vegetation. Views along much of the higher benchland are unrestricted in the fore and middle ground, with farms standing out as focal points on an open plain. The river is not commonly visible; it increases the view's interest substantially when it is in sight.

Form

Agricultural landform along the river is "low rolling" with a smaller scale than adjacent proposed project land. On the higher bench areas, the form becomes more massive in scale, where panoramic views to the east open up on the cross-river benches with the Big Horn Range in the background. Flood-plain benches lend some interesting surface variation but generally retain the "low-to-moderate" contrast of the bottomland, compared to the distinct contours of some parts of the proposed project area.

Line

Levelled fields predominate on the gently rolling benchlands along the river. Their horizontal lines are reinforced by vegetation, canals, fences, roads and power lines. Edges of the flood-plain benches lend some vertical relief to the scene. Interest value is "low to moderate."

Texture

Trees and shrubs lend much interest to the area's texture, which is otherwise quite "finegrained." (The unvarying surfaces of crops or plowed fields are examples of fine texture.) Large vegetation stands out well in both texture and color from the surrounding croplands and adds interest to the scene. This landscape variety makes the river bottomland more scenically interesting than much of the proposed project lands.

Color

This is dominated by crops, depending upon the season of the year. Color values are "moderate" and have substantially greater importance than in the surrounding region.

Where proposed-project land is visible in the background it does not detract greatly from scenic values in the agricultural lands. Usually the unvarying harmony of this background area lacks sufficient scenic interest to compete with the agricultural lands.

Cultural values

Recreational values

Significant recreation values have been identified on and adjacent to proposed-project lands. They include off-road vehicle use, rock and mineral collecting, hunting, and scenic, geological, zoological and historical sightseeing areas.

Off-road vehicle use

Signs of extensive ORV use are evenly distributed across the lands. Very few areas are not crossed by four-wheel vehicles. This use is almost exclusively incidental to hunting, sightseeing, or collecting, however. Practically none is specifically a challenge of terrain or a test of equipment.

Most of the intensive ORV activity is motorcycle use adjacent to towns. Slopes on Fifteen Mile Creek, along Highway 433, and in areas near Basin, Worland and Greybull get heaviest use. No single site receives "moderate-to-heavy use," though.

ORV values on potential irrigation land are generally low. Adjacent slopes, ridges, and escarpments may have "fair-to-moderate" value. By comparision with sites receiving substantialy use in the basin, however, very little of this land has a "high" value.

Collecting

All proposed-project lands are on alluvial fill material. Because of this, no known sites have a large concentration of collectable rocks, gems or minerals. Collectable material seems to be evenly distributed across the area. Material found is primarily agate and petrified wood. Some isolated invertebrate fossils such as shells, and vertebrate fossils such as teeth, are found in the vicinity, although the collecting of these is prohibited by law. The scientific value of such fossils has not been established. No other collectable material is known in the area.

Recreation use for rock and fossil collecting is light and limited to local residents.

Hunting

Hunting pressure is quite low, corresponding to low game populations. Hunted species include antelope, deer, sage grouse, rabbits, prairie dogs and doves. Waterfowl hunting on the river is substantial (38.6 percent of all waterfowl hunting in Big Horn and Washakie Counties).

Proposed-project lands are in antelope hunting area 77 (Fifteen Mile Creek) and deer hunting areas 124 and 125 (Emblem and Fifteen Mile). Game and Fish Department harvest reports are summarized in Table 13.

Fishing

No fishing activity is known in the project area. The nearby river supports a warm-water fishery of non-game species and some walleye. According to the Game and Fish Dept., an estimated 48.3 visitor-days of fishing use occur on the River between Worland and Greybull.

Sightseeing

Travel off the highway for sightseeing is light compared to highway sightseeing, but trail and back-road travel for this purpose is a common pastime. Travel is generally on and near through-roads, however, and most roads and trails across proposed-project lands do not connect with maintained roads. The more heavily travelled roads in and near the project area include Fifteen Mile, Five Mile Dome Oilfield, Elk Creek, and Six Mile Creek (Worland Oil Field) Roads. Of these, only Fifteen Mile receives substantial recreational traffic. None of the roads has been metered to survey use.

Table 13

Antelope - Area 77

	1972	1973
Hunters	93	103
Antelope Killed	58	90
Days Hunted	2.70	2.71
Success Ratio	62.37	87.38

Deer - Area 124

	1972	1973
Hunters	166	397
Deer Killed	57	179
Days Hunted	2.37	2.83
Success Ratio	33.13	45.09

Deer - Area 125

	1972	1973
Hunters	223	213
Deer Killed	41	190
Days Hunted	2.14	2.22
Success Ratio	18.39	89.20

Based on these reports, a derived estimate of hunter use in the area shows:

Antelope - 21.6 hunters, 13.6 visitor days hunted
Deer - 17.4 hunters,
11.0 visitor days hunted

A total of 1,203.3 visitor days** are attributable to hunting and fishing on or near the study area. For a breakdown of visitor days, see Table R-3.

** Visitor Day - the time spent by a recreational visitor on national resource lands for a particular activity (like hunting, fishing, or historical sightseeing) in one day. An average hunting visit lasts 7.6 hours; an average daylight period in one day is 12 hours. Thus four hunters in one day would contribute 2.5 visitor days:

$$\frac{4 \text{ hunters X } 7.6 \text{ hours}}{12 \text{ hrs. in a day}} = 2.53$$

By comparison, 176.8 visitor days of antelope hunting occurred in all of Area 77 and a combined total of 1,011.1 visitor days of deer hunting occurred in deer areas 124 and 125.

As a rule, sightseeing visits, whether for zoological (wildlife), geological, historical, or scenic values, are usually made with all these purposes involved. That is, on a trip to the badlands people actively search for a glimpse of animals and take in the scenery along the way. Zoological sightseeing is "low-to-moderate" in value. Wild horses can be seen in winter between Ten and Five Mile Creeks, although no bands are known to be resident on proposed-project lands. In the same area antelope can be seen. Small populations of deer can be seen, usually near stream bottoms. Generally, population densities are low, types are moderately interesting, variety is moderate, observation is difficult.

Geological sightseeing is "low" in value, with some adjacent badlands moderately valuable. Form, color, extent and frequency of occurrence of badland formations is "low-to-moderate" in value; the remaining lands have little value for this purpose.

There is little potential for "historical" sightseeing. The single identified historic site is the Bridger Cutoff to the Bozeman Trail, the general route of which has been documented. The trail originally crossed to the west side of the River in the vicinity of Worland. From there, camps of the pioneering party were made on the benches along the river at Ten Mile Creek and north of either Dobie Creek or Alamo Creek. At Elk Creek their route turned west and crossed the Greybull River west of Otto. No documented portions of the trail remain visible in the study area. A rock outcrop bearing signatures dating to 1864 is rumored to exist near Dobie Butte, but has not been located.

The historical significance of the Bridger Cutoff is its connection with Jim Bridger, a romantic and legendary Old West personality. No major importance can be attributed to the route itself. It was in recorded use for one year, 1864, with only three groups known to have followed it. Portions of the trail were used by settlers in succeeding years, but the trail itself never became an important travel route. The trail does have interest for local history enthusiasts.

Scenic sightseeing is "low to fair" for the region. With some exceptions, little distinction in color, vegetation and land form exists. The land lacks uniqueness, although many areas do present an interesting setting and an impressive quality of expanse and openness. Intrusions detract from this open space quality in a few places, generally to a "low" degree.

General sightseeing occurs when highway travelers, for example, view the landscape along the road. Travelers may not be in the area to see particular geological, botanical, scenic or other sights. They may be traveling for commercial purposes or other non-recreational reasons. Nonetheless, they are viewing the landscape and, depending on what they see, deriving some degree of pleasure from it. For this reason we consider sightseeing values as they relate to all persons in the area who will view them; this includes all highway travelers.

Based on data in Table 14, we can estimate general sightseeing use along Highways 433 and 16-20-789. These routes are adjacent to or within the proposed-project boundaries. Table 15 shows values derived from an estimated three occupants per vehicle.

Table 14

Average 24-Hour Vehicle Traffic Rates In Study Area

	Hwy. 433 Washakie Co.-Big Horn Co. Line				Hwy 789-16-20 Washakie Co.-Big Horn Co. Line			
Year	All Ve	For Pas	Com'l	Local	All Ve	For Pas	Com'l	Local
58					1321	361	181	779
68					1240	451	192	597
69	560	76	415	69	1290	465	198	627
70					1210	484	164	562
71	320	22	248	50	1330	497	155	678
72					1350	458	178	714
73					1380	468	168	744

	Hwy. 789-16-20 Manderson (north side)				Hwy. 789-16-20 Basin (south side)			
Year	All Ve	For Pas	Com'l	Local	All Ve	For Pas	Com'l	Local
58	1548	360	215	973	2409	352	203	1854
68	1260	447	161	652	2420	440	188	1792
69	1310	460	166	684	2510	453	194	1863
70	1240	472	144	624	2600	458	202	1940
71	1370	485	167	718	2620	471	179	1970
72	1500	468	192	865	2640	460	210	1970
73	1530	478	182	870	2700	490	214	1996

	Hwy. 789-16-20 Greybull (south side)			
Year	All Ve	For Pas	Com'l	Local
58	1915	352	203	1360
68	1900	437	180	1283
69	1970	450	185	1335
70	2060	456	190	1414
71	2070	469	166	1435
72	2200	460	198	1542
73	2270	472	200	1583

Source: Wyoming Traffic, 1969, 1971, 1973, Wyoming Highway Department, Cheyenne

All Ve - All vehicles
For Pas - Foreign passenger (from outside the four-county Big Horn Basin)
Com'l - Commercial
Local - Local (non-commercial)

Table 15

Visitors & Visitor-Days of General Sightseeing Use
In the Area in 1973

	Visitors	Visitor Days
Basin to Greybull (Hwy. 20-789)		
Local Non-Commercial	5,391	65.1
Foreign Passenger[1]	1,443	17.4
All Vehicles	7,455	90.0
Manderson to Basin (Hwy. 20-789)		
Local Non-Commercial	4,299	65.2
Foreign Passenger	1,452	22.0
All Vehicles	6,345	96.2
Worland to Manderson (Hwy. 20-789)		
Local Non-Commercial	2,239	64.4
Foreign Passenger	1,404	40.4
All Vehicles	4,140	119.0
Worland to Manderson (Hwy. 433)		
Local Non-Commercial	744	21.4
Foreign Passenger	66	1.9
All Vehicles	960	27.6
Grand Totals	36,038	630.6

1. Vehicles from outside the four-county Big Horn Basin

Archaeology and paleontology

Background

Sites of archaeological and paleontological interest are of similar cultural value. For this reason the two disciplines will be treated together.

Man has been in the Big Horn Basin possibly more than 12,000 years and animals much longer. The earliest recognized culture, Paleo-Indian or early prehistoric people, are known to have lived in the Big Horn Basin. A site near Worland, recently excavated, contained tools of a type used by the first variety of man, Clovis (Llano). These tools were associated by location with a mammoth site. Both the mammoth, an early form of elephant, and the Clovis culture became extinct at about the same time.

Folsom man, thought to be somewhat more recent than Clovis, appears to have inhabited the Basin also. A find of Folsom culture artifacts was made near Shell, Wyoming. These men, who hunted a large, early form of bison, disappeared about 10,000 years ago.

Members of later cultures, Plano, also were big game hunters and they became extinct, along with the large bison they hunted, about 7,000 years ago. The Basin contains a major site of the Plano tradition, the Horner site near Cody. This site has yielded many artifacts bearing the name the "Cody Complex." After this time the climate became somewhat hot and dry. This period is called the Altithermal Period (5,000-2,500 years ago). Sites relating to the Altithermal are very rare, and those that existed during this period reflect a diminished population or more infrequent use of the area.

After the Altithermal, there appeared various cultures which make up what is known as the Middle Prehistoric Period. These people were hunters and foragers. One of the early cultures of this time is known as the McKean Complex. This complex has so far been located on the western and eastern sides of the Basin -- the Mummy Cave Site near Cody and the Leigh Cave Site near Ten Sleep.

The Late Middle Period started somewhat around 2,000+ years ago and lasted until about 500 A.D. Artifact design, especially projectile points, changed to a smaller triangular and often notched shape. The Big Horn Mountains contain many sites of this period. Local point-hunters collections testify to the variety and abundance of artifacts which can be found in the area.

The Late Prehistoric Period, 500-post 1700 A.D., exhibits even more cultural material than the Late Middle Period. Horses, bows and arrows, and pottery came into use at this time. Buffalo jumps are often associated with this period. A site of this type, where the buffalo were stampeded off steep cliffs, has tentatively been identified in the northern part of the Basin. Many other sites of this period can be found throughout the area.

Survey information

Proposed-project lands are roughly at the center of the Basin. Research of literature and consultation with an archaeologist quite familiar with the area, Dr. Frison of the University of Wyoming, indicate that even though many sites are known near the boundaries of the Basin, not much is known about the archaeology of the central portion.

Field surveys for the present study appear to be one of the first, if not the first, systematic on-the-ground inventories in this area. These field surveys were conducted at three levels of intensity: assessment (Class I); reconnaissance (Class II); and intensive (Class III).

Assessment surveys are low-intensity examinations of localities known, through examinations of similar regions, to have a high probability of containing cultural remains. The object is to find out the quantity and quality of archeological and paleontological resources in the area at minimum cost.

Reconnaissance surveys are middle intensity examinations of an area to gain a general understanding of the kinds of cultural remains present. The object of a reconnaissance survey is to locate as large a sample of cultural-resource properties as possible without examining all or nearly all areas.

The intensive survey is the most painstaking search for information on all varieties of cultural resources in the area. The object of an intensive survey is to locate as large a sample as possible of these cultural resource properties.

Sites found during these surveys were rated for the following levels of significance:

— High Significance (S1) A cultural resource that meets the criteria for inclusion in the National Register of Historic Places. Any S1 cultural resource must ultimately be listed on the National Register.

— Mid-Significance (S2) A cultural resource that has significant scientific, educational and recreational value, but does not meet National Register criteria.

— Low Significance (S3) A cultural resource which does not meet criteria for inclusion in the National Register, and which possess little or no scientific, educational or recreational value.

Sites, archaeological and paleontological, and surveys are discussed below with reference to sections A through M noted on map 3.

<u>Section A</u> This section had no archaeological survey. Sites are probable in this section.

<u>Section B</u> Two archaeological sites were found: a small quarry and a campsite on an overlook of Ten Mile Creek. Both sites are of S3 significance. Sites are probable in unsurveyed areas.

<u>Section C</u> Seven sites were found: three small campsites, two quarry sites and two chipping and lookout stations. All sites are of S3 significance. Sites are possible in unsurveyed areas.

<u>Section D</u> No sites were found, but sites are possible in unsurveyed areas.

<u>Section E</u> No sites were found.

<u>Section F</u> One quarry and chipping site was found. Site is of S3 significance.

Section G One quarry was found. Site is of S3 significance.

Section H No site was found.

Section I No site was found.

Section J No site was found.

Section K No site was found.

Section L One paleontological site was found. Site is of S3 significance.

Section M No site was found.

Summary

Of the total area of the proposed project, five percent received intensive survey (Class III), 18 percent received reconnaissance survey (Class II), 30 percent received assessment survey (Class I), and 47 percent was not surveyed.

A total of 12 sites was discovered and recorded. The most numerous type of site was the quarry, five. Naturally occurring cobbles of a fair-to-good toolstone quality can be found almost anywhere in the area. Small outcroppings of these cobbles served as quarries. Second most numerous site found was the small campsite. Four of these were found, two of them on the bench areas of larger local streams and valleys.

The third most numerous sites were of the chipping and lookout type. It was noted that many more of this type were found fairly close to the proposed project's boundaries (the project's proposed lands are the lower and flatter sections).

It appears that early man was using this central portion of the Basin, but that populations were probably not large for any length of time. Possibly small hunting groups came to look for game in the stream drainages. This is a Sonoran-type life zone and many small animals such as rabbits and prairie dogs inhabit the area. Large game includes deer and antelope. A site containing at least one bison and possibly more was found close to the proposed-project land. Most likely, bison grazed the drainages when grass was plentiful. Also, hunters may have pushed these animals there for entrapment purposes. At any rate, it appears that the area was inhabited for short periods of time by rather small bands of hunters who kept lookouts and possibly chipped tools while doing so. These people probably made small camps and used locally-available materials to make stone tools.

In all, there were a dozen sites on proposed-project land and many more nearby. Of them all, only one is possibly of S2 significance, and it is not on proposed-project lands. It should be noted however, that 47 percent of the proposed-project land received no survey at all. Also, since the survey was conducted by surface hunting, there may be many undiscovered sites of a subsurface nature. Rougher lands tended to yield more sites than flatter areas.

Socio-economic environment

General

This section describes the study-area environment in terms of the life styles, including social and economic factors, of Washakie and Big Horn Counties. "Life styles" is a brief overview of the attitudes and cohesiveness of small, rural communities. Population, employment, income and so on are then discussed for each county, to enable some insight into the type of services that are offered and available.

Life styles

Washakie and Big Horn Counties are agriculturally oriented. The dominance of farming-ranching as both an economic activity and a way of life profoundly affects the economic and social structure, the value system and community attitudes: in short, the life style of the area. Current use of the area for grazing results in a low rural population density. Isolation, the affect of this low density, demands self-sufficiency and self-reliance. The agriculture ethic is thus tied to the land in a hardworking lifestyle, in which the closeknit community fends for itself and takes care of its own. Agricultural communities tend to be stable and very "internally oriented." Immigration is rare, and, with the exception of migrant workers, the little population growth that occurs is almost exclusively dependent upon the birth and death rates. Tables 15 through 21 indicate general population characteristics of the two counties.

Table 15a WASHAKIE COUNTY

GENERAL POPULATION CHARACTERISTICS

Total Population

1960 Population: 8,883 1970 Population: 7,569

Percent change between 1960 and 1970 population: -14.8

1960 Urban Population: 5,806 1970 Urban Population: 5,055

Percent change between 1960 and 1970 urban population: -12.9

1960 Rural Population: 3,077 1970 Rural Population: 2,514

Percent change between 1960 and 1970 rural population: -18.3

Percent of county population to state population: 2.3

Percent of males in county population: 51.1

Percent of females in county population: 48.9

Age and Sex Distribution

Male, all ages:	3,867	Female, all ages:	3,702	Percent of age groups to population (M & F)
Under 5 years:	329	Under 5 years:	309	8.4
5 - 9 years:	418	5 - 9 years:	395	10.7
10 - 14 years:	470	10 - 14 years:	419	11.7
15 - 19 years:	453	15 - 19 years:	346	10.6
20 - 24 years:	176	20 - 24 years:	237	5.5
25 - 29 years:	215	25 - 29 years:	213	5.6
30 - 34 years:	215	30 - 34 years:	220	5.7
35 - 39 years:	182	35 - 39 years:	203	5.1
40 - 44 years:	244	40 - 44 years:	246	6.5
45 - 49 years:	243	45 - 49 years:	209	6.0
50 - 54 years:	234	50 - 54 years:	229	6.1
55 - 59 years:	203	55 - 59 years:	196	5.3
60 - 64 years:	188	60 - 64 years:	149	4.5
65 - 69 years:	109	65 - 69 years:	115	3.0
70 - 74 years:	78	70 - 74 years:	89	2.2
Over 75 years:	110	Over 75 years:	127	3.1
Under 18 years:	1,561	Under 18 years:	1,379	38.8
Over 62 years:	404	Over 62 years:	412	10.8
Over 65 years:	297	Over 65 years:	311	8.3
Median Age:	27.0	Median Age:	28.4	31.5

Table 16

WASHAKIE COUNTY

VITAL STATISTICS BY PLACE OF RESIDENCE

Year	Population	Natural Increase Rate	Births	Deaths	Infant Deaths	Infant Mortality Rate	Vital Index	Crude Death Rate	Crude Birth Rate	Marriages	Divorces	Divorce Rate
1950	7,252	.002	218	55	8	36.7	396	7.58	30.1	54	0	0
1951		.024	226	54	8	35.4	418	7.45	31.2	49	1	0.1
1952		.025	326	55	7	29.7	429	7.58	32.5	65	0	0
1953		.032	280	49	8	28.6	571	6.76	38.6	48	22	3.0
1954		.029	266	59	5	18.8	451	8.14	36.7	57	30	4.1
1955		.032	272	69	5	18.4	394	5.52	37.5	61	23	3.2
1956		.032	283	47	8	28.4	602	6.48	39.0	61	19	2.6
1957		.032	299	64	10	33.4	467	8.82	41.2	70	31	4.3
1958		.032	277	44	3	10.8	630	6.07	38.2	63	29	4.0
1959		.029	264	52	4	15.2	508	7.17	36.4	61	26	3.6
1960	8,883	.017	209	59	4	19.1	354	6.64	23.5	72	26	2.9
1961		.016	208	58	3	14.4	359	6.53	23.4	57	24	2.7
1962		.017	217	63	4	18.4	344	7.09	24.4	55	33	3.7
1963		.016	207	61	7	33.8	339	6.87	23.3	56	21	2.4
1964		.015	184	52	8	43.5	354	5.85	20.7	78	33	3.7
1965		.010	148	55	4	27.0	269	6.19	16.7	59	32	3.6
1966		.011	155	55	3	19.4	282	6.19	17.4	69	25	2.8
1967		.008	131	60	3	22.9	218	6.75	14.8	60	31	3.5
1968		.007	144	81	4	27.8	178	9.12	16.2	75	33	3.7
1969		.009	153	71	7	45.8	216	7.99	17.2	80	32	3.6
1970	7,569	.009	144	73	3	20.8	197	9.64	19.0	86	27	3.6

TWENTY-YEAR SUMMARY

	Population	Natural Increase Rate	Births	Deaths	Infant Deaths	Infant Mortality Rate	Vital Index	Crude Death Rate	Crude Birth Rate	Marriages	Divorces	Divorce Rate
	168,919	.019	4,521	1,236	116	25.7	366	7.32	26.8	1,336	498	2.9

TABLE 17

GENERAL SOCIO-ECONOMIC CHARACTERISTICS
Washakie County

Industry of Employed Persons

Agriculture, Forestry and Fisheries	532
Mining	233
Construction	165
Manufacturing	253
Railroads & Railway Express Service	5
Trucking Service and Warehousing	84
Other Transportation	34
Communications	70
Utilities & Sanitary Services	83
Wholesale Trade	69
Food, Bakery, and Dairy Stores	45
Eating and Drinking Places	117
General Merchandise Retailing	65
Motor Vehicle Retailing & Service Stations	94
Other Retail Trade	141
Banking and Credit Agencies	30
Insurance, Real Estate, and Other	57
Business and Repair Service	70
Private Households	20
Other Personal Services	117
Entertainment and Recreation Services	10
Hospitals	63
Health Services except Hospitals	53
Schools and Colleges - Government	203
Schools and Colleges - Private	37
Other Education and Kindred Services	0
Welfare, Religious, etc. (nonprofit)	44
Legal, Engineering & Misc. Profession	69
Public Administration	175
Per Capital Income of Persons	$2,576
Median Income	8,354
Percent under $3,000	10.4
Percent $10,000 and over	35.4
Number of Persons per Household	3.1
Number of Households	2,362

Unemployment

Civilian Labor Force: 3,080

Unemployed: 142

TABLE 17
(continued)

GENERAL SOCIO-ECONOMIC CHARACTERISTICS
Washakie County

Labor Force - Age and Distribution by Sex

	Male	Female
14 and 15 years:	13.4	11.4
16 and 17 years:	29.6	22.6
18 and 19 years:	76.1	44.6
20 and 21 years:	87.5	33.3
22 to 24 years:	94.9	46.2
25 to 34 years:	97.7	41.2
35 to 44 years:	97.9	53.7
45 to 64 years	92.6	49.4
65 years & older:	42.0	10.0

Occupation Groups of Employed Persons -	Total
Professional, Tech., & Kindred Workers	481
Managers & Administrators, except Farm	249
Sales Workers	175
Clerical and Kindred Workers	419
Craftsmen, Foremen, & Kindred Workers	326
Operatives, except Transportation	209
Transport Equipment Operatives	145
Laborers, except Farm	121
Farmers and Farm Managers	280
Farm Laborers and Farm Foremen	201
Service Workers except Private Households	312
Private Household Workers	20

Occupation Groups of Employed Persons -	Female
Professional, Tech., & Kindred Workers	177
Managers & Administrators, except Farm	54
Sales Workers	33
Clerical and Kindred Workers	225
Craftsmen, Foremen, & Kindred Workers	5
Operatives, except Transportation	26
Transport Equipment Operatives	6
Laborers, except Farm	10
Farmers and Farm Managers	7
Farm Laborers and Farm Foremen	0
Service Workers except Private Households	433
Private Household Workers	15

Unemployment Rate: 4.6%

Table 18

GENERAL POPULATION CHARACTERISTICS

Total Population

1960 Population: 11,898 1970 Population: 10,202

Percent change between 1960 and 1970 population: -14.3

1960 Urban Population: 0 1970 Urban Population: 0

Percent change between 1960 and 1970 urban population: 0

1960 Rural Population: 11,898 1970 Rural Population: 10,202

Percent change between 1960 and 1970 rural population: -14.3

Percent of county population to state population: 3.1

Percent of males in county population: 50.4

Percent of females in county population: 49.6

Age and Sex Distribution

Male, all ages:	5,146	Female, all ages:	5,056	Percent of age groups to population (M & F)
Under 5 years:	434	Under 5 years:	375	7.9
5 - 9 years:	524	5 - 9 years:	484	9.9
10 - 14 years:	597	10 - 14 years:	580	11.5
15 - 19 years:	521	15 - 19 years:	473	9.7
20 - 24 years:	222	20 - 24 years:	233	4.5
25 - 29 years:	241	25 - 29 years:	271	5.0
30 - 34 years:	249	30 - 34 years:	253	4.9
35 - 39 years:	230	35 - 39 years:	249	4.7
40 - 44 years:	271	40 - 44 years:	257	5.2
45 - 49 years:	287	45 - 49 years:	292	5.7
50 - 54 years:	303	50 - 54 years:	307	6.0
55 - 59 years:	328	55 - 59 years:	305	6.2
60 - 64 years:	304	60 - 64 years:	294	5.9
65 - 69 years:	215	65 - 69 years:	222	4.3
70 - 74 years:	190	70 - 74 years:	184	3.7
Over 75 years:	230	Over 75 years:	277	5.0
Under 18 years:	1,914	Under 18 years:	1,793	36.3
Over 62 years:	796	Over 62 years:	841	16.0
Over 65 years:	635	Over 65 years:	683	12.9
Median Age:	30.7	Median Age:	32.2	31.5

Table 19

BIG HORN COUNTY
Population: 10,000

HEALTH SERVICES

Number of Physicians:	5	**Physician Speciality**	
Average Age:	52.1		
Number of Dentists:	5	General Practice:	4
		Gynacology:	1

Number of R.N.'s: 29 (employed)
10 (unemployed)
Number of L.P.N.'s: 11 (employed)
4 (unemployed)

Number of School Nurses: 3
Number of P.H.N.s: 0
Number of Home Health Aides: 0

Number of Pharmacists: 10
Number of Optometrists: 1
Number of Dental Hygienists: 0

Number of Veterinarians: 2

Sanitation Coverage by Dist. #2 - Worland

Population Ratios

Dentists:	1 per 2,000
Physicians:	1 per 2,000
R.N.'s	1 per 345
L.P.N.'s:	1 per 909
Pharmacists:	1 per 1,000
Optometrists:	1 per 10,000

HEALTH FACILITIES

Nursing Care:	2	Hospitals:	2
Pharmacies:	5	Beds:	60
Dental Clinics:	3	Bassinets:	20
Clinical Laboratories:	2	Mental Health Centers:	0
Ambulances:	5		

VITAL STATISTICS BY PLACE OF RESIDENCE

Year	Population	Natural Increase Rate	Births	Deaths	Infant Deaths	Infant Mortality Rate	Vital Index	Crude Death Rate	Crude Birth Rate	Marriages	Divorces	Divorce Rate
1950	13,176	.019	375	121	15	40.0	310	9.18	28.5	65	0	0
1951		.021	384	100	6	15.6	384	7.59	29.1	54	36	2.7
1952		.018	336	95	5	14.9	354	7.21	25.5	51	37	2.8
1953		.019	332	82	2	6.0	405	6.22	25.2	84	35	2.7
1954		.020	376	107	8	21.3	351	8.12	28.5	83	35	2.7
1955		.017	325	101	11	33.8	322	7.66	24.7	72	40	3.0
1956		.014	298	114	8	26.8	261	8.65	22.6	77	30	2.3
1957		.015	308	106	8	26.0	290	8.04	23.4	75	34	2.6
1958		.016	308	103	7	22.7	299	7.82	23.4	66	42	3.2
1959		.013	301	127	11	36.5	237	9.64	22.8	67	28	2.1
1960	11,898	.012	266	127	6	22.6	209	10.67	22.4	81	41	3.4
1961		.013	278	124	10	36.0	224	10.42	23.4	94	32	2.7
1962		.012	249	133	11	44.2	187	11.18	20.9	86	22	1.8
1963		.010	207	90	1	4.8	230	7.56	17.4	98	35	2.7
1964		.010	235	116	8	34.0	202	9.75	19.8	88	37	2.8
1965		.007	194	108	3	15.5	180	9.08	16.3	84	33	2.7
1966		.008	192	92	3	15.6	209	7.73	16.1	89	37	2.8
1967		.004	155	109	0	0	142	9.16	13.0	84	40	3.0
1968		.007	172	91	4	23.2	189	7.65	14.4	90	31	2.6
1969		.006	157	81	3	19.1	194	6.81	13.2	110	33	2.7
1970	10,202	.005	169	121	5	29.6	140	11.86	16.6	84	32	3.1

TWENTY-YEAR SUMMARY

	260,942	.013	5,617	2,248	135	24.0	250	8.61	21.5	1,682	690	2.6

TABLE 21

GENERAL SOCIO-ECONOMIC CHARACTERISTICS
Big Horn County

<u>Industry of Employed Persons</u>

Agriculture, Forestry and Fisheries	837
Mining	282
Construction	323
Manufacturing	328
Railroads & Railway Express Service	103
Trucking Service and Warehousing	21
Other Transportation	49
Communications	33
Utilities & Sanitary Services	69
Wholesale Trade	81
Food, Bakery, and Dairy Stores	97
Eating and Drinking Places	139
General Merchandise Retailing	38
Motor Vehicle Retailing & Service Stations	84
Other Retail Trade	151
Banking and Credit Agencies	39
Insurance, Real Estate, and Other	36
Business and Repair Service	83
Private Households	58
Other Personal Services	104
Entertainment and Recreation Services	28
Hospitals	92
Health Services except Hospitals	76
Schools and Colleges - Government	312
Schools and Colleges - Private	41
Other Education and Kindred Services	28
Welfare, Religious, etc. (nonprofit)	22
Legal, Engineering & Misc. Profession	50
Public Administration	152
Per Capital Income of Persons	$2,716
Median Income	8,056
Percent under $3,000	12.8
Percent $10,000 and over	32.0
Number of Persons per Household	3.1
Number of Households	3,288

<u>Unemployment</u>

Civilian Labor Force: 3,916

Unemployed: 160

TABLE 21
(continued)

GENERAL SOCIO-ECONOMIC CHARACTERISTICS
Big Horn County

Labor Force - Age and Distribution by Sex

	Male	Female
14 and 15 years:	39.6	6.0
16 and 17 years:	48.5	22.8
18 and 19 years:	49.7	31.8
20 and 21 years:	81.0	31.3
22 to 24 years:	90.8	43.1
25 to 34 years:	95.6	38.6
35 to 44 years:	98.7	47.1
45 to 64 years	87.7	43.7
65 years & older:	35.4	14.5

Occupation Groups of Employed Persons -	Total
Professional, Tech., & Kindred Workers	407
Managers & Administrators, except Farm	394
Sales Workers	161
Clerical and Kindred Workers	355
Craftsmen, Foremen, & Kindred Workers	565
Operatives, except Transportation	235
Transport Equipment Operatives	139
Laborers, except Farm	242
Farmers and Farm Managers	447
Farm Laborers and Farm Foremen	360
Service Workers except Private Households	392
Private Household Workers	59

Occupation Groups of Employed Persons -	Female
Professional, Tech., & Kindred Workers	195
Managers & Administrators, except Farm	84
Sales Workers	107
Clerical and Kindred Workers	279
Craftsmen, Foremen, & Kindred Workers	26
Operatives, except Transportation	43
Transport Equipment Operatives	20
Laborers, except Farm	14
Farmers and Farm Managers	18
Farm Laborers and Farm Foremen	47
Service Workers except Private Households	293
Private Household Workers	59

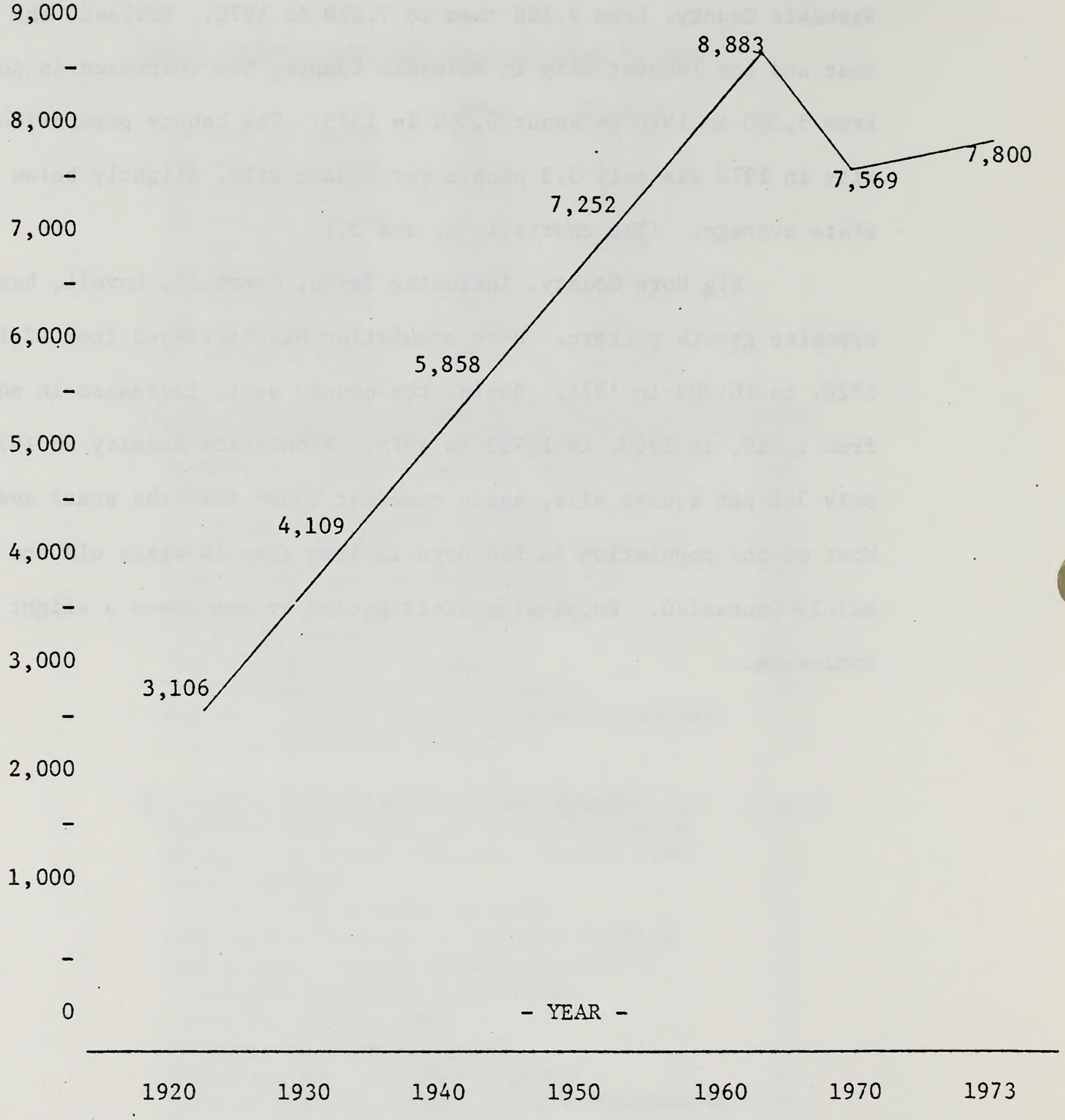
Unemployment Rate: 4.1%

Population

Since 1920 there has been a gradual increase of population in Washakie County, from 3,106 then to 7,570 in 1970. Worland, the county seat and the largest city in Washakie County, has increased in population from 5,500 in 1970 to about 6,000 in 1975. The county population density in 1970 was only 3.3 people per square mile, slightly below the 3.4 state average. (See charts 1, 2, and 3.)

Big Horn County, including Basin, Greybull, Lovell, has had an opposite growth pattern. Here population has decreased from 12,105, in 1920, to 10,202 in 1975. Basin, the county seat, increased in population from 1,319, in 1960, to 1,953 in 1975. Population density in 1975 is only 3.2 per square mile, again somewhat lower than the state average. Most of the population in Big Horn is less than 14 years old and is mainly Caucasian. Population distribution by sex shows a slight male dominance.

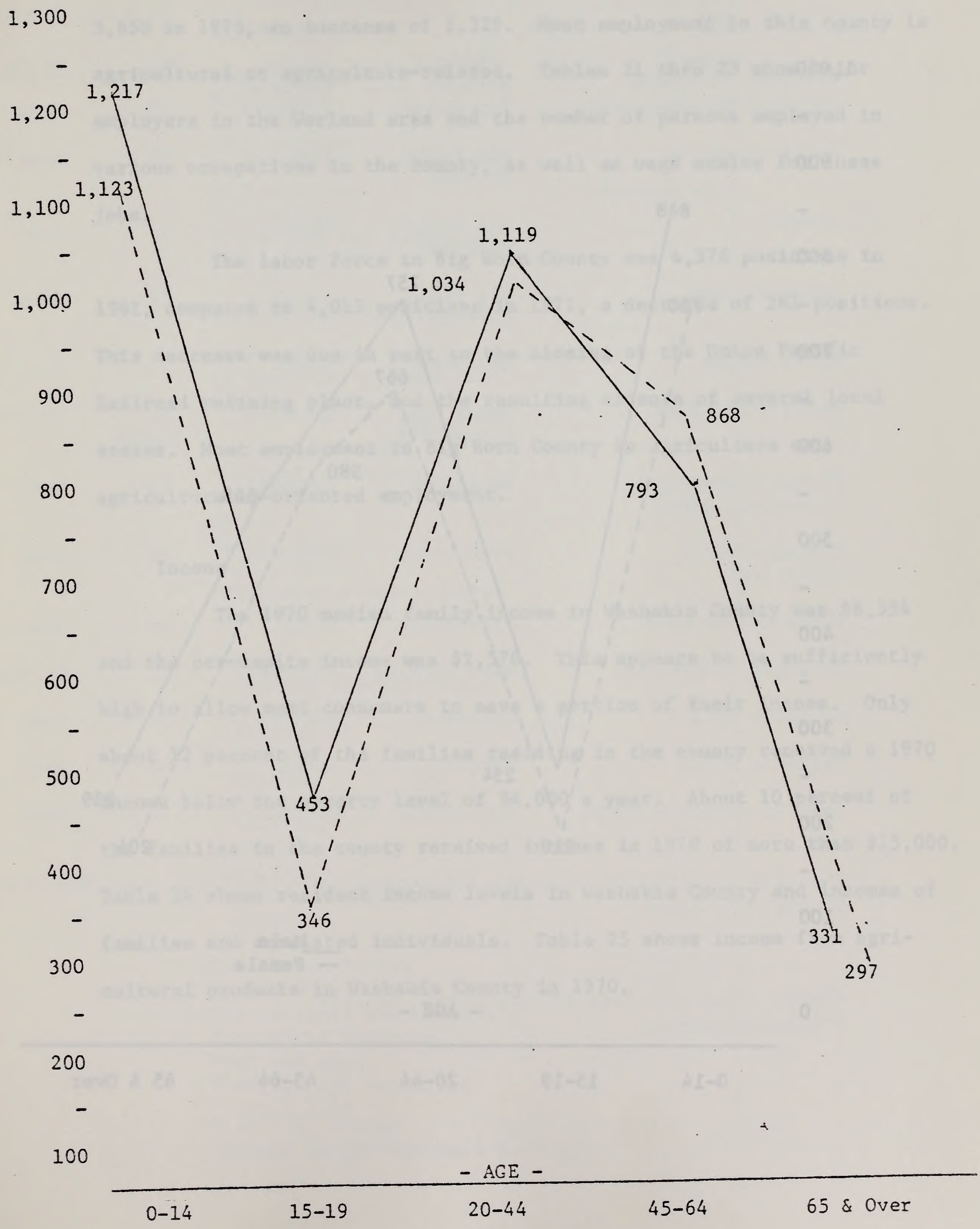
WASHAKIE COUNTY POPULATION CHART 1
1970



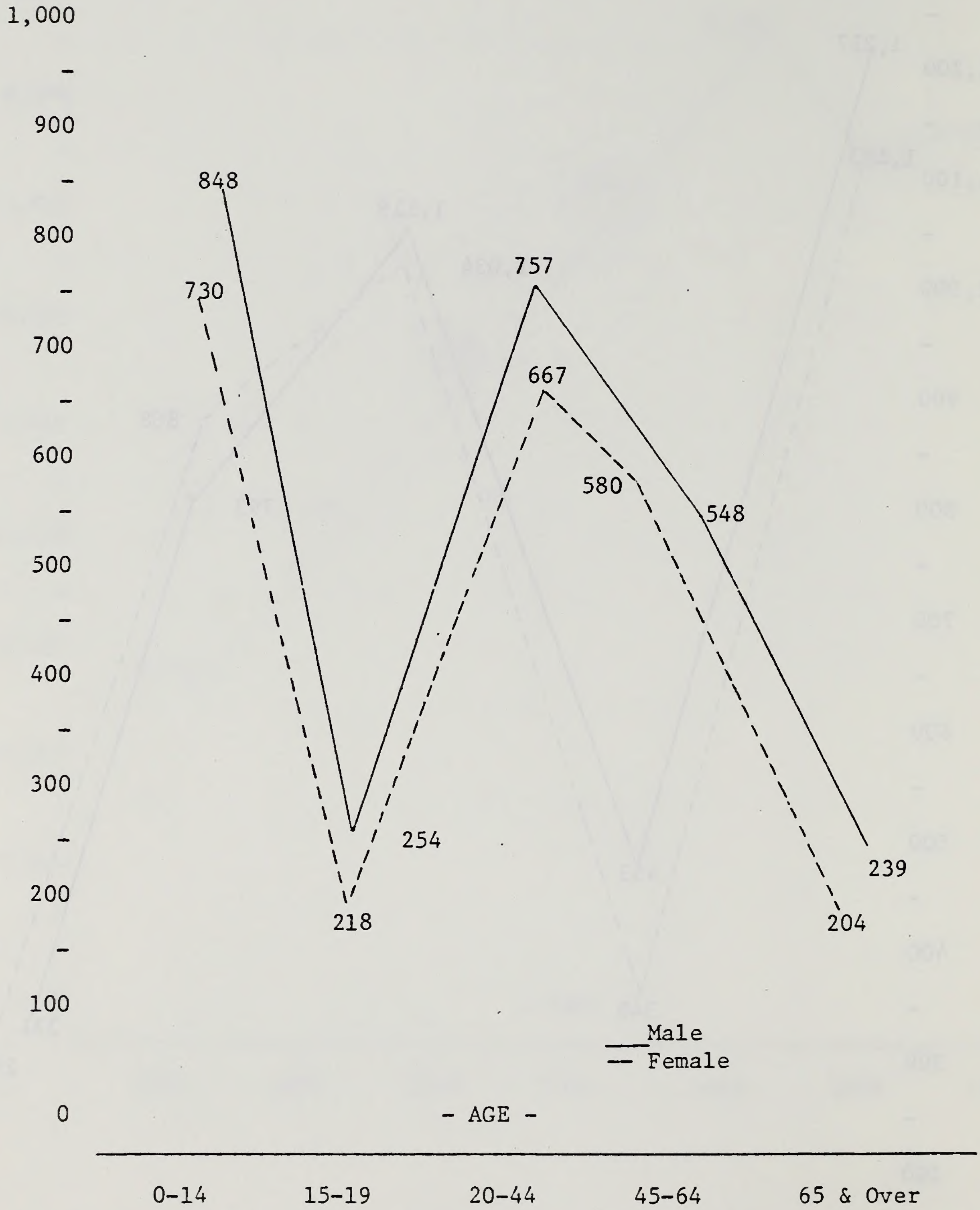
1970-1971

MALE & FEMALE POPULATION CHART 2

(County) Washakie



1970-1971
MALE & FEMALE POPULATION CHART 3
(CITY) WORLAND



Employment

The labor force in Washakie County was 2,421, in 1960, and 3,650 in 1975, an increase of 1,329. Most employment in this county is agricultural or agriculture-related. Tables 21 thru 23 show major employers in the Worland area and the number of persons employed in various occupations in the county, as well as wage scales for these jobs.

The labor force in Big Horn County was 4,376 positions in 1961, compared to 4,015 positions in 1971, a decrease of 261 positions. This decrease was due in part to the closing of the Union Pacific Railroad refining plant, and the resulting closure of several local stores. Most employment in Big Horn County is agriculture or agriculturally-oriented employment.

Income

The 1970 median family income in Washakie County was $8,354 and the per-capita income was $2,576. This appears to be sufficiently high to allow most consumers to save a portion of their income. Only about 12 percent of the families residing in the county received a 1970 income below the poverty level of $4,000 a year. About 10 percent of the families in the county received incomes in 1970 of more than $15,000. Table 24 shows resident income levels in Washakie County and incomes of families and unrelated individuals. Table 25 shows income from agricultural products in Washakie County in 1970.

Table 21

Major Employers in the Worland Area

Company	Product	Market	Emp.	Union
Freemont Beverages	Bottler	Regional		
Adminral Beverage Corp.	Pop Canner	7 States	35	None
Halliburton Co.	Oil Field Service	Regional	32	None
Dowell	Oil Field Service	National	17	None
Byron-Jackson	Oil Field Service	Local	12	None
Coors Barley	Beverage	Local	3	None
Holly Sugar Corp.	Sugar Beet Processing	National	40 350***	AFGM**
Kaycee Bentonite Processing Plant	Bentonite	Regional	13	None
Montana-Dakota Utilities	Production	Regional	30	None
Union Oil of Calif.	Production	Local	24	None
Triangle Packing Co.	Meat Packing	Regional	35	Teamsters
Mountain Bell	Telephone	Regional	50	Comm. Workers
Washakie Hotel	Service	Local	50	None
John E. Toohey & Assoc.	Architects	Regional	7	None

The 1974 unemployment rate was 290 persons or 7.1% of the total Washakie County work force.

**AGFM - American Federation of Grain Millers
***During campaign

Table 22

BUSINESS, PROFESSIONAL SERVICES
AVAILABLE IN WORLAND AND TEN SLEEP

Professional:	Wor.	T.S.
Anesthetists	2	
Architects	2	
Attorneys	5	
Chiropractor	2	
Dentists	5	
Orthodontists	service of 2	
Optometrists	2	
Physicians and Surgeons	5	
Veterinarian	3	
Business and Commercial:		
Accounting and Bookkeeping Agencies	3	
Ag Implement Dealers	5	
Apparel Stores--Men	1	
Women	4	
Appliance Stores	6	
Automobile Dealers	5	
Bakeries	1	
Banks	2	
Barber Shops	5	
Beauty Shops	6	1
Creameries & Dairy Stores	3	
Credit Bureaus	1	
Contractors--		
Buiding Specialities	1	
Earth Moving	4	
Electrical	3	
General	6	2
Heating	3	
Irrigation	1	
Painting	3	
Plumbing	3	
Roofing	1	
Sand and Gravel	2	
Steel	1	
Department Stores	6	
Drug Stores	3	2
Dry Cleaners and Laundry	1	
Employment Agencies	1	
Feed and Seed	3	
Florists and Nurseries	1	
Funeral Home	2	
Furniture Stores	4	
Grocery Stores and Meat Markets	5	1

Business and Commercial (continued):

Hardware Stores	3	1
Hotels (81 rooms)	2	
Insurance Agencies	12	
Jewelry Stores	2	
Liquor Stores	6	
Lumber Yards	3	
Machine Shops	2	
Motels	8 (134 units)	6 (68 units)
Music Stores	1	
Office Supplies	2	
Painting Shops	2	
Photography Studios	1	1
Real Estate Agencies	3	
Recreation Parlor	1	
Restaurants	11	4
Gasoline Service Stations	19	4
Sporting Goods Stores	1	
Taverns	7	2
Television and Radio Repair	4	
Theatres	2	
Transfer and Storage	3	
Variety Stores	3	
Welding Shops	4	

Table 23

Industry of Employed Persons and Occupation of Experienced Unemployed Persons For County

1970

Industry	Washakie County
Total employed, 16 years old and over	2,938
Agriculture, forestry, and fisheries	532
Mining	233
Construction	165
Manufacturing	253
Furniture and lumber and wood products	10
Metal industries	--
Machinery, except electrical	10
Electrical machinery, equipment, and supplies	--
Transportation equipment	--
Other durable goods	18
Food and kindred products	118
Textiles and fabricated textile products	5
Printing, publishing, and allied industries	57
Chemicals and allied products	5
Other non-durable goods (incl. not specified mfg. indus.)	30
Railroads and railway express service	5
Trucking service and warehousing	84
Other transportation	34
Communications	70
Utilities and sanitary services	83
Wholesale trade	69
Food, bakery, and dairy stores	45
Eating and drinking places	117
General merchandise retailing	65
Motor vehicle retailing & service stations	94
Other retail trade	141
Banking and credit agencies	30
Insurance, real estate, and other finance	57
Business & repair service	70
Private households	20
Other personal services	117
Entertainment and recreation services	10
Hospitals	63
Health services, except hospitals	53
Elementary, secondary schools & colleges -- government	203
Elementary, secondary schools & colleges -- private	37
Other educational & kindred services	--
Welfare, religious and non-profit membership organizations	--
Legal, engineering, and miscellaneous professional services	69
Public administration	175

Source: County data taken from General Social and Economic Characteristics 1970 Census of Population, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1971, pp. 52-155.

Table 24

Resident Income Levels in Washakie County

1970 Median Family Income	$8,354
Percent of families with income less than poverty level in 1970	12%
Percent of families with income of $15,000 or more in 1970	10%

Incomes of Families and Unrelated Individuals

All Families		1,962
Less than $1,000		39
$1,000 to $1,999		57
$2,000 to $2,999		109
$3,000 to $3,999		128
$4,000 to $4,999	Poverty Level	132
$5,000 to $5,999		143
$6,000 to $6,999		146
$7,000 to $7,999		170
$8,000 to $8,999		161
$9,000 to $9,999		182
$10,000 to $11,999		305
$12,000 to $14,999		191
$15,000 to $24,999		144
$50,000 or more		--

Table 25

Income
Agricultural Products
Washakie County 1970

Livestock		
All cattle & calves		$37,840
Milk cows		172
Sheep & lambs		111,091
Hogs & pigs		1,294
Chickens		2,481
Livestock Sold Alive		
Cattle & calves		28,715
Hogs & pigs		86,599
Sheep & lambs		
Livestock & Poultry Sold		
Chicken eggs (dozen)		75,000
Milk & cream (dollars)		$38,245
Value of Farm Products Sold		
All farm products sold		$10,204,211
All crops sold		3,257,201
All livestock & products		6,947,010
Crops		
Corn harvested for grain		2,260 acres
		36,886 tons
Oats		1,593 acres
		84,440 bu.
Barley		7,568 acres
		487,244 bu.
Alfalfa		11,427 acres
		34,417 tons
All other hay		2,290 acres
		3,355 tons
Dry beans		800 acres
		16,000 (100 lb. bags)
Sugar beets	(1968)	8,845 acres
		159,991 tons
	(1969)	10,139 acres
		198,885 tons
	(1970)	12,700 acres
		285,000 tons

Housing

In Washakie County there are 1,600 houses with approximately 80 percent owner-occupancy rate. This is typical of the state. As of June 1975, there were 16 vacant houses in the county, for a one percent vacancy rate. Average cost of a two bedroom house with 830 square feet of living space is $24,000 to $26,000. For a three bedroom home with 1,200 square feet, the average purchase price is $35,000 to $37,000.

Average monthly rent is from $110 to $145 for a two bedroom home, and from $145 to $200 a month for a three bedroom home. A condominium and an eight-plex structure are under construction in Worland and will be completed by August 1975. In 1971 the volume of residential construction in Worland was 17 permits of $307,000 value. Table 26 describes housing occupancy in Washakie County.

Table 26

Type of Housing Occupancy in Washakie County

	City of Worland	Washakie County
Total Housing Units[1]	1,750	2,659
Vacant - Seasonal & Migratory[1]	6	77
All Year-Around Housing Units[1]	1,744	2,582
Owner Occupied Housing Units	1,091	1,541
Renter Occupied Housing Units	547	821
Median Value of Owner Occupied Units	$27,400	$24,100
Median Monthly Contract Rent of Renter Occupied Units	$140	$138
Vacant for Sale Only or for Rent	106	N/A
Vacant: For Sale Only	12	N/A
Vacant: For Sale Only, but for sale less than 6 months	11	N/A
Median Price Asked	$24,500	N/A
For Rent	$140	N/A
For Rent: Vacant Less than 2 Months	41	N/A
Median Rent Asked	$110	N/A

1. Source: General Housing Characteristics: 1970 Census of Housing, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., June 1971, pp. 20 through 52.

Schools

Washakie County has four grade schools, one junior high and one senior high with a total student enrollment of 2,022. Worland has three grade schools with an enrollment of 927, one junior high with 472 students and one senior high with 445 students. Ten Sleep has a grade school with 120 pupils and a high school with 58 pupils.

Big Horn County has 12 grade schools, 2 middle schools and 8 high schools with a total student enrollment of 2,886. Greybull has an elementary school with 496 students and a high school with 230 students. Shell has an elementary school with eight students, and Emblem has an elementary school with five students. Lovell has an elementary school with 349 students, a middle school with 182 students and a high school with 279 students. Basin has a grade school with 200 students, a middle school with 50 students and a high school with 165 students. Manderson has a grade school with 85 students; Hyattville has a grade school with 30 students. The Manderson/Hyattville high school, located in Manderson, has 65 students. Burlington has a grade school with 97 students and a high school with 63 students. Otto has a grade school with 48 students; Byron has a grade school with 135 students and a high school with 62 students. Cowley has a grade school with 95 students and a high school with 52 students. The Deaver/Frannie grade school, located in Frannie, has 89 students and the Deaver/Frannie high school, located in Deaver, has 51 students.

Health and social services

Health services are limited in Washakie and Big Horn Counties with those available located at Worland, Lovell and Greybull. In 1962 the 40-bed Washakie County Memorial Hospital was completed in Worland.

It was built on a plan designed for constructing additions in future years at minimum cost. Five physicians on the staff include two surgeons. A privately owned medical clinic building was constructed in 1965, providing modern offices for private physicians. A 76-bed private nursing home was completed in 1970. Both air and ground ambulance service are available.

Physicians consult with specialists in regional metropolitan areas regarding patients requiring specialized medical services unavailable in the Basin. When such service is required it is not uncommon for the patient to go to Casper, Billings, or Denver for treatment. Health services in Washakie County also include five dentists, an orthodonist, two chiropractors, and scheduled visits by a podiatrist.

Lovell, in Big Horn County, has a hospital with 15 beds, staffed by two doctors and a dentist. Lovell also has a 12-bed nursing home. The South Big Horn County Hospital, between Greybull and Basin, has 30 beds and is staffed by two doctors and two dentists. Tables 27 and 28 show the health services and facilities available in the two counties.

Water and sewage

Municipal water for Worland is taken from the Big Horn River. The system has a capacity of four-million gallons for a 24-hour period. Peak usage is three-million gallons in 24 hours, normally occurring in July and August when domestic water needs are greatest. Some small industries in Washakie County have found satisfactory ground water from wells 50 to 300 feet deep. Basin also takes their municipal water from the Big Horn River. The municipal system has been modernized in the last three years and is adequate for projected growth through 1990. Greybull obtains its water from Shell Creek and Manderson from a 1200 foot deep well.

Both cities have sewer lagoon systems, with sewers emptied into oxidation ponds outside city limits. People living outside the cities depend on wells for domestic water and septic tanks for sewage disposal. The poor quality of ground water near the project area forces a few home owners to haul water from the nearby communities and store it in cisterns for domestic use.

Table 27

WASHAKIE COUNTY
Population: 8,269

HEALTH SERVICES

Number of Physicians:	7	**Physician Speciality**	
Average Age:	51.8		
Number of Dentists:	6	General Practice:	5
		Surgery:	1
Number of R.N.'s:	30 (employed)	Unknown:	1
	5 (unemployed)		
Number of L.P.N.'s:	7 (employed)		
	2 (unemployed)		

Number of School Nurses:	2
Number of P.H.N.'s:	1
Number of School Health Aides:	0
Number of Pharmacists:	10
Number of Optometrists:	3
Number of Dental Hygienists:	0
Number of Veterinarians:	5

Population Ratios

Dentists:	1 per 1,378
Physicians:	1 per 1,181
R.N.'s	1 per 276
L.P.N.'s	1 per 1,181
Pharmacists:	1 per 827
Optometrists:	1 per 2,726

HEALTH FACILITIES

Personal Care:	0	Hospitals:	1
Nursing Care:	1	Beds:	36
Pharmacies:	2	Bassinets:	10
Dental Clinics:	5	Mental Health Centers:	0
Clinical Labs:	1	Ambulances:	4

TABLE 28

BIG HORN COUNTY
Population: 10,000

HEALTH SERVICES

Number of Physicians:	5	
Average Age:	52.1	
Number of Dentists:	5	
Number of R.N.'s:	29 (employed)	
	10 (unemployed)	
Number of L.P.N.'s:	11 (employed)	
	4 (unemployed)	
Number of School Nurses:		3
Number of P.H.N.s:		0
Number of Home Health Aides:		0
Number of Pharmacists:		10
Number of Optometrists:		1
Number of Dental Hygienists:		0
Number of Veterinarians:		2

Physician Speciality	
General Practice:	4
Gynacology:	1

Sanitation Coverage by Dist. #2 - Worland

Population Ratios

Dentists:	1 per 2,000
Physicians:	1 per 2,000
R.N.'s	1 per 345
L.P.N.'s:	1 per 909
Pharmacists:	1 per 1,000
Optometrists:	1 per 10,000

HEALTH FACILITIES

Nursing Care:	2	Hospitals:	2
Pharmacies:	5	Beds:	60
Dental Clinics:	3	Bassinets:	20
Clinical Laboratories:	2	Mental Health Centers:	0
Ambulances:	5		

Law enforcement

Various city police and county sheriff departments as well as units of the state highway patrol provide the local law enforcement. Worland has a full time police department, including a chief, assistant chief, six officers and five radio operators. The department is equipped with two-way-radio patrol cars. The Washakie County sheriff's department includes a sheriff and a deputy. County law enforcement shares jail facilities with the city.

Fire protection

Fire protection is provided in both counties by volunteer fire departments. Both counties are well organized and well equipped, and both have some fire trucks standing by on ranches in rural areas.

Churches

Worland has 19 churches, with at least three denominations having two churches, one of which is for Spanish-speaking citizens. Ten Sleep has three churches. Byron, Cowley and Shell each have one church; Basin has six, Lovell, nine, and Greybull, eleven.

Communications

The Worland newspaper is published five days a week. Basin, Greybull and Lovell each have a newspaper also. Daily newspapers from Casper and Billings are delivered throughout the Basin on the day published. Worland also has a radio station and community television of Wyoming serves Worland with cable television.

Transportation

The Worland airport, about three miles south of the city, has a 7,000 foot asphalt runway. It has FAA flight service 24 hours a day and an instrument approach facility. Frontier Airlines provides commercial air service to this airport twice daily. Greybull and Lovell also have airports, and charter flight service is available in Worland and Greybull.

The Burlington Northern railroad provides Worland, Basin, Greybull and Lovell with freight service daily. This is a north-south line with connections to regional centers and tie-ins to the east-west transcontinental link. Additional service is added during the beet harvest season, October through January.

Continental Trailways bus system provides all-year passenger and package express service to the cities, with a scheduled stop northbound and southbound daily. Burlington Northern Transport Inc. and Salt Creek Freightways provide motor carrier service and have freight docks in Worland. There are also local and regional trucking firms serving the oil and gas fields and agricultural needs.

ANTICIPATED IMPACTS

Non-Living Components

Air

Dust created by the project will have two effects. That raised by machine activity and vehicles will be visible in the immediate area but will not significantly affect air quality in the general area. Dust raising activities will be greatest during construction and land clearing in the development phase, and during farming operations which require soil disturbance. Typical dust-raising farm activities are fall plowing, cultivation and harvesting. Hauling beets during harvest will cause increased dust for a short period each year.

The second effect will result from the removal of existing vegetation and exposure of soil to wind erosion. Land cleared for pipelines and powerlines will contribute dust during windy periods for several years until revegetated. Initial land clearing during development would expose large areas to erosion for a period of a few months. The amount of dust from such clearing would depend on the time of year the clearing is done. If done during a dry, windy season, the impact would be greater than at other times of the year.

The practice of winter fallowing would result in removal of vegetative cover from early fall to mid-April. This would allow dust to be discharged from fall plowing until the ground freezes, and from thaw until the first irrigation. These two periods are commonly subject to high winds and are often quite dry. Significant amounts of wind-borne dust would be added to the air during this period, reducing air quality.

The extent of air contamination resulting from removal of vegetation would be directly dependent on weather conditions. In dry seasons with winds associated with frontal movements and thunderstorms, air clarity will be noticeably lessened in the study area. This might be noticeable as far south as Thermopolis and north as far as Lovell. In addition, under very windy conditions vision may be obscured by dust along Highway 433, making driving hazardous. This condition is expected to occur less than five days a year, in the early spring. Dustfall will occur on the downwind peripheries of the fields and may be an inconvenience to homeowners within a mile downwind in the form of dust in houses and on clothing. There will not be sufficient quantities to be a hazard to health.

During the irrigation season, the amount of dust discharged into the air from the area would be less than is now being discharged, improving the quality of the air. This period is from early May through September.

Carbon monoxide and unburned hydrocarbons would be discharged into the air by vehicles and farm equipment in small quantities. Concentrations would not be sufficient to cause a significant impact.

The practice of burning crop residues, fencelines, and waste areas would cause air contamination by smoke. The smoke would be visible only in the near vicinity and would not have a significant effect on the study area as a whole. Hazards to driving might be created by impaired visibility on portions of Highway 433 for short periods. Smoke would be a driving hazard for a few hours each year.

Summary

The most significant impact on air would be increased dust from plowed fields, when ground cover is removed and the soil is dry. The amount of dust is directly affected by soil moisture and wind speed. Impacts would be periodic throughout the life of the project, when winds are high and soil moisture is low. This is typical of farms currently in this area.

Land

Land-use compatibility

Disposal of the project lands under the Desert Land Act would cause the loss of 1,954 animal-unit-months of livestock grazing. A portion of this loss would be compensated for by grazing crop-aftermath. However, individuals now using the area may not be able to realize the benefit of this compensation, since this type of grazing is limited to fall use, and would not compensate for grazing losses at other times of the year. Some range users may be forced to reduce livestock numbers or secure other pasturage as a result.

The entire project area is under oil and gas leases. There are six producing wells on the project. Exploration for and production of oil and gas will continue, and may conflict with farming activities. Wells, pipelines, access roads and so will take some farmland out of production. These structures would impede the movement of sprinkler lines and the farmer would have to detour around them when operating farm equipment. It is not known how long these wells would produce. When production ceases the structures would be removed and the land returned to agricultural production.

Existing oil and gas pipelines are generally too shallow to be plowed over and thus would preclude some agricultral production. Portions of these pipeline rights-of-way would be used as farm roads, minimizing the loss. One of the most significant of these pipelines is the Montana-Dakota Utilities line which traverses the area from north to south, crossing about seven miles of proposed farmland. Map 2 shows the location of this and other pipelines.

Existing gravel pits in the project area would be excluded from desert-land entry and could supply material for new roads. Additional pits would be needed for the anticipated road construction and would probably be located on lands not suitable for DLEs.

Existing recreation use is not compatible with the proposal and will be changed greatly. This change would result from the change in land ownership from public to private, and the resulting loss of unrestricted access.

The change from a primary use for grazing to irrigation agriculture would greatly increase production on the land. This would create a significant increase in the flow of goods and services in nearby communities, benefiting not only the agriculture industry but all businesses which furnish support to it.

Summary

The use of the land will change from semi-arid grazing land to irrigated farmland. Present uses will nearly all be changed to a certain extent by the project.

Soil

In discussing probable impacts, the soil can be considered in three major groups. The first is of the Uffens soil association. These soils are unique to the Basin and require intensive irrigation-water management. Initially these require very heavy irrigation, to move dissolved salts below the root zone of growing plants. This must be followed by light irrigation at intervals, to cause an upward movement of gypsum into the plow layer. Infiltration of gypsum causes these clay soils to "flocculate" or open up, and improves water intake and the availability of nutrients. Over-irrigation has to be done periodically to move the sodium salts from the root zone of the plants. This over-irrigation, with the drainage characteristics of the study area, would cause areas of perched water tables which would make very wet areas in the fields and cause low production on as little as 260 or as much as 2,940 acres. It would also cause surface accumulation of sodium in the fields over these perched water tables. Salts moved out by this excessive water are likely to seep out where underlying impervious structures are near the surface. This would increase the salinity of runoff from the area, thereby eventually increasing salinity in the Big Horn River.

Cultivation of this soil would turn under the surface layer and increase the size and number of saline or slick spots, and subsequently deteriorate the soil structure in these spots. The high alkalinity of this soil, in the 8 to 9.4 pH range, would affect available nutrient and trace elements, and thus require great inputs of fertilizer. In some areas it might require soil amendments such as gypsum or sulphur to counteract the alkalinity of the soil.

The second major association is the Persayo series. This soil is typically very-heavy clay and quite shallow, creating serious problems for irrigation management. The shallow depths would allow a maximum of two inches of available water at field capacity, after irrigation. This low field capacity would necessitate frequent irrigation to replenish soil moisture lost through evapotranspiration. The shallow depth to bedrock under these soils would create a perched water table at a depth of 12 inches or less, well within the plow layer. This perched water table would act as a restrictive layer limiting nitrogen availability and root respiration.

Frequent and light irrigation would create a rapid surface accumulation of sodium and calcium salts deposited by the action of evaporation and capillary action. Soluable calcium and sodium on the surface would further reduce permeability of the soil and increase slick spots on the surface, creating highly-saline seeps at the margins of slopes. These areas would have a very low productive capacity and would amount to as little as 270 acres or as much as 980 acres.

High amounts of sodium ions in the soil would cause a fertility problem when irrigated because the sodium replaces such micro-nutrients as iron, copper, manganese and nickel. In addition, phosphorous availability would be low. These micro-nutrients are as necessary for plant growth as the major nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium and sulfur.

The perched water table will result in anaerobic conditions, reducing nitrogen compounds. Available nitrogen compounds will be reduced to atmospheric nitrogen, thus removing this vital nutrient from availability and causing low production.

Water seepage from these fields after irrigation might create a hazard to downslope fields, and the perched water tables may cause areas of low production in the fields themselves. This seeping water would be a complex solution of sodium, calcium and magnesium salts of CO_2, HCO_3 and nitrogen compounds. It would be high in pH and contain nitrogen compounds which readily oxidize by microbial activity to NO_2 and NO_3 compounds. These nitrogen compounds are hazardous to man and animals in drinking water, and prolonged drinking by wildlife and livestock might result in death. Therefore, such water must be considered a pollutant and not be allowed to mix with drinking water for animals or man.

The third major group is of the Enos associations. These soils have a light texture with 50 to 75 percent sand. They do not have the necessary structure for holding water, allowing it to pass through quite rapidly. They are further affected by sodium salts. Therefore, much of the water applied to the surface through sprinkler irrigation would move downward through the soil quite rapidly, carrying sodium with it. If water applications are continued, the water will move downward to an impermeable layer. Water would then follow this layer in the direction of the slope. Where the impermeable layer approaches the surface, this water would emerge as seeps, creating deposits of sodium salts. If water application rates are too light to maintain soil moisture, evaporation and capillary action would cause accumulations of salt on the surface causing low crop production. Therefore, proper application rates will be necessary to prevent either excessive seeps or salt problems on the surface.

Because of the lightness of these soils and their low aggregation characteristics they are very susceptible to wind erosion. This problem is increased by cultivation and removal of vegetation. Under windy conditions, when vegetation is removed such as during winter fallowing when fields are not frozen, loss of soil will occur. The soil may be redeposited downwind of the fields in the form of sand dunes.

In general, the structure and water intake rate of soils in the study area would be improved by cultivation, the addition of organic matter in crop residues, and the use of various fertilizers and soil amendments. Should the project fail, revegetation of disturbed areas, while difficult, could be accomplished using species adapted to the arid conditions common to the area. With proper water management, surface salt conditions will be improved in the area as a whole, although salt concentrations in seep areas will be increased.

Water

Introduction

Irrigation of 20,718 acres would have a direct effect on the Big Horn River. Withdrawal of 63,000 acre-feet of water a year would at times significantly reduce the River's flow. Dissolved solids and sediment would be increased. The temperature of the river would also change.

Hydrologic cycle

The hydrologic cycle would be affected. Sprinkler irrigation and increased vegetation during the summer would cause increased evapotranspiration. We estimate this predicted increase to be between 40,000 and 45,000 acre-feet of water a year. Other than increasing humidity in the irrigated fields, this evapotranspiration would have little effect on weather conditions or climatic factors.

Ground water supplies would also be directly affected by the project. Some irrigation water would flow downward through the soil horizons, recharging deeper ground water supplies. The amount of recharge would be small. Ground water would also recharge alluvial material in the Big Horn River valley. Total recharge of up to 12,600 acre-feet a year would occur, largely through underground flow. Water wells might be drilled in the area for domestic use. The amount of water thus withdrawn would be small.

Sediment load

An increase in sediment in the River would result from three project actions: general construction, farming, construction of river diversions.

In the construction period, land would be cleared of vegetation and the soil would be disturbed by the installation of pipelines, pumps, roads and so on. These actions would make the land more susceptible to erosion. Runoff from thunderstorms and other precipitation would transport this sediment to the river. Areas along the river where the pumping plants are installed would also contribute sediment.

The construction period would be temporary, lasting at most three years. Vegetation would begin to recover in most areas in from three to five years. Increased sedimentation from construction would be short lived. During construction, sediment in the river would increase less than half of one percent above the present sediment load.

Sprinkler irrigation would not send much sediment to the River. When properly managed, sprinkler irrigation produces no effective runoff to cause erosion. Underground water would seep into natural drainages, eroding some soils. Very little sediment carried by these seeps would reach the River. Expected farming practices include leaving the fields fallow from fall until spring. This increases the susceptibility of such lands to erosion. Because of spring and early summer storms, these lands might contribute more sediment than they now do. This increase in erosion, however, would have little overall effect on the sediment load of the River.

Natural drainages such as Cottonwood, Gooseberry, Fifteen Mile and Ten Mile contribute more than a million tons of suspended sediment yearly to the River. Sediment from the proposed project would increase the present annual sediment load in the River by less than 0.1 percent.

Construction of temporary diversion dams during the irrigation season would stir up river sediment. Earth moving machines would work in the riverbed during low-flow, piling up riverbed material. The River would be affected by these dams an average of 27 days an irrigation season. Construction would increase turbidity, with both fine and coarse sediments. Larger sediments would be deposited within a few hundred yards downstream. Fine sediments would stay in suspension for many miles. The actual amount of increased turbidity cannot be predicted. Return flow from irrigation, plus the settling out of heavier sediments, would diminish downstream effects of the dam. Thus the dams are expected to have only a local effect on sediment load in the River.

Some changes in the River channel would be caused by the earth moving machinery. These changes would be minor and temporary. High water would wash away any such channel changes.

Dissolved solids

Soluable salts on proposed project lands would be partially leached by irrigation water. This water would migrate downward toward the valley. Little subsurface flow would enter the Big Horn Canal during the irrigation season. In the non-irrigation season, however, some water would seep into the canal, depositing soluable salts. These deposits would be flushed out to the River in the spring, when the canal is reopened. This should cause no adverse effects to irrigators on the canal.

However, since water supplies are presently marginal in meeting sulfate parameters for public water supplies, the return irrigation flow, coupled with the river low flow may cause a concentration of sulfates such that Basin may not meet public drinking water standards without demineralization treatment.

Subsurface flow would also reach the River within a few years after irrigation began. Additional dissolved solids reaching the river through underground flow would have a minor effect on the total of dissolved solids carried by the river.

The possibility of dissolved solids reaching the Canal or River in significant quantities depends largely on what water management practices were used. Runoff from irrigation or natural precipitation could add measurable amounts of dissolved solids. Wise water-management practices are expected, due to the cost of pumping the water. Runoff from natural precipitation is infrequent in the area. The amount of dissolved solids reaching the canal or River, therefore, would be low and have a very minor impact on the River.

The concentration of dissolved solids during periods of low flow cannot be predicted. Return-flow from present irrigation would make up a major part of the stream flow during these times. Concentrations of dissolved solids are generally higher in return flows. Limited water quality data taken at Worland however, reveals no major increase in dissolved solids during reduced flow. The town of Basin's municipal water supplies would be most affected by any change in water quality.

Chemicals

Application of various herbicides, pesticides and fertilizers should not affect the Big Horn Canal or the River. These chemicals, however, do present a potential for environmental damage through misuse.

Solid debris

Some solid debris might be discarded into the River during pumping-plant construction. This would be temporary and would not have a significant impact on the river.

Coliform contamination

Some local coliform contamination might occur from improper sewage facilities associated with homesites. Livestock and wildlife would also contribute to this situation. Water wells or stock ponds could become polluted. Problems with coliform contamination should be minor and localized.

Temperature

During the peak irrigation season, July and August, diversion of water at the pumping plants would reduce streamflow and increase the River's susceptibility to temperature variations. Based on existing surface-water data, we estimate the highest stream temperatures to be about 27° to 28° C. Lowest stream temperatures will not change.

Average monthly temperatures would be about 2° to 4° C. higher during the irrigation season, directly below the pumping plants. During the non-irrigation season, average monthly temperatures would not change. Minimum flows in the river below any of the river diversion pumps would be 100 cfs. Generally, there would be very few noticeable river depletions.

Supply

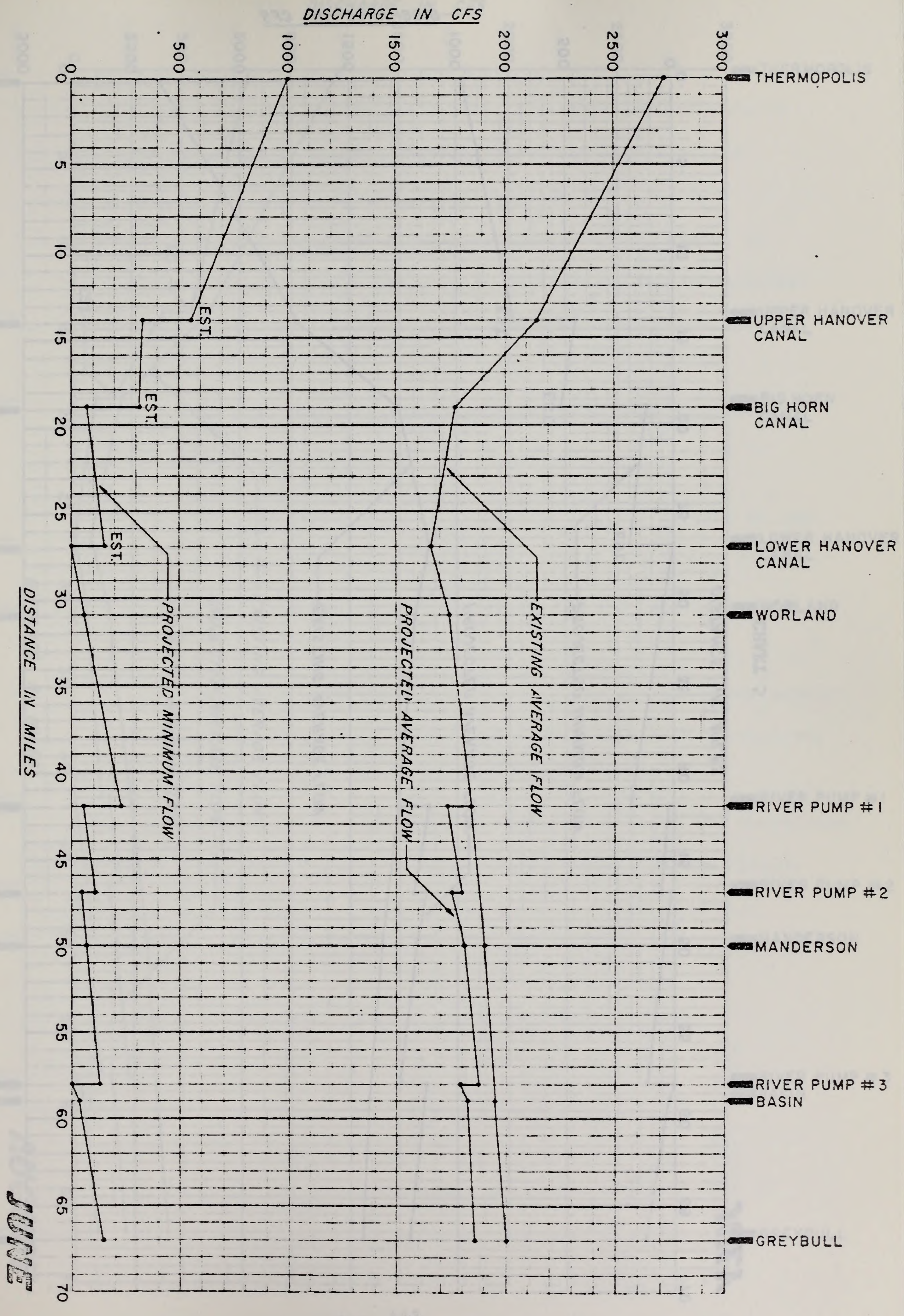
In June, irrigation requirements increase. An average discharge of 240 cfs would be needed. Peak requirements would reach 365 cfs. Chart No. 4 illustrates the current average discharge at various stream points, and projected average discharge once the proposed project were in operation. The bottom line on the graph shows projected minimum flows. (It is important in this analysis to identify low flows that will occur, since these might be critical for irrigation, wildlife, recreation, and so on.) River flow during June is usually high with runoff from mountain snowpacks.

In particularly dry years minimum flow below the second and third pumping plants would be less than 60 cfs. This condition would occur up to 10 percent of the time. The entire flow may be diverted at one of the river pumps about two percent of the time in June.

Water requirements peak in July. An average discharge of 320 cfs would be needed. Peak demand would be 375 cfs. Chart No. 5 illustrates current and projected average discharge at various locations. The projected minimum flow is also shown. Forty percent of the time (during low flows) discharge at Manderson is predicted to be 75 cfs and at Basin 45 cfs. Flow at the river pumping plant during these times would be near zero. An estimated 20 to 25 percent of the time, flow below the second and third pumping plants would be less than 10 cfs, making the stream bed "dry." Return flow from existing irrigation would replenish the River further downstream. The exact rate of replenishment cannot be predicted. However, a flow of 50 cfs could be expected within three miles downstream from the river diversions.

Irrigation requirements would decline in August to an average of 210 cfs. Peak requirements would be 360 cfs. Chart No. 6 shows the average current and projected discharge. The minimum projected discharge is also shown. River flow at Manderson and Basin would be low throughout August. At the second and third pumping plants, flows less than 50 cfs could be expected up to 40 percent of the time.

In September, water requirements would again be reduced to an average of 105 cfs. Peak demand would be 230 cfs. River flow during September is generally low. Irrigation needs, however, are equally lower during this period. Flows less than 50 cfs are infrequent. No shortages should occur. Chart No. 7 shows the average current and projected discharge.


DISCHARGE IN CFS
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DISTANCE IN MILES
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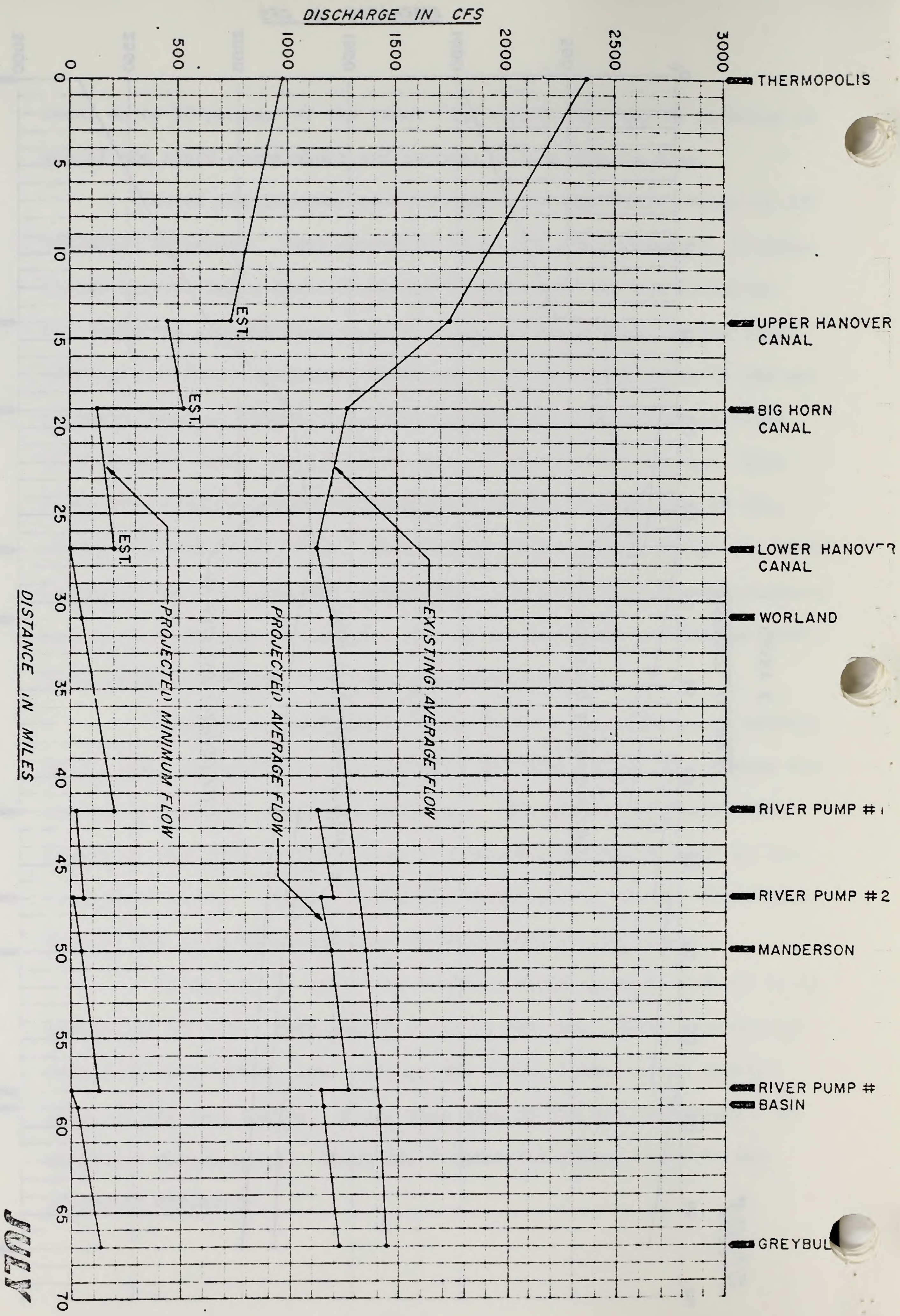
65
70
THERMOPOLIS
UPPER HANOVER CANAL
BIG HORN CANAL
LOWER HANOVER CANAL
WORLAND
RIVER PUMP #1
RIVER PUMP #2
MANDERSON
RIVER PUMP #3
BASIN
GREYBULL
EST.
EST.
EST.
PROJECTED MINIMUM FLOW
PROJECTED AVERAGE FLOW
EXISTING AVERAGE FLOW
JUNE

CHART 4



DISCHARGE IN CFS
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UPPER HANOVER CANAL
BIG HORN CANAL
LOWER HANOVER CANAL
WORLAND
RIVER PUMP #1
RIVER PUMP #2
MANDERSON
RIVER PUMP #
BASIN
GREYBULL
EST.
EST.
EST.
PROJECTED MINIMUM FLOW
PROJECTED AVERAGE FLOW
EXISTING AVERAGE FLOW
DISTANCE IN MILES
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JULY

CHART 5

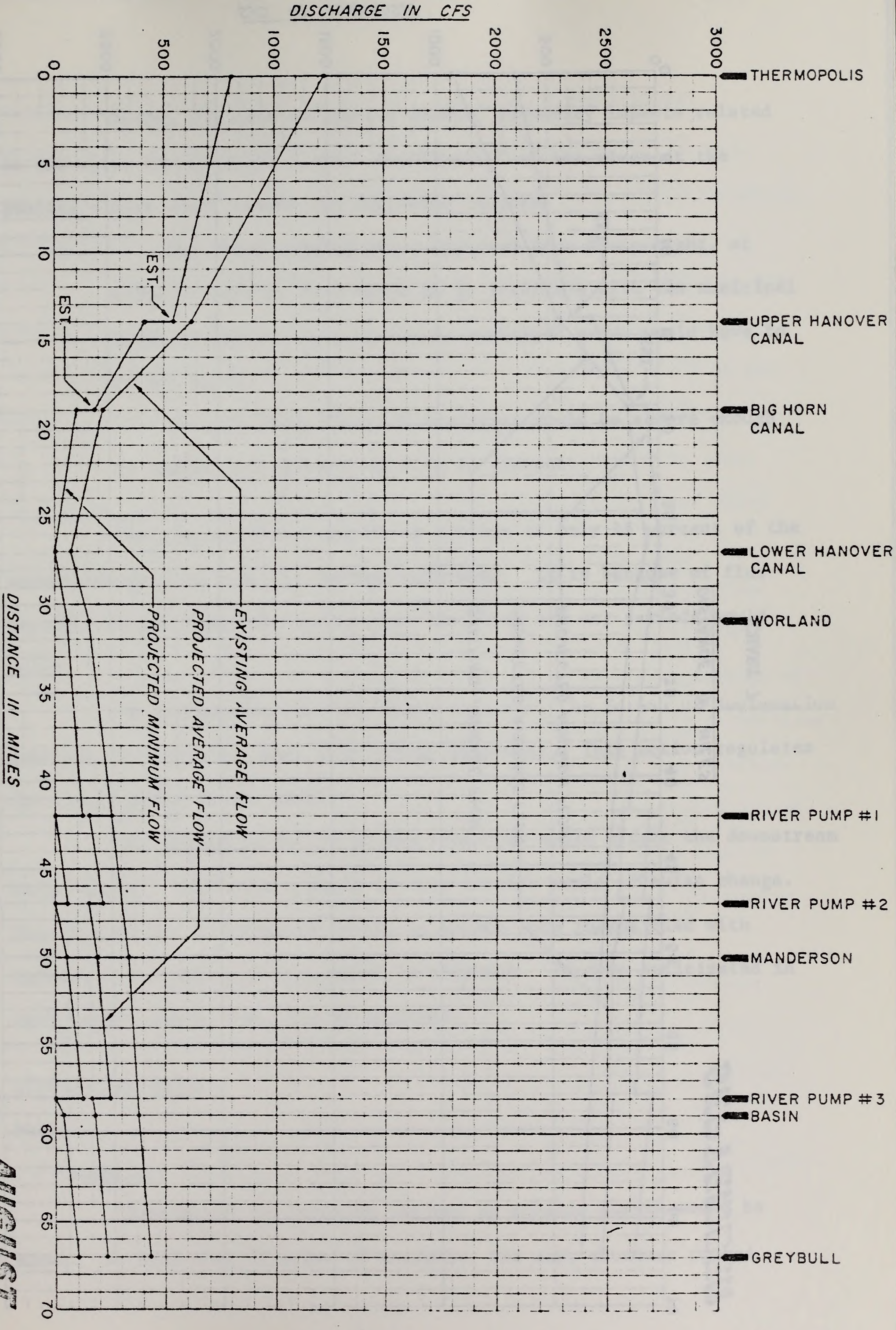

CHART 6

AUGUST

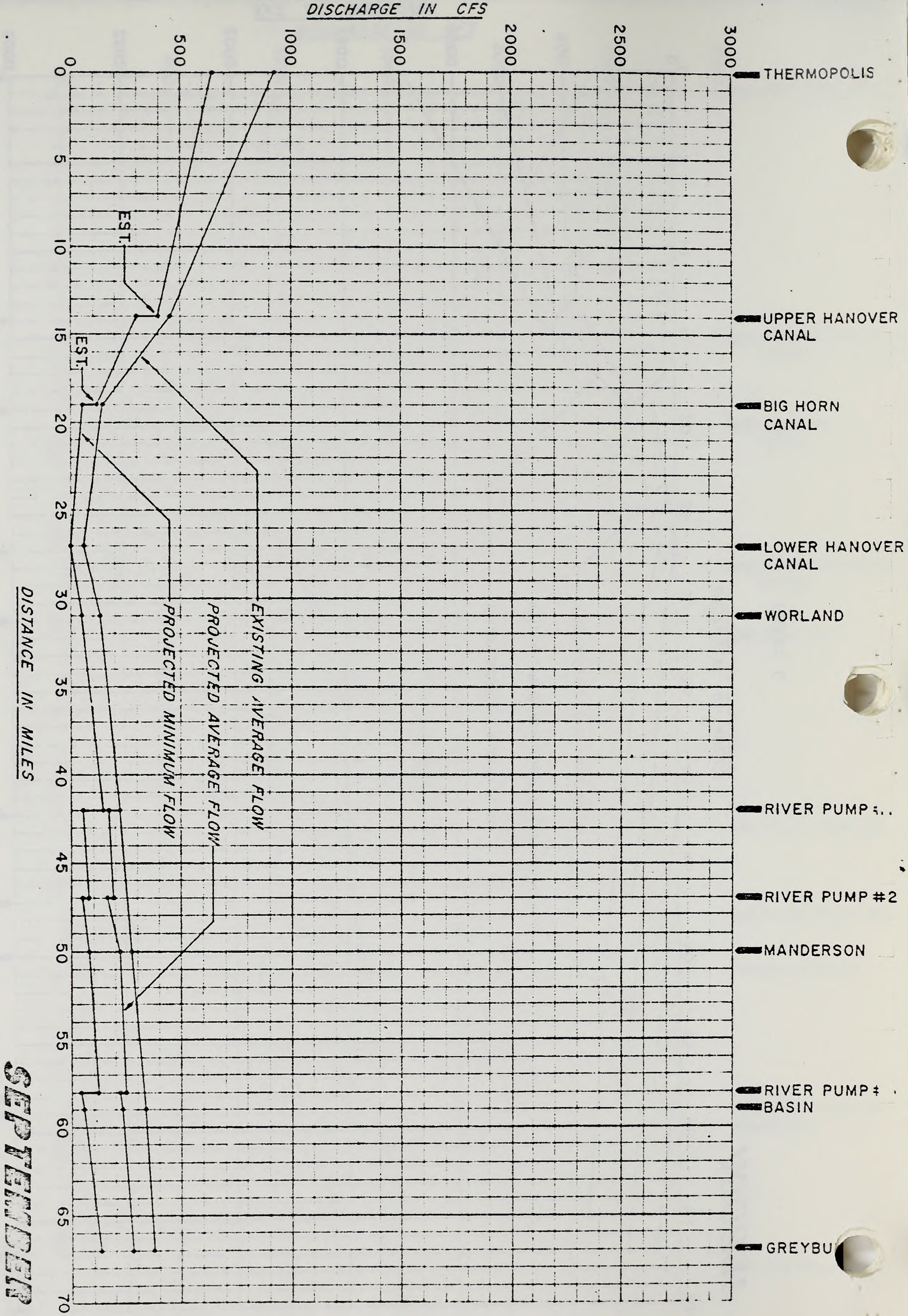

CHART 7

SEPTEMBER

During the peak irrigation season, secondary impacts related to the water supply might occur. The "drying" of the river at the pumping plants could create the following impacts:

-- The third pumping plant upstream from Basin might, at times, divert so much water as to interfere with the municipal needs of Basin. In such cases, municipal needs would have to be met first.

-- Once in 10 to 15 years shortages would be severe enough to reduce crop production 5 to 15 percent.

The project would require an average of only 15 percent of the normal stream flow from May through September. It is because of fluctuations in discharge and demand that low flows and dry periods would occur.

In cooperation with the state engineer, the Bureau of Reclamation controls discharge of water from Boysen Reservoir. This action regulates the water supply in the River.

Any change in policy at the reservoir would effect the downstream water supply. Predicted impacts in this section would likewise change. Flow regulation at Boysen is likely to become more intensified with increased irrigation or industrial development. Impacts anticipated in this report would, then, not be accurate.

Living Components

Plants

Aquatic

Effects of the proposed project on aquatic plants would be minor. No more than 75 acres of cattails, the most abundant rooted aquatic plant, would be affected by river drawdown below the pumps. Considering probable duration and frequency of dewatering in these areas, any reduction in acreage of cattails would be small.

A few acres of streamside marshes and ponds supporting submerged aquatics with river backwaters would undergo de-watering severe enough to temporarily destroy pond weeds (Potamogeton spp.) and others. These plants would probably re-establish more or less permanently in areas where water levels suit their requirements of depth, current and so on.

Terrestrial

Vegetation of cropland and waste-water drainages below the canal will change little, since farming and irrigation practices there would not change appreciably. Some loss of vegetation would occur in small areas as a result of pump-station and access-road construction. This would permanently remove about 15 acres of vegetation, at the most. River-bottom (riparian) vegetation -- including cottonwood, willows, silverberry, rosebushes and other species dependent on water in the river alluvium -- would eventually be reduced in areas downstream from the river-pump stations. This would result from reduction of flow during the irrigation season. Short-term effects on mature vegetation would hardly be noticeable. But as these sites are dried out during the growing season, seedlings and young riparian plants would not provide replacement. Aquatic plants would, instead, be replaced by such plants as dry-land grasses, sagebrush and rabbitbrush.

Accurate information is lacking concerning the amount and location of return flows which would presumably replenish the river downstream from the river pumps. Reductions in flow sufficient to affect adjacent vegetation would occur from one to three miles downstream from each pump. This would eventually result in change in 100 to 300 acres of river bottom vegetation.

The major impact on vegetation in the study area would be the complete removal of about 22,500 acres of semi-arid, native, rangeland vegetation. Approximately 1,801 acres of such vegetation would be permanently removed from land occupied by improvements. The remaining 20,718 acres would be converted from native vegetation to farm crops and, to some extent, weeds and exotics in disturbed waste areas along fence rows and so on.

Native vegetation would be prevented from re-invading these lands by irrigation, cultivation, pesticide application, burning and other common farm practices. With the exception of an annual average of about 2,500 acres of year-round alfalfa cover, crop land would be fallowed and without any vegetative cover for about seven months a year. Waste-area vegetation on and near farm units would be burned or sprayed periodically to control undesirable plants. These activities would tend to keep such areas bare or covered with only the hardiest weeds and exotic annuals.

Construction of a major power line to the proposed project area would disturb an unknown amount of native vegetation. Effects would probably be temporary, with native vegetation eventually reinvading the disturbed areas. The disturbance would mainly be in small, temporarily-cleared areas around power poles, and a possible truck trail along the route. If use of the trail continues and increases after construction, the trail could become a permanent road and vegetation would not be reestablished. This impact would involve a narrow strip of vegetation along as much as 50 miles of powerline. A maximum of 1,000 acres would be so affected.

Animals

Fish and wildlife

Development and operation of the proposed project would cause major changes in land use on more than 28,540 acres. It would also require large water withdrawals annually from the River. These broad changes would result from a variety of activities. Some of the more important of these activities, for their possible impact on fish and wildlife, would include access and powerline construction, land clearing and terrain modification. Following development, farming operation, water delivery and increased human activity would cause additional and continued impact on fish and wildlife. The effects would be different for different species, but all would fit into the following general categories:

- -- Destruction of animals;
- -- Permanent destruction of habitat;
- -- Replacement of existing habitat by that of a different type;
- -- Impairment or reduction in value of habitat near human activity;

-- Increased introduction of hazards into the wildlife environment;

-- Offsite and secondary impacts caused by displaced animals, disrupted food chains, etc.;

-- Improvement of habitat.

Threatened species

No species nationally threatened is expected to be affected by the project. The peregrine falcon is not known to nest in the study area and only occasionally migrates through. Considering the species' low density and high mobility, there would be little possibility for any proposed actions to affect the peregrine.

The black-footed ferret, should it exist on proposed-project lands, would be adversely affected by destruction of prairie dog colonies which would unavoidably accompany development and farming. This impact, while somewhat speculative with current knowledge of ferret distribution, would be severe if they inhabit the study area. Recent cursory surveys by Worland district BLM personnel have found no evidence of ferrets in prairie dog colonies in the study area. It therefore seems improbable that ferrets would be affected by the proposed project.

State-listed threatened species will be affected. Western burrowing owls, estimated at five pairs in the study area, would be lost. Land clearing, ripping, plowing, farming and road building would remove prairie dog colonies and other burrowing-rodent populations which supply nest sites and food for the owls. Some owls might be destroyed in their burrows, especially if young are present.

The shovelnose sturgeon and the sturgeon chub, if present in the study portion of the river, are probably very few in number. Near-complete dewatering of the river during low run-off years, accompanying higher water temperature, and decreased habitat area and ability of the river to move silt, would eliminate reproducing populations of these fish between the upper river-pump station and the confluence of the Greybull River.

Big game animals

Mule deer and antelope are dependent on native vegetation. Much important sagebrush-grassland and saltbush vegetation would be eliminated by clearing, ripping, plowing, road building, powerline construction and farm-facility construction. Cropland would be covered by crops during the growing season. Much of it would then be fallow (bare) during the winter. An effort would be made to prevent re-invasion by weeds and native plants. This would include such activities as the use of pesticides and burning. Land used for roads, farm buildings, corrals, driveways and pump stations would cease to provide habitat for deer and antelope.

Human habitations and other human activities will further reduce deer and antelope habitat. Farm dogs often harass big game animals. Increased vehicle traffic increases road kills. Fencing would hinder antelope movement and increase the incident of animal hang-up and entrapment.

For deer and antelope, effects of project-related actions discussed above would include loss of approximately 5,000 acres of deer habitat and 15,000 acres of antelope habitat. These losses would result in the annual loss of 15,000 deer-days of use and 18,000 days of antelope use. The deer herd would thus be reduced by 35 to 45 animals, and the antelope herd by 45 to 55 animals. (See Table 9.) While these animals would only be displaced as the project is developed, the population would eventually be reduced to the new carrying capacity of the habitat.

Present populations of deer and antelope are at or near the carrying capacity of the habitat. Loss of part of the habitat, with resulting displacement of animals, would cause increased competition for forage in the remaining habitat. The end result would be reduction of populations and, possibly, overuse of remaining habitat before populations are stabilized.

Waste-water run-off into low areas and drainages not subject to development could result in new browse areas which could be beneficial to deer. This impact is expected to be very slight, however, because the sprinkler irrigation system is intended specifically to avoid the waste of water.

Further reduction in the deer and antelope herds might result if they damage crops after farming starts. Deer and antelope could be expected to cause damage to small grains and alfalfa during certain seasons. Experience in similar situations suggests that landowners would demand herd reduction and make damage claims against the State Game and Fish Dept.

Predatory and furbearing mammals

Large predators such as the coyote, fox and bobcat would be affected primarily by the loss of the cover of native vegetation and, secondarily, by reduction of prey populations. Changes in vegetation from native to crops removed and, usually, "fallowed" at harvest time, would bring about large reductions among cottontail rabbits, jackrabbits, kangaroo rats, prairie dogs and other small rodents.

Burning waste areas, fence rows and roadsides for weed control would further reduce cover for predators and eliminate habitat for prey species. Increased human use and occupation of the area, coupled with reduced food and cover, would cause eventual elimination of resident coyote and bobcat populations. Badgers would be reduced with destruction of prairie dog colonies. Red foxes, striped skunks and weasels are more adaptable to civilization, and might increase somewhat in areas where developed lands border undisturbed range lands. Because of the distance from the River bottomlands and the farming operation proposed, fox, skunk, weasel populations would be somewhat reduced over the study area.

Land and facility development would have little effect on mink, raccoon, muskrat and beaver. But these species might be significantly affected by changes in aquatic and riparian habitat resulting from removal of water from the River and the canal. Project water would apparently depend heavily on return flows to the River from upstream irrigation projects. These waters now return through waste drainages, and supplement river flows below Worland. During low run-off years and periods of peak use, these return flows often provide nearly all the water in the river, downstream as far as Greybull. Judging water-use plans against water availability, it appears that flows in some waste-water drainages and stretches of the river below the pumps would be significantly reduced for periods during June, July and August. The 50,000 plus acre-feet of water removed from the system would have some long-term effects on aquatic and riparian habitat in the study area. With existing data it is impossible to quantitatively predict effects upon such species as beaver, muskrat, and mink, but the net impact will probably be negative.

Demands by range-sheep operators for predator control would continue or possibly increase, with more farm sheep and poultry flocks as part of farm operations, a common practice in the basin.

Small mammals

Populations of cottontail rabbits, prairie dogs, jackrabbits and kangaroo rats would be reduced on 22,000 acres where native vegetation is replaced by farm operations and improvements. Again, populations of these species might be enhanced somewhat along the peripheries of cultivated lands and where seep areas develop attractive vegetation. These improved habitat areas would not provide enough additional vegetation production to counterbalance habitat eliminated over large acreages. Beet and small grain production, fallowing during critical winter months, prairie dog burrow areas plowed under, and fence rows and waste areas burned for weed control, would account for these small mammal reductions. Nearly the entire prairie dog population of 200 to 300 animals on project lands will be lost. While no good estimate of the present cottontail population is available, it is known to be quite high periodically. Total population reduction would be in the neighborhood of 75 percent.

Non-game birds

Again, removal of large acreages of native vegetation would cause major impact. Non-game birds most effected would be the golden eagle, rough-legged hawk, and great horned owl which depends upon rabbits and other rodents for food. With reduction in prey species, these raptors would be reduced in number. The one golden eagle nest known in the study area would likely be abandoned permanently when the adjacent tract is developed and human activity increases.

Native songbirds such as Brewer's, vesper and savannah sparrows would also decline with removal of the native vegetation. Other species such as Brewer's and yellow-headed blackbirds, crows and magpies would increase with establishment of grain crops. Aerial insectivores such as nighthawks and swallows would probably also increase as prey species are benefited by the change to a moist environment. Horned larks and grey-crowned rosey finches would probably find as suitable winter habitat in the barren, fallowed fields as they do under present conditions.

Over a long period, as suitable nest trees grow, some summer resident raptors such as marsh and red-tailed hawks would probably expand range and numbers from present habitat into the proposed-project lands.

The burning of weed patches, fence rows, roadsides and other waste areas would remove nesting and food producing areas for a variety of birds.

Killdeers, herons, snipe, sandpipers and other shore birds may be affected to some degree by periodic reduction in river flow as a result of pumping operations. There are possibilities for both beneficial and detrimental impacts on some of these species, but data for accurate analysis is not available.

Upland game birds

The sage grouse population, estimated at about 80 birds would be reduced by at least 50 percent, and possibly by as much as 90 percent. The major known flock in the area uses sagebrush lands on the edge of one proposed-project tract. It appears that 50 percent or more of the sagebrush habitat of this population would be eliminated by farm development. The strutting ground for this flock has not been found but, if it exists on proposed-project lands, the flock might be entirely lost.

Mourning doves would increase in numbers with production of habitat providing grain crops, water and, in waste areas, more weed seeds. Where weed burning is practiced, the potential would be reduced. Since doves are migratory, they would escape the detrimental effects of winter fallowing.

There is some potential for beneficial effect on ringneck pheasant and Hungarian partridge populations. These birds now exist only in small numbers, primarily on agricultural land at the edge of the area and on riparian lands. With the change of 22,000 acres to farmland and some of it in grain crops, an expanded food supply would allow for increases in pheasants and partridges.

A more important factor determining benefit to these species, however, would be the amount of nesting and wintering cover established and maintained. The sprinkler irrigation system with its low water loss, and the common practice of burning waste areas, pasturing off crop residues with livestock and fallowing fields during winter, all suggest that a minimum of additional cover would be created. That which is created might well be destroyed annually before it can fulfill habitat requirements.

Waterfowl

Effects of the project on waterfowl would be low. Both beneficial and detrimental impacts would occur. The effects of water removal on the river in June and July would at times be sufficient to present nesting problems. Predation on duck and goose broods might increase where side channels protecting island nesting sites are de-watered. Some goose nesting sites might become undesirable near river pumping stations due to noise, human activity and water fluctuations.

Goose nesting sites would probably decline slightly in the study area, causing a decline in goose production. An increase in irrigated cropland, to the extent that it included grain crops, would increase the food supply for migrating ducks and geese in the fall. More waterfowl would be induced to spend more time in the area. Winter fallowing of fields would tend to reduce this beneficial impact.

Seeps and waste-water runoff areas would increase duck nesting habitat, but this would be minimal with the sprinkler type irrigation system. Without specific water committed to improvements, any habitat created would likely be affected by small losses resulting from annual removal of the 50,000 acre-feet of water from the canal, return flow drainages and the river.

Fish

Changes in water quality and quantity would be sufficient to adversely effect already deteriorated fish habitat. During low-water periods, project operations would sometimes completely de-water parts of the River downstream from the pumps. How extensive this would be cannot be predicted with present data. This condition, of course, would eliminate fish in these sections.

River sections watered by irrigation runoff might still support some fish, but habitat would be further deteriorated by a variety of factors. Some sediment from development activities would reach the River. The volume might be relatively small but it would still be detrimental, especially with reduced flows. Water temperature would increase with reduction in flow and effective bank cover, and shading would be reduced.

To the extent that runoff from proposed-project land returned to the river, pesticide residues, fertilizer and chemical salts from saline soils (see soils impacts) would contaminate the river. This would further reduce the ability of the river to produce aquatic invertebrate food sources. The few game fish remaining in the study portion of the river would probably be eliminated, and fish discussed under "Threatened species" might also be lost. Other non-game fish which are food for herons, kingfishers, merganser and other predators would also be reduced in number.

Reptiles and amphibians

Land clearing and levelling would destroy present populations of eastern short-horned lizards, sagebrush lizards and most of the prairie rattlers and bullsnakes. With the change to intensive agricultural production these species would not re-establish in the developed lands. Snapping and softshell turtles would be reduced in number with periodic dewatering of portions of their river habitat.

Amphibians might benefit somewhat with irrigation of proposed-project lands. Salamanders, toads and frogs should find sufficient water in low areas and small seeps to expand their populations. Some habitat reduction would occur in periodically-dewatered portions of the river.

Invertebrates

The western harvester ant populations would be greatly reduced with the land-use change. Insects such as mosquitoes would be favored by the more moist environment created by irrigation. Large acreages in single-crop production, such as beets and barley, would encourage large populations of insects commonly infecting these crops, but pesticides would undoubtedly be employed to reduce any populations considered detrimental. Since pesticides generally kill species in addition to target species, over-all insect populations, especially terrestrial species, on the agricultural lands might well be reduced below those now found in the area.

Domestic livestock

Grazing use by the 11 sheep and cattle permittees using proposed-project lands would be reduced. (See Table 12.) Grazing in allotments such as the Buchanan and Six Mile would be almost completely eliminated, while others such as the Basin (south) and Elk Creek would be reduced by about 10 percent. (See Map 4.) Total reduction would be about 1,842 AUMs. Of this, about 1,089 AUMs would be lost to sheep grazing and 753 AUMs to cattle.

While these AUMs might be lost by present operators, actual grazing loss to the livestock industry in the Basin would be considerably less. Forage production from a relatively small area expected to be put into hay production each year, and secondary forage from beet tops and corn stalks, would significantly offset range forage losses. This, of course, would depend upon the type of crops grown and what use farm operators make of forage and crop residues. Forage raised on the project could either almost completely offset range forage loss, or amount to only a few hundred AUMs.

Some of the present grazing permittees could be among the successful applicants for DLEs, in which case they might suffer no net forage loss. It is probable, however, that most of the present grazing users would experience reductions in forage for their herds.

Additional range forage would be lost to present users where new roads are necessary for access to national resource lands, where new fences are necessary, where cropland protection isolates tracts of land not actually in the proposed project, and where water is not available to the livestock. The extent of these additional reductions in available forage cannot be predicted at this time.

Wild horses

Present use by wild horses on proposed-project land would be incompatible with the new land uses. These animals would be pushed out as human and developmental activity increased. Fences along the perimeter might be necessary, at least in areas traditionally frequently by the horses, in order to protect crops. Although forage now used would be unavailable, and the horses would be forced to forage on adjacent national resource land, they would be able to survive.

Little competition with other livestock and wildlife would occur because of the horses' wide-ranging habits and small number. Some territorial strife might be generated with other wild horse bunches, if stallions are present among the displaced horses and are forced into territory now occupied by other herds with stallions. This could cause changes in use patterns or death to one or more stallions. Should fences or other developments result in the entrapment of horses on proposed-project lands, they might have to be rounded up and moved to other national resource lands.

Ecological relationships

Succession

Current biotic succession on 22,519 acres of the proposed project would cease with removal of the natural communities. Plant communities would be replaced by man-planted monocultures (crops) over about 20,718 acres. These cultured communities would be restricted as to numbers of different plant and animal species. The use of fertilization, irrigation, pesticides, harvest and winter fallowing would further simplify the communities, making them habitable only to cultivated crops and a few other plants and animals capable of adapting to a relatively controlled environment.

Effects upon succession in the aquatic environment of the River can not be predicted accurately. Alternate effects of flooding, normal flow and reduced flow over the year, and differences between years depending upon the need to lower or manipulate water in the system, would be further magnified by factors such as increased concentration of chemical pollutants, and river bed and bank modification. These complex variables make analysis impractical with present data.

Food relationships

Many of the probable effects on important food relationships are described above. The most significant would be to reduce or eliminate current food chains through replacement of the present group of primary producer organisms (existing plant life) with an entirely new group, the cultivated crops.

Primary producers planted and cultivated by man are selected to expand "energy pathways" leading to man. With modern fertilization and irrigation, proposed-project lands would be stimulated to greater energy production, in forms of maximum benefit to man. Only a small portion of the energy fixed by cultivated producer organisms would be allowed to remain on the lands to enter food chains other than those directly benefiting man. That portion entering other food chains would benefit certain other organisms. Examples are insects and small animals which feed on crop plant foliage and grain eating birds such as pheasants, blackbirds and crows which might benefit.

Fluctuations in plant material available to these other creatures would probably be much less severe among the irrigated crops than among species of native vegetation, under natural precipitation conditions.

Community relationships

The obvious result of exchanging natural vegetation communities for crops, and employing the methods necessary to cultivate these crops, is that most of the many present relationships between organisms and their present environment would be modified or entirely replaced by those characteristic of cropland communities. These communities would be less stable, due to their simple nature and fewer species interactions, and would therefore be more vulnerable to such disasters as fire, insect plague and a water supply failure.

Human Values

Landscape

Proposed project would cause adverse impact upon the landscape.

Major modification would result from vegetation clearing and levelling and soil disturbance. These actions would increase the "horizontal" appearance of the landscape, decreasing scenic interest. They would also make more uniform the land texture, creating a more monotonous appearance. This effect would result, too, from the loss of vegetative variety and the increased fineness of texture as rock outcrops, trees, sagebrush, and other features are removed.

Color, already of low contrast, would become more drab except during the growing season. On the other hand, access roads, pumps, powerlines and substations would add scenic deviation in an area which lacks visual interest because of its great harmony.

Of the adverse impacts, the greatest and most far reaching would result from land clearing, and construction of powerlines and substations.

Farming and human occupation of project lands would have both adverse and beneficial effects. Tilling, harvesting, and fallowing would reduce variety and visual interest. Utility lines to farm buildings would intrude, visually.

Planting would add color to an otherwise drab landscape. Irrigation would lend added interest, and fencing would give definition to the open planes of fields. (In the absence of fence lines, fields are substantially more monotonous.) Farm buildings, beet dumps and similar structures would add interest. Landscaping, human activity and the presence of animals would add to the agrarian character of the landscape.

The 115-kilovolt line which would be built between Thermopolis and a substation west of Manderson would be a major scenic intrusion over 45 miles of right-of-way. At the line's terminus near Manderson, the substation would occupy one to two acres, with structures over 30 feet tall. A large canal pump would be required west of Manderson. Other pumps would be necessary northwest and southeast of Basin. These facilities, plus powerlines and access roads, would significantly modify local landscape.

Other, similar river stations north of Rairden and south of Six Mile Creek would be less intrusive because of their locations. The fourth river pump, an alternate, would be near Highway 16-20, near its intersection with the Basin Golf Course Road. It would be in the foreground of the highway corridor. This site would also be exposed and inharmonious with the land character.

While the scenic character of proposed-project lands would be very greatly changed, the relative esthetic importance of them is not high compared with others in the region. Relative beauty, uniqueness and the absence of intrusions do not distinguish these lands sufficiently that impact of the proposed project would be of major significance. Individual impacts might, however, be more severe although limited to small areas on and off proposed-project land.

Cultural values

Recreational values

No historical values have been identified which could be directly impacted by the proposed development. No historic sites either enrolled on or eligible for the National Register of Historic Places are known in the study area.

The values of proposed project land for sightseeing would be impaired mainly by land and water development. Primary negative impacts would result from vegetation clearing, land levelling, access-road construction, and powerline and substation construction. These actions would moderately diminish the quality of the scenery. Specific impacts are described in greater detail above, under "Landscape."

Site occupation - buildings, wells, beet dumps, etcetera --and farming would cause minor adverse impacts and such activities as farm landscaping, planting, irrigating and grazing would moderately benefit the scenic resource.

Because sightseeing values here are low compared to other such resources in the region, the significance of probable impacts cannot generally be called major. Individual impacts, both on and off proposed-project land, are exceptions. An example is the 115-KV transmission line between Thermopolis and Manderson.

The quality of the sightseeing resource is a subjective value. While some persons viewing such land see value in the large scale, open space and desert scenery, others would find the new agricultural landscape much more pleasing. In some ways, the esthetic quality of the land, according to objective definitions, would be enhanced after farming begins.

Impacts on the Big Horn River would include loss of recreational fishery. This value is already marginal. While activities such as pump and access construction would diminish the quality of the fishing experience, the major impact would come from the loss of water to irrigation. As many as 15 of the 48 visitor days of fishing recorded in 1973 would be lost. Given the quality of fishing on this stretch of the Big Horn, the probable impact of the proposed project is slight.

Game species would be severely affected by land levelling and vegetation clearing with resultant loss of much of their habitat. Hunting quality would, as a result, decrease substantially for present species. Because of the "clean" farming practices expected, no new game species would replace affected ones as significant recreation values.

Once again, this impact on the hunting resource must be considered relative. Although hunting opportunities would decrease, in 1973 they provided only 80.4 visitor days of hunting across 20,000 acres. Visitor days of use would be reduced by two thirds. Waterfowl hunting along the Big Horn River involves substantially more use: 1,203 visitor days in 1973. This use would be impaired only slightly by the proposed development.

Collectable rocks and archaeological and historical material would be disturbed by land levelling and plowing. Artifacts, fossils, and rocks would be stirred into the soil. Agate and petrified wood would be similarly disturbed. A question exists as to whether this would decrease the amount of collectable material -- some of it would be exposed rather than buried. Significant impact would be caused by loss of access to farm fields for collecting, and decreased access to the land beyond because of fences and the obliteration of roads. Exact acreages which would be lost cannot be accurately estimated.

Collectable material is evenly distributed across the thousands of acres surrounding the proposed-project land. It is not a rich deposit, and high value material is infrequently found. The significance of probable impact is low to moderate.

Off-road vehicle areas on proposed-project lands have little value relative to others in the region, and they would be modified only slightly by land clearing and levelling. Generally, impacts would be of minor importance. The most significant impact would result from access blockage by fences and the elimination of roads. Loss of access would isolate substantial acreages of otherwise unaffected land. Other sites in the area would get more use and have a poorer appearance as a result. Given the small amount of off-road vehicle use in the area, this impact would be minor.

Archaeology and paleontology

Archaeological and paleontological sites would be affected by the same sorts of actions. Therefore, all sites can be expected to receive the same impacts from the proposed action.

Development

Construction which results in ground disturbances could cause partial or total destruction of sites.

Operation

First-time tilling would severely disturb surface sites in areas tilled. At least six known sites would be so damaged. Although the remaining known sites are on lands not likely to be tilled, they would probably suffer some damage from grazing animals which disrupt site integrity by kicking rocks around as they move.

Human activity such as arrowhead hunting would result in some loss of archaeological and paleontological data of unknown significance.

The total impact upon sites in the proposed-project area cannot be predicted. Unsurveyed areas have a fair to good chance of containing significant sites. Subsurface sites are sure to exist but exact locations and their significance are unknown. Therefore, probable impacts on these sites are also unknown.

Socio-economic impacts

Population

Approval of the project would result in a population increase of both permanent residents and migrant labor, as well as construction workers during development. The first noticeable increase would be in workers constructing the water delivery system. We estimate about 100 such workers. They would begin construction on the northern third of the project, move to the middle third and then to the southern third of the project. We anticipate that these people would be in each of the areas during the summer months of one year, taking three years to complete construction of the project.

A permanent population increase would result directly from creation of about 80 new farming units, bringing 80 new families to the area. Although some of the entries might be made by persons already living here, each would either be managed by a new family, or a new family would replace the local entryman at his present occupation.

Migrant labor would be required for field work. Current practice calls for one migrant worker for each 30 acres of sugar beets, requiring a total of 250 migrant workers for the expected sugar beet crop. About 50 additional migrant laborers would be needed for irrigation work such as moving sprinklers for other crops. Migrant labor for the project would total about 300 persons. This force will come to the area in late May and leave in late September.

A secondary population increase in Worland, Basin and Greybull would include service people supplying the needs of those engaged in agriculture. While the exact amount of this increase cannot be predicted, it would not be great, and would not cause a significant impact on any of the communities.

Housing

Because of the temporary nature of the population increase during construction, permanent housing would not be a major problem. Construction workers would most likely disperse over a large area, they wouldn't be accompanied by families, and they would use existing hotels or motels, or a camp for mobile homes and campers. The impact on permanent housing by this group would be insignificant. However, a shortage in short-term rental housing would be felt.

Because of the isolated nature of the proposed tracts, some permanent residents would build homes on the desert-land entries themselves. However, we do not anticipate that all the houses would be on the entry, because of problems with potable water supplies and other living conditions. Some would build on adjacent farm land and some would live in nearby communities.

Persons taking up permanent residence would probably live in mobile homes for several years, eventually building permanent houses either on proposed-project lands or nearby. There is a shortage of vacant houses suitable for this use, so nearly all the families will require new homes. However, since this would be spread out over several years, impact on the housing industry would be slight.

Migrant workers would be housed on the farm where employed. Small mobile homes or bunkhouse type buildings would probably be constructed. Very few migrant workers would live in Worland, Manderson, Basin or Greybull.

Schools

Because of the seasonal nature of both construction and migrant workers, schools would not be affected by this force. Permanent residents would be scattered throughout the project and no large numbers of new students could be expected in any one school. Therefore, the total impact of new students on the school system would be minimal.

Health care

Because the expected population would be dispersed from Greybull to Worland, it would use health services in Worland, Greybull, and Basin. Due to the seasonal nature of the migrant worker force, the largest segment of the population increase, we do not expect that these health facilities would be impacted greatly. Present hospital and clinic facilities should be sufficient to handle the expected population increase.

Social services

Population projections suggest that a large proportion of the construction force would probably be single males. These would be relatively highly paid and self supporting, and should not affect the welfare system significantly. However, a short-term local boom might occur where these construction forces are centered, and the resulting increase in the cost of living might be a hardship on local residents living on a fixed income. This might be a rather serious impact on a short-term basis.

A 50-percent increase in the migrant worker force would affect social service facilities only during the summer months. The welfare program might experience increased demands, especially when migrant workers are arriving in the area and before they receive their first wages.

Social services, such as migrant worker child daycare centers, would have to be increased. Present recreational facilities used by migrant workers might not be sufficient and would have to be increased.

Law enforcement

Some increase in work for law enforcement agencies would result, since increasing population results in increased crime incidence. Experience indicates that somewhat less desirable behaviour can be expected from the predominantly single, temporary construction worker. This added work would be short-term and within the capabilities of local law enforcement agencies. We do not anticipate that these agencies would have to be expanded.

Fire protection

While some increase in demand for fire protection would result, it would not have a significant impact on the present fire protection system. Water from the project in both Big Horn and Washakie Counties would be available to augment county firefighting supplies. However, this water would only be available during the irrigation season.

Water and sewer

Both Basin and Greybull take their water from the River. While in Basin the River would be lowered by the proposed project, municipal water use has a priority right to water for city use. However, if the River were lowered significantly at the intake point for the town of Basin, the intake system might have to be modified. Basin is the only town on the River expected to be affected in this manner.

Although some of the new permanent population might live in Worland, Basin and Greybull, the present sewer system is sufficient to handle this increase.

Roads

Good quality, improved roads would be needed in the proposed project. We anticipate that these roads would be constructed by private individuals or possibly by the development association. Improvement, surfacing and maintenance for approximately 30 miles of these roads would be the responsibility of the counties. This additional demand should not cause a rise in taxes since development would broaden the county tax base.

Community attitudes and lifestyles

The multitude of variables that come together in the unique combinations known as "community attitudes" are difficult to assess. The impact of the proposed development on lifestyles and attitudes would depend on the magnitude and speed of population growth, the degree to which public services can accomodate that growth, and the ability of incoming persons to establish ties in the community.

However, since the communities are agriculturally oriented and the proposed project is agricultural, these communities would probably have a positive attitude toward the proposal. The people expected to come into the area are not different from those already here. They would have somewhat the same lifestyle and fit well into the communities. Migrant workers are not new to this area and would be assimilated quite well.

Economic considerations

Although the proposed-project lands are used for grazing, because of low production and a low carrying capacity they do not create a large gross product in dollars. Conversion to agricultural use would increase this gross product greatly. In full cropland production, the lands should produce a gross of about $15 million dollars annually. Although this money would not all be spent in the Basin, a considerable amount would, for such items as farm equipment, fertilizer, gasoline, fuel and wages. Much of this money would be re-spent in the Basin, resulting in an economic boost. Although many services furnished by the counties would have to be increased, the tax base would be broadened with additional revenues compensating for these increased demands.

ANALYSIS OF THE ALTERNATIVE

(Failure to classify the proposed lands as suitable for agricultural entry.)

Failure to classify the proposed lands as suitable for agricultural entry will result in a continuation of the status quo. The lands will remain in their current uses, primarily for grazing, oil and gas, and gravel production. A major effect of not allowing agricultural entry will be the continued availability of the water which would be used for the project.

Analysis of the impacts of an alternative use for this water is not possible because the alternative uses are not definite. Possible alternatives are other desert land entries downstream of the proposed project and possible industrial use of the water. The energy which would be used for development of the project and subsequent farming activities will be available for other uses; but again, the alternative uses for this energy are not known.

POSSIBLE MITIGATING MEASURES

Introduction

Measures which could reduce the severity of adverse impacts or enhance the quality of the environment must be discussed in two categories -- those which can be directly brought about by BLM and those which are not enforceable by BLM but which are nevertheless sound resource management practices that would bring about mitigation or enhancement.

Enforceable by BLM

Land

Use compatibility

In the classification process major conflicts in land use could be avoided by not classifying the land where the conflict exists as suitable for agricultural entry.

Living Components

Plants (Terrestrial)

The impact of proposed development on terrestrial vegetation could, in a broad sense, be somewhat mitigated by its replacement with crop vegetation. Impacts on natural plant communities and their component species, however, can be mitigated on only a relatively small acreage. BLM road rights-of-way could be replanted after road construction with the species previously found on those sites. Stipulations on power line rights-of-way across national resource land could require re-establishment of native vegetation. These routes could be closed to vehicle traffic after rehabilitation to aid in this re-establishment.

Animals

Fish and Wildlife (threatened species)

While it does not appear that the black-footed ferret inhabits the proposed project area, a more thorough survey could be made before the land is classified for entry; and, if a population is found, the habitat could be protected by not classifying as suitable for entry.

Big game animals

Deer losses could be mitigated by about 50 percent through preservation of some major drainageways now included in the proposed project area but in public ownership. Part of the estimated 5,000 acres of deer habitat which would be lost is in that part of the proposed project which does not appear farmable due to poor soils and topography. This land could be classified as not suitable for irrigation development and remain in public ownership to be managed primarily for wildlife habitat, including fencing.

Birds and small animals

Most of the impact on these animals which can be mitigated significantly would be caused by the change from natural vegetation to crops. Retention of key drainage areas in public ownership accompanied by management and improvement of wildlife would provide some mitigation for a number of species in this group. These areas are strips of land along dry water courses and the adjacent slopes and flood plains. Removal of livestock, creation of brush piles for cover, planting of adaptable brush, forb and grass species and reservoir or guzzler development where feasible would create such improvement. These areas would be


WestSide Irrigation Project
LEGEND
PROPOSED PROJECT BOUNDARY
PRIVATE LANDS WITHIN PROJECT
MULE DEER
PRONGHORN ANTELOPE
FISH & WATERFOWL
1 REPORTED PRAIRIE DOG TOWNS
2 EAGLE NEST SITE
3 SAGE GROUSE USE
3
3
1
2
1

APPENDIX

Plant List

The following plants are present in varying abundance. This is not a complete list.

Below the Big Horn Canal

Shrubs & Trees	Forbs	Grasses
Willow	curly dock	Canada wild-rye
cottonwood	burdock	switchgrass
Russian olive	cocklebur	reed canary-grass
wild rose	Canada thistle	sloughgrass
serviceberry	stinging neetle	meadow foxtail
chokecherry	common mint	slender wedgegrass
snowberry	common mulley	witchgrass
buffaloberry	bullthistle	
salt cedar	dandelion	
rabbitbrush	iris	
sagebrush	purple clematis	
	wild geranium	

Above the Big Horn Canal

Shrubs	Forbs	Grasses
Nuttall saltbush	prickly pear cactus	cheatgrass
black sagebrush	phloxes	western wheatgrass
big sagebrush	Russian thistle	needlegrass
bud sage	halogeton	blue grama
winterfat	buckwheat	Indian ricegrass
shadscale	death camas	sandberg bluegrass
spiny hopsage	wild onion	desert saltgrass
greasewood	globemallow	
salt cedar	paintbrush	
rabbitbrush	snakeweed	

Section E No sites were found.

Class III survey = 7% of the area

Class II survey = 28% of the area

Class I survey = 65% of the area

Section F One quarry and chipping site was found. Site is of S3 significance.

Class III survey = 7% of the area

Class II survey = 52% of the area

Class I survey = 41% of the area

Section G One quarry was found. Site is of S3 significance

Class III survey = 31% of the area

Class II survey = 33% of the area

Class I survey = 37% of the area

Section H No site was found.

Class III survey = 26% of the area

Class II survey = 49% of the area

Class I survey = 25% of the area

Section I No site was found.

Class III survey = 9% of the area

Class II survey = 41% of the area

Class I survey = 50% of the area

Sites, archaeological and paleontological, and surveys are discussed below with reference to sections A through M noted on Map 2

Section A This section had no archaeological survey. Sites are probable in this section.

Section B Two archaeological sites were found: a small quarry and a campsite on an overlook of Tenmile Creek. Both sites are of S3 significance. Sites are probable in unsurveyed areas.

Class III survey	=	3% of the area
Class II survey	=	10% of the area
Class I survey	=	17% of the area
No survey	=	70% of the area

Section C Seven sites were found: three small campsites, two quarry sites and two chipping and lookout stations. All sites are of S3 significance. Sites are possible in unsurveyed areas.

Class III survey	=	10% of the area
Class II survey	=	25% of the area
Class I survey	=	46% of the area
No survey	=	19% of the area

Section D No sites were found, but sites are possible in unsurveyed areas.

Class III survey	=	0% of the area
Class II survey	=	25% of the area
Class I survey	=	42% of the area
No survey	=	39% of the area

SOIL SURVEY NARRATIVE

WESTSIDE IRRIGATION PROJECT

Section J No site was found.

Class III survey = 34% of the area

Class II survey = 40% of the area

Class I survey = 26% of the area

Section K No site was found.

Class III survey = 22% of the area

Class II survey = 30% of the area

Class I survey = 48% of the area

Section L One paleontological site was found. Site is of S3 significance

Class III survey = 7% of the area

Class II survey = 30% of the area

Class I survey = 63% of the area

Section M No site was found.

Class III survey = 23% of the area

Class II survey = 41% of the area

Class I survey = 37% of the area

SOIL - MAPPING UNIT DESCRIPTION FOR BIG HORN IRRIGATION DEVELOPMENT ASSOCIATION

65-AC Sharland clay loam, alkali, 0 to 10 percent slopes

Shallow, medium textured soils over gravel. The alkali condition will reclaim under irrigation leaving 0 to 15 percent slick spots. The slick spot areas will have low production.

67, 67-AC Uffens silty clay loam, 0 to 10 percent slopes

Deep moderately fine textured alkali soils. The alkali condition will reclaim under irrigation. Five to 25 percent of the area will have low production.

102 Badland

Exposures of saline alkaline shales with small drainageways of deep soil Erosive.

315,315-BD Preatorson-Persayo complex. 3 to 45 percent slopes

Clifterson-Preatorson complex, 3 to 45 percent slopes

These units are deep very gravelly soils at the top of the escarpments and shallow gravelly soils at the bottom of the escarpments The drainageways are deep stratified soils.

343,343-AC Enos-Wallson Association, 0 to 10 percent slopes

This sandy loam unit has about 50 percent moderately deep over sandstone soil and 50 percent deep soil. Where over-irrigated saline spots will appear at slope breaks. Wind erosion hazard is moderate.

BIG HORN IRRIGATION DEVELOPMENT REPORT

by John E. Iiams

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363,363-AC Binton-Youngston Association, 0 to 10 percent slopes

This moderately fine textured unit is found adjacent to drainageways. Saline alkali soils cover about 50 percent of the area. About 10 to 30 percent of the area will have saline-alkali spots after irrigation water is applied.

367,367-AC Rairdent-Uffens Association, 0 to 10 percent slopes

The soils of this unit are medium textured. Rairdent soils have a layer of gypsum that will disolve and cause some subsidence and saline spots when irrigation water is applied. The Uffens is alkali soil and from 5 to 15 percent of the area will be slick spots or areas of low production.

368, 368-AC Lostwells-Kinnear Complex, 0 to 10 percent slopes

These deep moderately fine textured soils will respond favorably to irrigation water. Slope is the major limitation.

467-CC Pavillion-Kinnear Association, 3 to 30 percent slopes

This moderately fine textured unit has about 50 percent of a moderately deep soil 20 percent of a shallow soil, and 30 percent of deep soil. They are underlain by shale The moderately deep soil is strongly alkaline. There will be from 5 to 20 percent of the area in slick spots.

471, 471-CE Bributte-Persayo Association, 6 to 60 percent slopes

This unit is composed of shallow fine textured soils and shale outcrops. Some deeper soils occur along drainageways. Topography is steep for irrigation. About 15 to 30 percent of the area will be slick spots. These areas are not feasible for irrigation.

371, 371-AD Greybull-Persayo clay loam, 0 to 30 percent slopes

This moderately fine textured unit has about 50 percent moderately deep soil, 45 percent shallow soil and about 5 percent shale. The undulating to moderately steep topography will cause excess waste water and erosion is overirrigated. The underlying shale will weather so that plants will be able to extract moisture from the area in a few years. Five to 15 percent of the area will have saline spots and/or shale.

374,374-AD Chipeta clay loam, 10 to 60 percent slopes.

This fine textured shallow soil will have excessive erosion and waste water because of steep slopes. There are some small less sloping areas within this unit, but production will be very poor.

393 Griffy-Garland Association, 0 to 10 percent slopes

This unit will respond favorably to the application of irrigation water. There will be less than 10 percent alkali spots in the area. Some small gravel bars occur in this unit.

442,442-AC Apron-Worland sandy loams, 0 to 10 percent slopes

This sandy loam unit has about 40 percent moderately deep over sandstone soil and about 60 percent deep soils. Saline spots may occur at the slope breaks. Wind erosion hazard is moderate.

351,351-AC Lostwells Complex, 0 to 10 percent slopes

This unit is found along drainageways. It is a deep medium textured soil with about 45 percent of the area alkali soil which will reclaim under irrigation. Five to 25 percent of the area will be slick spots or saline spots of low production.

601 Youngston-Uffens Complex, 0 to 10 percent slopes

This unit is composed of deep moderately fine textured soils with about 35 percent of the area alkali soils. The alkali soil will reclaim under irrigation but the area will have from 5 to 15 percent slick spots or saline spots.

607 Uffens-Rairdent Association, 0 to 10 percent slopes

This unit is composed of deep medium textured soils with about 35 percent of the area alkali soil and about 30 percent of the area a soil having a layer of gypsum salts. About 5 to 35 percent of the area will be spots or saline spots. The gypsum may dissolve and cause some subsidence in small areas.

643 Lostwells-Youngston complex, 0 to 10 percent slopes

This unit is composed of deep moderately fine textured soils. About 5 to 10 percent of the area will be slick spots or saline spots.

661 Persayo-Badland Association, 0 to 10 percent slopes

This unit is composed of about 65 percent shallow moderately fine textured over shale, about 15 percent shale badlands and 20 percent deep soils. There will be about 5 to 20 percent of the area in slick spots or saline spots. Production of this area would be low.

667 Rairdent-Uffens Association, 0 to 10 percent slopes

This unit is composed of deep medium textured soils. About 40 percent of the area has a gypsum layer that will dissolve and cause subsidence and possibly saline spots; about 20 percent is alkali soils which will reclaim with irrigation water. There will be about 0 to 20 percent of the area in slick spots or saline spots.

671 Persayo-Badland Association, 6 to 60 percent slopes

This unit is composed of shallow moderately fine textured soils and badlands (shale). There is some small areas of deep soils along the intermittent drainageways. These areas are not feasible for

474,474-AD Chipeta-Deaver Complex, 0 to 30 percent slopes

This unit is composed of fine textured soils over shale. Shallow soils make up about 40 percent of the area, moderately deep soils about 30 percent, deep soils about 15 percent and shale exposures about 15 percent of the area. The steep topography would eliminate about 40 percent of the area. Intake rates are slow and water and wind erosion hazard is moderate.

493,493-BD Emblem-Griffy complex, 3 to 30 percent slopes

This unit is composed of deep loam and sandy clay loam soils. Moderately deep soils over sandstone cover about 10 percent of the area. Some small gravel knobs are found in the area. The major portion of this unit has topography suited for irrigation.

497 Persayo-Saddle Association, 0 to 30 percent slopes

This unit has about 35 percent shallow clay loam over shale and 65 percent moderately deep and deep sandy clay loam over sandstone. The topography is undulating with the shallow soils in the depressional area.

570,570-AD Uffens-Chipeta Association, 0 to 30 percent slopes

This unit has about 65 percent deep alkali soils, 30 percent shallow fine textured soils over shale and five percent exposures of shale. The alkali soils will reclaim under irrigation, but there will be from 10 to 25 percent slick spots or areas low production.

BIG HORN IRRIGATION DEVELOPMENT ASSOCIATION

SOIL FEATURES INTERPRETATION FOR SPRINKLER IRRIGATION DEVELOPMENT

	Depth Inches	TEXTURE Surface 0-10 Inches	Underlying layer >10
Apron	> 60	Sandy loam	Sandy loam
Avalon	> 60	Loam	Loam/Sandy loam
Badland	--	--	--
Binton	> 60	Silty clay loam	Silty clay loam/Shale
Bributte	8-20	Silty clay	Silty clay/Shale
Chipeta	8-20	Silty clay	Silty clay/Shale
Cliffterson	4-12	Gravelly loam	Very gravelly loam
Deaver	20-40	Silty clay	Silty clay/Shale
Emblem	24-40	Loam	Loam
Enos	20-40	Fine sandy loam	Sandy loam/Sandstone
Garland	20-40	Clay loam	Loam
Greybull	20-40	Clay loam	Clay loam/Shale
Griffy	> 60	Sandy clay loam	Sandy loam
Gystrum	20-40	Very fine sandy loam	Very fine sandy loam
Kinnear	> 60	Clay loam	Sandy clay loam
Lostwells	> 60	Sandy clay loam	Sandy clay loam
Lostwells, alkali	> 60	Sandy clay loam	Sandy clay loam
Oceanet	8-20	Fine sand loam	Fine sandy loam/Sandstone
Pavillion	20-40	Clay loam	Clay loam/Shale
Persayo	8-20	Clay loam	Clay loam/Shale
Rozatorson	10-20	Gravelly sandy clay loam	Very gravelly sand
Fairdent	> 60	Loam	Sandy loam/Clay loam
Saddle	20-40	Sandy clay loam	Sandy clay loam
Sharland, alkali	10-24	Clay loam	Clay loam/Very gravelly sand
Uffens	> 60	Silty clay loam	Clay loam
Uffens, moderately deep	20-40	Silty clay loam	Sandy clay loam/Shale
Wallson	> 40	Fine sandy loam	Fine sandy loam
Willwood	8-20	Gravelly sandy loam	Gravelly sand
Worland	20-40	Sandy loam	Sandy loam
Youngston	> 60	Clay loam	Clay loam
Sand alluvium	> 60	Loamy sand	Loamy sand

SOIL MANAGEMENT

GENERAL

Soils in the area are generally low in organic matter. Cropping systems used should add residues to maintain tilth and water intake. Hay and pasture are important in a rotation for this purpose.

Wind erosion hazard is quite low in the area except on sandy soils left bare after row crop and on clay soils that are trampled over the winter by livestock. Control measures should be part of the grazing system.

Water erosion is not a great problem. Furrows may be run up and down slopes up to 3 percent without excessive soil loss. Furrows should be on the contour or cross slope on 3-6% slopes.

	Coarse Fragment %	Soil Design Group for Sprinklers* Clean Tilled	Soil Design Group for Sprinklers* With Water	Water Holding Capacity in/in
Apron	<15	15	3	.11-.13
Avalon	<15	11	7	.16-.18
Badland	--	--	--	--
Binton	<5	2	2	.03-.05
Bributte	--	1	1	.07-.09
Chipeta	--	5	1	.15-.17
Clif/terson	35-80	14	10	.09-.11 over .05 at 12 inches
Deaver	--	6	2	.15-.17
Emblem	<15 Above gravel	11	7	.16-.18 over .05 at 30 inches
Enos	<5	14	6	.13-.15
Garland	<15 Above gravel	10	6	.19-.21 over .04 at 31 inches
Greybull	--	10	6	.19-.21
Griffy	<10	11	7	.11-.13
Gystrum	--	10	6	.11-.13
Kinnear	--	15	7	.14-.16
Lostwells	<5	15	7	.14-.16
Lostwells, alkali	<5	14	6	.14-.16
Oceanet	--	13	5	.13-.15
Pavillion	--	14	6	.14-.16
Persayo	--	9	4	.19-.21
Pegtorson	35-80	14	10	.14-.16 over .03 at 11 inches
Fairdent	<15	12	8	.16-.18
Saddle	<5	14	11	.14-.16
Sharland, al.ali	<20 Above gravel	10	6	.19-.21 over .04 at 18 inches
Uffe.s	<5	12	8	.19-.21
Uffens, moderately deep	<5	10	6	.19-.21
Wallson	--	15	7	.13-.15
Willwood	35-80	18	13	.07-.09 over .04 at 8 inches
Worland	--	14	2	.11-.13
Youngston	<5	12	8	.19-.21
Sandy Alluvium		16	10	.08-.11

	Parent Material	Permeability In/Hr	Soluable Salts mmhos/cm	Alkalinity pH
Apron	Sandy alluvium	2.0-6.0	< 2	7.4-9.0
Avalon	Moderate coarse textured alluvium	0.6-2.0	< 2	7.9-8.4
Badland	Shale	--	--	--
Binton	Medium to moderately fine textured alluvium	0.6-6 0	>16	8.5-9.0
Bributte	Alkaline shale	<0.06	8-16	>9.1
Chipeta	Shale	0.06-0.2	4-16	8.5-9.0
Cliffterson	Loamy gravel	6.0-20.0	<2	7.4-9.0
Deaver	Shale	0.06-0.6	4-16	7.9-8.4
Emblem	Very gravelly sand	0.6-6.0	<4	7.9-8.4
Enos	Sandstone	2.0-6.0	<4	7.4-8.4
Garland	Very gravelly sand	0.6-2 0	<4	7.4-9.0
Greybull	Shale	0.06-0.6	2-8	7.9-9.0
Griffy	Medium textured alluvium	0.6-2.0	<4	7.9-9.0
Gystrum	G.prock	0.6-2.0	4-16	7.9-9.0
Kinnear	Medium textured alluvium	0.6-2.0	<4	7.9-9.0
Lostwells	Medium textured alluvium	0.2-2.0	2-8	7.9-9.0
Lostwells, alkali	Medium textured alluvium	0.2-0.6	2-16	8.5- 9.1
Oceanet	Sandstone	2.0-6.0	<4	7.9-8.4
Pavillion	Shale	0.6-2.0	2-8	8.5- 9.1
Persayo	Shale	0.06-0.6	2-8	8.5-9.0
Pregatorson	Very gravelly sand	6.0-2.0	<4	7.9-8.4
Rairdent	Medium textured alluvium	0.2-6.0	2-16	6.6-9.0
Saddle	Sandstone	0.2-2.0	2-8	7.9-9.0
Sharland, alkali	Very gravelly sand	0.6-20.0	<4	7.9-8.4
Uffens	Shale	0.06-0.6	2-8	7.8- >9.1
Uffens, moderately deep	Shale	.06-.2	2-4	8.5- >9.1
Wallson	Moderatel. coarse textured alluvium	2.0-6.0	<4	6.6-9.0
Willwood	Gravelly alluvium	6.0-20.0	<8	7.4-8.4
Worland	Sandstone	2.0-6.0	<4	7.9-8.4
Youngston	Stratified alluvium	0.2-0.6	?-8	7.9-8.4
Sandy Alluvium	Recent sandy alluvium	6.0-20.0	<4	7.4-8.4

	Land Capability Unit for Irrigation 0-3% Slopes	3-6% Slopes	6-10% Slopes	10-15% Slopes
Apron	IIe5	IIIe5	IVe5	--
Avalon	IIc2	IIIe2	IVe2	--
Badland	VIIIs83	VIIIs83	VIIIs83	VIIIs83
Binton	VIs71	VIs71	--	--
Bributte	VIIs14	VIIe14	VIIe14	VIIe14
Chipeta	VIe14	VIe14	VIe14	VIe14
Clifterson	IVs9	IVs9	IVs9	VIs9
Deaver	IVs13	IVe1	IVe1	VIe1
Emblem	IIs2	IIIe2	IVe2	--
Enos	IVs5	IVe5	IVe5	VIe5
Garland	IIc2	IIIe2	IVe2	--
Greybull	IVs2	IVe1	IVe1	VIe1
Griffy	IIc2	IIIe2	IVe2	--
Gystrum	VIs3	VIs3	VIs3	VIs3
Kinnear	IIc1	IIIe2	IVe2	--
Lostwells	IIc1	IIIe2	IVe2	--
Lostwells, alkali	IVs12	IVs12	IVe12	--
Oceanet	IVe14	IVe14	IVe14	VIe14
Pavillion	IVs2	IVe2	IVe2	--
Persayo	IVe14	IVe14	IVe14	VIe14
Pretorson	VIIe9	VIIe9	VIIe9	VIIe9
Fairdent	IIc2	IIIe2	IVe2	--
Saddle	IVs2	IVe2	IVe2	VIe2
Sharland, alkali	IVs6	IVs6	IVs6	--
Uffens	IIc1	IIIe2	IVe2	VIe2
Uffens, moderately deep	IVs2	IVe1	IVe1	VIe1
Wallson	IIe5	IIIe5	IVe5	--
Willwood	VIs9	--	--	--
Worland	IVs5	IVe5	IVe5	VIe5
Youngston	IIc1	IIIe2	IVe2	--
Sandy Alluvium	IIIs4	IVe4	IVe4	--

	Potential as an irrigated soil
Apron	Good
Avalon	Good
Badland	--
Binton	Fair - saline-alkali spots
Bributte	Very poor alkali, steep slopes
Chipeta	Poor-Shallow fine texture, slow intake rate
Clifterson	Fair-Very gravelly, steep slopes
Deaver	Fair - Poor intake rate, fire texture
Emblem	Good
Enos	Good-20-40 inches deep over sandstone
Garland	Good
Greybull	Fair - Moderately deep over shale
Griffy	Good
Gystrum	Poor-Salinty (gypsum)
Kinnear	Good
Lostwells	Good
Lostwells, alkali	Fair - 10-15% slick spots
Oceanet	Fair - Shallow over sandstone
Pavillion	Fair - Moderately deep over shale, 10-20% slick spots
Persayo	Poor-Shallow over shale
Preatorson	Fair - very gravelly
Fairdent	Good - ~~5-15% saline-spots~~
Saddle	Fair - Moderate deep over shale
Sharland, alkali	Fair - Shallow over gravely 10-15% slick spots
Uffens	Good - 10-25% slick spots
Uffens, moderately deep	Fair - 15-30% slick spots
Wallson	Good
Willwood	Poor-Very gravelly
Worland	Good-Moderately deep over shale
Youngston	Good - 5% saline spots
Sandy Alluvium	Good-Small areas, Erosive

CLASS II

1. Suitable for 3-4 years row crop in rotation with hay and pasture.

2. IIc1 - Fall plowing is desireable and important to incorporate organic matter for tilth and water intake.

3. IIe5 - Some erosion hazard. No fall plowing. Emergency tillage on cover crop usually needed after row crop. Fall and winter livestock trampling increases problem.

CLASS III

1. Suitable for 2-3 years row crop in rotation with hay and pasture.

2. S4 and Se5 - Some wind erosion hazard. No fall plowing. Emergency tillage on cover crop usually needed after row crop. Fall and winter livestock trampling increases problem.

CLASS IVe1, s2, s6, s12, s13, s5

1. Suitable for 1-2 years row crop in rotation with hay and pasture except corn, beans and potatoes are not adapted to IVe1 and IVs12.

2. IVe1 and s13 - Fall plowing is desireable and important to incorporate organic matter for tilth and water intake.

CLASS IVe2, e5, e6, s9, e12, e14

1. These soils are suitable for hay, pasture and small grain. They are not generally suited for row crop.

CLASS VI lands are suitable for the production of sod crops only. Grazing and fertility management should be designed to prolong the productivity. Care is needed in reestablishment of stands to prevent erosion.

CLASS VII - Not suitable.

MAXIMUM SPRINKLER APPLICATION RATE - P - (In./Hr.)

Soil Design Group	Design Slope Groups	NET IRRIGATION APPLICATION 1.0 Clean Tilled	1.0 With Cover	1.5 Clean Tilled	1.5 With Cover	2.0 Clean Tilled	2.0 With Cover	2.5 Clean Tilled	2.5 With Cover	3.0 Clean Tilled	3.0 With Cover	4.0 Clean Tilled	4.0 With Cover	5.0 Clean Tilled	5.0 With Cover
1, 2, 3, 4	0.40 or less	1.00	1.50	0.55	0.80	0.35	0.50	0.30	0.45	0.30	0.40	0.25	0.35	0.20	0.30
	0.75 or 1.25	0.80	1.20	0.50	0.70	0.35	0.45	0.30	0.40	0.30	0.40	0.25	0.35	0.20	0.30
	2.00	0.70	1.00	0.40	0.60	0.30	0.40	0.25	0.35	0.25	0.35	0.20	0.30	0.20	0.25
	3.00	0.55	0.80	0.35	0.50	0.30	0.40	0.25	0.35	0.25	0.35	0.20	0.30	0.20	0.25
	5.00 or 8.00	0.35	0.50	0.30	0.40	0.25	0.35	0.20	0.30	0.20	0.30	0.20	0.25	0.20	0.20
5, 6,	0.40 or less	1.20	1.80	1.00	1.50	0.60	0.90	0.55	0.80	0.50	0.70	0.40	0.50	0.35	0.50
	0.75 or 1.25	1.20	1.80	0.90	1.30	0.55	0.85	0.50	0.75	0.45	0.65	0.40	0.55	0.35	0.50
	2.00	1.20	1.80	0.75	1.10	0.50	0.75	0.45	0.65	0.40	0.60	0.35	0.55	0.30	0.45
	3.00	1.00	1.50	0.60	0.90	0.45	0.70	0.40	0.60	0.40	0.55	0.35	0.50	0.30	0.45
	5.00 or 8.00	0.70	1.00	0.50	0.70	0.40	0.60	0.35	0.55	0.35	0.50	0.30	0.45	0.25	0.40
9, 10,	0.40 or less	1.20	1.80	1.20	1.80	1.20	1.30	1.10	1.70	1.00	1.50	0.90	1.30	0.80	1.20
	0.75 or 1.25	1.20	1.80	1.20	1.80	1.10	1.70	1.05	1.60	0.95	1.40	0.85	1.20	0.80	1.20
	2.00	1.20	1.80	1.20	1.80	1.10	1.60	1.00	1.50	0.90	1.30	0.80	1.20	0.75	1.10
	3.00	1.20	1.80	1.20	1.80	1.00	1.50	0.95	1.40	0.85	1.30	0.75	1.10	0.75	1.10
	5.00 or 8.00	1.20	1.80	1.15	1.70	0.95	1.40	0.90	1.30	0.80	1.20	0.75	1.10	0.70	1.00
13-19	All slopes	No restrictions within practical design criteria													

PREATORSON-PERSAYO complex, 3 to 30 percent slopes (315-BD)

This complex consists of about 30 percent Preatorson very gravelly sandy clay loam, 2 to 30 percent slopes, 25 percent Persayo gravelly loam, 3 to 60 percent slopes, and 20 percent Willwood very gravelly or very cobbly sandy loam, 0 to 6 percent slopes. These soils have profiles described as representative for the respective series, except Persayo has a gravelly surface.

Preatorson and Willwood soils are on the upper part of the terrace escarpments and Persayo soils are on the lower part.

These soils are on or adjacent to terrace escarpments. Twenty-five percent Apron sandy loam, Greybull loam and Rockland are included in mapping.

Preatorson and Willwood soils have slow to medium runoff. Water erosion hazard is slight to moderate.

This complex is used for range land, homesites and other community uses and wildlife habitat.

Capability Unit: VIe9, dryland; Coarse upland range site.

ENOS-WALLSON ASSOCIATION, 0 to 10 percent slopes (343-AC)

This association consists of about 40 percent Enos loamy fine sand, 0 to 10 percent slopes, about 40 percent Wallson loamy fine sand, 0 to 10 percent slopes, and about 20 percent Worland loamy fine sand, 0 to 15 percent slopes. The profiles of these soils are similar to the profiles described as representative for the respective series. They are intermingled on undulating to rolling uplands with Worland and Enos soils on the steeper slopes and Wallson soils on the broader undulating slopes. Small areas of Apron sandy loam and Persayo loam may be included in mapping.

These soils have slow to medium runoff. Water erosion hazard is slight to moderate. Wind erosion hazard is moderate.

This complex is used for range land, homesites and other community uses and wildlife habitat.

Capability Unit: VIc5, dryland; Sandy range site.

LAND CAPABILITY UNIT DESCRIPTIONS FOR BIG HORN IRRIGATION DEVELOPMENT ASSOCIATION

SHARLAND clay loam, alkali, 0 to 10 percent slopes (65-AC)

This soil occupies nearly level to sloping fans and terraces. The profile of this soil is the same as the profile described as representative of the series except they have high reactions, pH more than 9.2 below the surface layer, but exchangeable sodium is more than 15 percent.

Included are about 15 percent Uffens clay loam and about 10 percent Kinnear clay loam.

Runoff is medium to rapid and erosion hazard is slight to severe.

This soil is used for range land, homesites, other community uses and wildlife habitat.

Capability Unit: VIIs12, dryland; Saline upland range site.

UFFENS silty clay loam, 0 to 10 percent slopes (67-AC)

This soil is on nearly level to sloping alluvial fans and terraces. It has the profile described as representative of the series. Five percent Sharland clay loam, alkali, 10 percent Kinnear clay loam, and 10 percent Lostwells clay loam are included in mapping, 5 percent Griffy and 5 percent Rairdent.

Runoff is slow to rapid. Water erosion hazard is slight to severe.

This soil is used for range land, community uses and wildlife habitat.

Capability Unit: VIIs12, dryland; Saline upland range site.

BADLAND (102)

This landtype consists of gentle to very steep uplands of exposed bedrocks, saline-alkaline soft interbedded shales and sandstones. Included are about 10 percent Persayo clay loam and about 10 percent Greybull clay loam or Beaver silty clay.

Runoff is rapid and erosion hazard is severe.

This land type is used for community uses, range land, and wildlife habitat.

Capability Unit: VIIIs23, dryland.

APRON-WORLAND SANDY LOAMS, 0 to 10 percent slopes (442-BC)

This complex consists of about 45 percent Apron sandy loam, 0 to 10 percent slopes, 30 percent Worland sandy loam and 15 percent Wallson sandy loam. Ten percent Oceanet sandy loam and Persayo clay loam are included in mapping. These soils have profiles described as representative of the respective series.

These soils are intermingled on rolling uplands with Worland soils on ridgetops; Apron and Wallson soils are on the alluvial sideslopes.

Runoff is slow to medium, water erosion hazard is slight to moderate and wind erosion hazard is moderate.

This complex is used for irrigated crops such as alfalfa, small grains, irrigation pasture, range land, homesites and wildlife habitat.

Capability Unit: IVe5, irrigated; VIe5, dryland.
Sandy (5 to 9 inch precipitation zone) range site.

LOSTWELLS COMPLEX, Alkali, 0 to 10 percent slopes (351-AC)

This soil is on broad nearly level to sloping alluvial fans and terraces. It has the profile described as representative of the series except it is strongly to very strongly alkaline (pH 8.9 to 9.2), below the surface layer and has more than 15 percent exchangeable sodium. Included is about 40 percent Lostwells clay loam and 15 percent Binton soils.

Runoff is slow to moderate and erosion hazard is slight to moderate.

This soil is used for range land, wildlife habitat and community uses.

Capability Unit: VIs12, dryland; Saline upland range site.

BINTON-YOUNGSTON ASSOCIATION, 0 to 10 percent slopes (363-AC)

This association consists of about 50 percent Binton silty clay loam, 0 to 6 percent slopes and about 30 percent Youngston clay loam, 0 to 10 percent slopes. The profiles of these soils are similar to the profiles described as representative for the respective series. Binton is located on lower lying and overflow areas. Youngston is located on nearly level to sloping fans. Included are about 10 percent of Lostwells clay loam, alkali, and about 10 percent of Lostwells clay loam.

Runoff for Binton is medium and erosion hazard is moderate to severe. Runoff for Youngston is slight to medium and erosion hazard is slight to moderate.

This association is used for range land, homesites, other community uses and wildlife habitat.

Binton - Capability Unit: VIIs71, dryland; saline lowland range site.
Youngston - Capability Unit: VIe1, dryland; loamy range site.

GREYBULL-PERSAYO ASSOCIATION, 0 to 30 percent slopes (371-AD)

This association consists of about 50 percent Greybull clay loam, 0 to 30 percent slopes; 30 percent Persayo clay, 0 to 30 percent slopes. They are on nearly level to steep rolling shale hills with Persayo on the ridge tops and Greybull on the sideslopes. Twenty percent Chipeta silty clay shale rockland are included in mapping.

Runoff is slight to rapid. Water and wind erosion hazard is slight to severe.

This association is used for range land and wildlife habitat.

Capability Unit: Greybull VIe1, dryland; Persayo VIIe14, dryland; Saline upland range site.

CHIPETA clay loam, 10 to 60 percent slopes (374-CE)

This soil is on rolling steep uplands. It has the profile described as representative of the series. Fifteen percent rockland shale; 10 percent Beaver silty clay, 0 to 30 percent slopes; and Persayo loam, 10 to 60 percent slopes are included in mapping.

Runoff is medium to rapid. Water erosion hazard is moderate to severe. Wind erosion hazard is moderate.

This soil is used for range land, community uses and wildlife habitat.

Capability Unit: VIIe14, dryland; Saline upland range site.

GRIFFY-GARLAND ASSOCIATION, 0 to 10 percent slopes (393)

Same as 493.

BRIBUTTE-PERSAYO ASSOCIATION, 6 to 60 percent slopes (471-CE)
This association consists of about 35 percent Bributte silty clay, 6 to 60 percent slopes, 30 percent Persayo clay loam, 6 to 60 percent slopes and 15 percent Shale. The profile of these soils are similar to the profiles described as representative for the respective series. Bributte and Persayo are intermingled with exposures of shale in sloping to steep hilly uplands dissected with many eroding drainageways. Twenty percent Chipeta and Deaver soils are included in mapping.

Runoff from Bributte soils is rapid and water erosion hazard is severe.

This association is used for range land and wildlife habitat.

Capability Unit: Bributte and Persayo - VIIe14, dryland, Saline upland range site.
Capability Unit: Rockland - VIIIes83, dryland.

CHIPETA-DEAVER complex, 0 to 30 percent slopes (474-AD)
This complex consists of about 50 percent Chipeta clay loam, 0 to 30 percent slopes; 30 percent Deaver silty clay, 0 to 30 percent slopes; and 15 percent Stutzman silty clay loam, 0 to 10 percent slopes. These soils have profiles described as representative for the respective series. Exposures of shale and Chipeta soils occur on the rolling ridgetops with Deaver on the sideslopes and Stutzman in the narrow valleys or drainageways between the ridges. Fifteen percent shale, 5 percent Persayo clay loam and 5 percent Greybull clay loam are included in mapping.

Runoff from Chipeta and Deaver soils is medium to rapid. Water erosion hazard is moderate. Wind erosion hazard is moderate.

Runoff from Christianburg soils is slow to medium, water erosion hazard is slow to moderate.

This complex is used for range land, community uses and wildlife habitat.

EMBLEM-GRIFFY COMPLEX, 3 to 30 percent slopes (493-BD)
This complex consists of about 40 percent Emblem sandy loam, 3 to 10 percent slopes; 25 percent Griffy sandy loam, 1 to 30 percent slopes and 20 percent Preatorson very gravelly sandy clay loam, 3 to 30 percent slopes. These soils have profiles described as representative for the respective series. These soils are intermingled on the broad, gently to moderately steep, dissected terraces adjacent to escarpments. Preatorson soils are adjacent to and on the escarpments with Emblem and Griffy on the lesser slopes. Fifteen percent Greybull loam, Persayo loam and Garland loam are included in mapping.

Preatorson soils have slow to rapid runoff and water erosion hazard is slight to moderate.

This complex is used for range land, homesites and other community uses and wildlife habitat.

Capability Unit: VIc2, dryland; Loamy range site.

RAIRDENT-UFFENS ASSOCIATION, 0 to 10 percent slopes (367-AC)

This association consists of 60 percent Rairdent loam and 35 percent Avaman silty clay loam. These soils have profiles described as representative for their respective series. They occur in association on nearly level to sloping alluvial fans and terraces. About 5 percent Gystrum is included in mapping.

Rairdent soils have slow to medium runoff and water erosion hazard is slight to moderate.

This association is used for range land and wildlife habitat.

Capability Unit: Rairdent, VIe2, dryland; Loamy range site.
Capability Unit: Uffens, VIIs12, dryland; Saline upland range site.

LOSTWELLS-KINNEAR ASSOCIATION, 0 to 10 percent slopes (368-AC)

This association consists of about 40 percent Lostwells clay loam, 0 to 10 percent slopes; about 40 percent Kinnear clay loam, 0 to 10 percent slopes. The profiles of these soils are the same as the profiles described as representative for the respective series. Lostwells is located on undulating to rolling fans and along drainageways. Kinnear is located on smooth singleplain more stratalized fans.

Runoff is medium to rapid and erosion hazard is moderate to severe.

This association is used for range land, homesites, other community uses and wildlife habitat.

Capability Unit: VIe2, dryland, Loamy range site.

PAVILLION-KINNEAR ASSOCIATION, 3 to 30 percent slopes (467-[illegible])

This association consists of about 50 percent Pavillion loam, 0 to 3[illegible] percent slopes, 30 percent Kinnear clay loam, 3 to 30 percent slopes and 20 percent Persayo loam, 3 to 45 percent slopes. The profiles of these soils are the same as the profiles described as representative of the respective series except the surface layer has 5 to 10 percent gravel and cobble. They are intermingled on rolling uplands wit Persayo on or near the ridgetops, Pavillion on the side slopes and Kinnear is on the valley filling slopes. Small areas of Greybull shale outcrop are included in mapping.

Runoff from Pavillion and Persayo is medium to rapid and water erosion hazard is moderate to severe. Runoff from Kinnear is medium and water erosion hazard is moderate.

This association is used for range land and wildlife habitat.

Capability Unit: Pavillion and Kinnear, VIe2, dryland; Loamy range site.
Capability Unit: Persayo, VIIe14, dryland; Saline Upland range site.

UFFENS-RAIRDENT ASSOCIATION (607)

This association consists of about 35 percent Uffens silty clay loam, 0 to 6 percent slopes, about 30 percent Rairdent loam, 0 to 10 percent slopes, and about10 percent Emblem loam, 0 to 6 percent slopes. The profiles of these soils are similar to the profiles described as representative for the respective series. These soils occur on nearly level to sloping alluvial fans and terraces. Uffens is located on the less sloping and depressional areas. Rairdent is located on the higher lying areas and Emblem is located adjacent to terrace escarpments or gravel ridges. Included are about 10 percent of Griffy sandy clay loam, about 5 percent of Kinnear clay loam, about 10 percent of Uffens moderately deep silty clay loam, and Clifterson gravelly loam.

Runoff for Uffens is medium and erosion hazard is moderate. Runoff for Rairdent is slow to medium and erosion hazard is slight to moderate. Runoff for Emblem is slow to medium and erosion hazard is slight to moderate.

This association is used for range land, community uses, and wildlife habitat.

Uffens - Capability Unit: VIIs12, dryland; Saline upland, 6 to 9 inch precipitation zone, range site.
Rairdent - Capability Unit: VIe2, dryland; Loamy, 6 to 9 inch precipitation zone, range site.
Emblem - Capability Unit: VIe2, dryland; Loamy, 6 to 9 inch precipitation zone, range site.

LOSTWELLS-YOUNGSTON COMPLEX (643)

This complex consists of about 40 percent Lostwells sandy clay loam, 3 to 10 percent slopes, about 20 percent Youngston silty clay loam, 3 to 10 percent slopes, about 10 percent Lostwells sandyclay loam, alkali, 3 to 6 percent slopes and about 10 percent Uffens fine sandy loam, 3 to 10 percent slopes. The profiles of the Lostwells sandy clay loam and Youngston soils are the same as the profiles described as representative for the respective series. The profile of the Lostwells sandy clay loam, alkali, is similar to the profile described as representative of the series except that it is very strongly alkaline. The profile of the Uffens soils is similar to the profile described as representative of the series. These soils occur in an intermingled pattern on gently sloping to sloping alluvial fans. Included are a total of about 20 percent Persayo clay loam, Worland sandy loam, Enos sandy loam and Oceanet sandy loam.

PERSAYO-SADDLE ASSOCIATION (497)

This association consists of about 35 percent Persayo clay loam, 0 to 25 percent slopes and about 30 percent Saddle sandy clay loam, 0 to 15 percent slopes The profiles of these soils are similar to the profiles described as representative for the respective series Persayo is located on the steep breaks and in small pockets and Saddle is located on the higher elevations or undulations. Included are about 15 percent of Griffy sandy clay loam, about 5 percent of Uffens silty clay loam, and about 10 percent of Enos sandy loam

Runoff for Persayo is slow to rapid and erosion hazard is slight to rapid. Runoff for Saddle is slow to medium and erosion hazard is slight to moderate.

This association is used for range land, community uses and wildlife habitat

Persayo - Capability Unit - VIe14, dryland; Saline upland range site
Saddle - Capability Unit - VIe2, dryland; Sandy, 5 to 9 Inch precipitation zone, range site

UFFENS-CHIPETA ASSOCIATION, 0 to 30 percent slopes (570-AD)

This association consists of about 60 percent Avaman silty clay loam, 0 to 10 percent slopes and 30 percent Chipeta clay loam, 0 to 30 percent slopes. The profiles of these soils are the same as described as representative for the respective series. About 10 percent Rockland (shale) and Avaman silty clay loam, shallow, 0 to 10 percent slopes are included in mapping.

This association is used for range land, community uses and wildlife habitat

Capability Unit: Avaman - VIIs12, dryland; Chipeta - VIIe14, dryland; Saline upland range site

YOUNGSTON-UFFENS COMPLEX (601)

This complex consists of about 45 percent Youngston silty clay loam, 0 to 10 percent slopes and about 35 percent Uffens fine sandy loam, 0 to 10 percent slopes The profiles of these soils are the same as the profiles described as representative for the respective series These soils occur in an intermingled pattern on nearly level to sloping alluvial fans, floodplains and valley fills. Included are a total of about 20 percent of Stutzman silty clay; Lostwells sandy clay loam, alkali; Lostwells sandy clay loam, sandy alluvium and some Greybull clay loam that occupies small isolated knobs. Slick spots are common and occupy about 20 percent of the surface area.

Runoff for soils in this complex is slow to rapid and erosion hazard is slight to severe. Wind erosion hazard is slight to moderate. This complex is used for range land, wildlife habitat and community uses.

The soils in this complex are in Saline Upland, 5 to 9 inch Precipitation Zone, range site

PERSAYO-BADLAND ASSOCIATION (671)

This association consists of about 40 percent Persayo clay loam, 6 to 60 percent slopes and about 40 percent Badland. The profile of the Persayo soil is the same as the profile described as representative for the series. Badland is steep or very steep nearly barren land, broken by numerous intermittent drainage channels that have entrenched themselves in soft varigated alkaline interbedded sandstone and shale. Persayo is located on the lower portions of the sideslopes and ridge tops. Badlands is located on the upper portion of the sideslopes. Included are a total of about 20 percent Lostwells sandy clay loam and Youngston silty clay loam.

Runoff for this association is rapid and erosion hazard is severe. Wind erosion hazard is slight to moderate.

This association is used for range land, wildlife habitat and community uses.

Persayo soils: Saline Upland, 5 to 9 inch Precipitation Zone, range site.
Badland: No range site assigned.

PERSAYO-BADLAND ASSOCIATION, 0 to 10 percent slopes (661)

This association consists of about 55 percent Persayo clay loams, 0 to 10 percent slopes, about 15 percent Badlands, and about 5 percent Uffens moderately deep silty clay loam, 0 to 10 percent slopes. The profiles of these soils are similar to the profiles described as representative for the respective series.

Persayo is located on nearly level to sloping uplands adjacent to exposures of shale. Badlands is gently sloping to steep nearly barren land, broken by numerous intermittent drainage channels that have entrenched themselves in soft varigated alkaline interbedded sandstones and shales. Uffens is located on nearly level to rolling uplands. Included are about 5 percent of Lostwells sandy clay loam, about 10 percent of Youngston silty clay loam, about 5 percent of Chipeta silty clay and about 5 percent Greybull.

Runoff for Persayo is medium and erosion hazard is moderate to severe. Runoff for Uffens is medium to rapid and erosion hazard is moderate to rapid. Runoff for Badland is rapid and erosion hazard is severe.

This association is used for range land, community uses and wildlife habitat.

Persayo - Capability Unit: VIIs14, dryland, Saline upland, 5 to 9 inch precipitation zone, range site.
Uffens moderately deep - Capability Unit: VIIs12, dryland, Saline upland, 5 to 9 inch precipitation zone, range site.
Badlands - Capability Unit: VIIIe83, dryland.

RAIRDENT-UFFENS COMPLEX, 0 to 10 percent slopes (667)

This complex consists of about 40 percent Rairdent loam, 0 to 10 percent slopes, about 20 percent Uffens clay loam, 0 to 6 percent slopes, about 15 percent Griffy sandy loam, 0 to 10 percent slopes; and about 5 percent Clifterson. The profiles of these soils are similar to the profiles described as representative for the respective series. These soils occur in an intermingled pattern on nearly level to sloping alluvial fans and terraces.

Rairdent and Griffy are located on nearly level to sloping alluvial fans and terraces. Uffens is located on nearly level to gently sloping depressional areas. Included are about 15 percent of Avalon loam and about 5 percent of Kinnear clay loam.

Runoff for Uffens is medium and erosion hazard is slight to moderate. Runoff for Griffy and Rairdent is slow to medium and erosion hazard is slight to moderate.

This complex is used for range land, community uses and wildlife habitat.

The Complex - Capability Unit: VIIs12, dryland; 40% Saline upland, 5 to 9 inch precipitation zone, range site; and 60% Loamy, 6 to 9 inch precipitation zone, range site.

CAPABILITY UNIT

VIe14

Soil Description: Sandy to clayey soils 10 to 20 inches in depth and underlain by bedrock. Slopes range from 3-15%.

Needs: Very good irrigation water management to prevent seepage and erosion on these slopes. These shallow soils are best adapted to permanent cover crops. Use only limited tillage to re-establish stands.

Use: Poor land suitable for permanent hay or pasture.

Included Soils:

MAPPING UNIT DESCRIPTION
FROM THE WASHAKIE AND BIG HORN COUNTY SOIL SURVEY AREAS

These mapping unit descriptions are from the Range land Survey Legend which does not list an irrigated capability unit on them. For the irrigated capability unit, refer to the Soil Features Interpretation Chart.

CAPABILITY UNIT

IIc1

Soil Description: Deep soils with clay or heavy silty clay loam surface layers and loamy subsoils. These soils take water rather slowly and have good water holding capacity. Growing season is more than 90 days. Slopes are level to nearly level (0-3%).

Needs: These soils tend to form clods if worked wet and they form hard surface crusts when they dry out after wetting. Fall plowing, plowing under manure or crop residues, or growing hay in a crop rotation will improve the tilth of these soils.

Use: Good land capable of producing good yields of all adapted crops.

Included Soils:

CAPABILITY UNIT

VIs14

Soil Description: Sandy to clayey soils 10 to 20 inches deep underlain by bedrock. Water intake ranges from slow to rapid and slopes are level to nearly level (0-3%).

Needs: Good irrigation water management is necessary to prevent these and nearby soils from becoming seeped and saline, and to minimize water erosion. Shallow rooted crops are best adapted with limited tillage to re-establish stands.

Use: Poor land suitable for permanent hay or pasture.

Included Soils:

CAPABILITY UNIT

IIs2

Soil Description: Soils with loamy surface layers that are underlain by gravel or permeable bedrock at depths of 20 to 40". These soils take water readily and have a limited water holding capacity. They have good subsurface drainage. Growing season is more than 120 days. Slopes are level (0-1%).

Needs: These soils need to be irrigated more frequently than deeper soils.

Use: Good land capable of producing good yields of all adapted crops.

Included Soils:

CAPABILITY UNIT

IIc2

Soil Description: Soils 20 inches or more in depth with loam or clay loam surface layers that take water readily and have good water holding capacity. Soils less than 40 inches deep are underlain by gravel. This soil is subject to slight wind erosion if left unprotected. The growing season ranges from 90-120 days. Slopes are level (0-1%).

Needs: Good management such as crop rotation and fertilization, is needed to maintain and improve this land.

Use: Good land capable of producing good yields of all crops adapted to the cool temperatures and short growing season.

Included Soils:

CAPABILITY UNIT

IIIe2

Soil Description: Soils over 20 inches deep with loamy surface layers that acquire water easily and have good water holding capacity. Soils less than 40 inches deep are underlain by gravel. Slopes are moderate (3-6%). These soils are subject to moderate water erosion.

Needs: Proper irrigation water management to prevent seepage of lower lying lands is needed. Irrigation water should be applied in moderate length runs and on the contour or across slope to control water erosion.

Use: Moderately good land capable of producing good yields of all adapted crops.

Included Soils:

CAPABILITY UNIT

IIe5

Soil Description: Soils more than 20 inches deep with sandy loam surface layers that take water readily and good water holding capacity. Soils less than 40 inches deep are underlain by gravel. Sandy topsoils are subject to wind erosion. Growing season is 90-120 days. Slopes are level to nearly level (0-3%).

Needs: Vegetative cover or emergency tillage is needed to protect the soil from wind erosion.

Use: Good land capable of producing good yields of all crops adapted to the cool temperatures and short growing season

Included Soils:

CAPABILITY UNIT

IIIe5

Soil Description: Soils over 20 inches deep with sandy loam surface layers which take water readily and have good water holding capacity. Soils less than 40 inches deep are underlain by gravel or bedrock other than shale. These soils are susceptible to wind and water erosion. Slopes are moderate (3-6%).

Needs: Vegetative cover or emergency tillage to control wind erosion is needed. Irrigation water should be applied in moderate length runs and on the contour or across slope to control water erosion.

Use: Moderately good land capable of producing good yields of all adapted crops.

Included Soils:

CAPABILITY UNIT

IIIs4

Soil Description: Sandy soils over 20 inches deep that take water readily, and have a low water holding capacity. Soil less than 40 inches deep is underlain by gravel. Slopes are level to moderate (0-6%).

Needs: Vegetative cover or emergency tillage is needed to protect the surface from wind erosion. Proper irrigation water management is needed to control erosion on moderate slopes. Close growing crops should dominate the rotation to control erosion.

Use: Moderately good land capable of producing good yields of adapted crops.

Included Soils:

CAPABILITY UNIT

IVe2

Soil Description: Soils over 20 inches deep with loamy surface soils that take water readily. Slopes are moderate to moderately steep (3-10%). This soil is subject to water erosion.

Needs: Proper irrigation water management and use of close growing permanent type vegetation to prevent erosion. Plow under crop residues and manures when possible.

Use: Fair land that is adapted to permanent hay or pasture but can be cultivated occasionally with good management and conservation practices.

Included Soils:

CAPABILITY UNIT

IVe1

Soil Description: Soils over 20 inches deep with clay or heavy silty clay loam surface layers and subsoils that take water slowly. Slopes are moderate to moderately steep (3-10%). These soils have poor tilth and are subject to water erosion.

Needs: Proper irrigation water management and use of close growing type vegetation to prevent erosion. Plow under crop residues and manures when possible.

Use: Fair land that is best adapted to permanent hay or pasture but can be cultivated occasionally.

Included Soils:

the same as those noted above as having potential to mitigate deer losses. Species which would realize significant benefit from such mitigation include cottontail rabbits, chipmunks, pheasants, deer mice, badgers, skunks, golden eagles, rough-legged hawks, big horned owls, Brewer's sparrows, mourning dove, horned larks, weasels and red fox. Mere retention in public ownership with termination of livestock use in these areas would cause some mitigation. To realize maximum mitigation on a variety of species, a considerable expenditure of money and manpower would be required. The cost would undoubtedly be paid by the public.

Domestic livestock and wild horses

Wild stallions could be removed from bands displaced from the proposed project area if it appeared necessary to avoid territorial strife.

<u>Human Values</u>

Landscape

A number of steps could be taken to lessen the damaging effect of the proposed agricultural development on the environment. The following measures would also enhance the scenic quality of the new landscape replacing the present cold desert landscape.

-- Select locations for road and powerline rights-of-way based in part on their enhancement of scenic qualities.

-- Retain land in federal ownership where existing scenic resources are valuable enough to merit such protection.

-- Restrict utility lines to road rights-of-way or require them to be put underground where suspended lines would be skylined or otherwise highly intrusive.

-- Provide and classify for sanitary landfills at strategic locations in the project to be maintained by the county.

Cultural values

Recreation

In addition to mitigating measures above -- which benefit recreation -- these additional mitigating measures are feasible.

-- Retain in public ownership leave areas in and around proposed project land for wildlife habitat.

-- Insure continued recreational access by keeping open major access routes to land beyond the proposed project and to the public land remaining within the project boundaries.

Archaeology and paleontology

Mitigation of effects on archaeological and paleontological values would require either salvage excavation or withdrawal of areas containing those values from agricultural entry. It would be possible to salvage sites by excavation. Such excavation would produce some information about the patterns of early man's life in the Basin. Retention in public ownership of areas containing sites would help to preserve them in their natural surroundings with the original placement of their components.

A visitor route could be established with information stations at individual sites. Further survey work should be done in all areas to insure that all significant sites are identified and protected.

Socio-economic

Most of the impacts expected with the increase in population could be mitigated by keeping affected communities informed of pending development. Communities could then plan for increased demand for services and be prepared for the added load.

Not Enforceable by BLM

The following measures were recognized by the team as being sound practices, but they are not enforceable by BLM under present regulations.

Air

Air quality standards are controlled by the state's department of environmental quality. We do not anticipate the emission of pollutants from proposed project activities would exceed these standards, but monitoring by the state agency would insure that if violations incur, they would be quickly discontinued.

Plowing methods which reduce wind erosion also reduce the amount of particulate matter released into the air. Where fall plowing is done, the soil should not be harrowed. This would reduce the amount of wind-borne dust during the fall and early spring.

Soil

Water erosion could be lessened by plowing along the contour and wind erosion could be lessened by not breaking soil lumps to small sizes during fall plowing. This could be done by not harrowing until spring. Concentrations of salt on the fields and seeps in them could be lessened by installation of drains. Areas of low production could thereby be reduced in those areas where water intake rates are slow. Organic matter could be added by plowing under crop residues. Where possible, high residue crops such as corn could be grown for the first few years to furnish more organic matter to be plowed under.

Water

Supply

Spacing river pumping plants an adequate distance apart would mitigate the impact of each pump on the supply of water in the River. However, engineering constraints limit possible pump locations.

Quality

Contour plowing should be done to reduce sediment yield. The state Department of Environment Quality should monitor sediment and chemical content of surface return flows from the project and of the Big Horn River.

Living Components

Plants

Aquatic

The loss of up to 75 acres of cattails could be mitigated greatly by development of marshes on national resource land along drainages such as Tenmile, Sixmile, Fivemile, Elk and Antelope Creeks. This would require development funds and a source of water. Some water might be available from the proposed irrigation system, but the water and the delivery system would have to be purchased and installed by the BLM.

Animals

Fish and wildlife

Threatened species

Possibilities for mitigating impacts on the shovelnose sturgeon and sturgeon chub depend on maintenance of minimum river flows. (See below under "Waterfowl, fish and amphibians.")

Big game animals

Water availability is critically related to the value of habitat in the study area. A cursory survey of land in cattle allotments to the west of the proposed project indicates that antelope use might be expanded if dependable water supplies were available. If, after more thorough investigation, a potential for expansion of habitat by water development is revealed, water could be delivered by pipeline from the proposed project. By inducing antelope to change areas of use to areas previously uninhabitable or only seasonably habitable, due to lack of water, antelope losses could be partially or wholly mitigated. This course of action would require agreement by the irrigation association to supply water and the BLM or the state Game and Fish Dept. to supply funds and manpower for development and maintenance. Antelope damage to crops and ensuing demands for herd reduction could be reduced by making fences antelope tight. Fencing costs and the hazard fencing introduces to antelope and deer, however, would make this measure of questionable value considering wildlife alone. Should the cost have to be borne entirely by the state or federal government, the money could probably be better spent on habitat improvement elsewhere. Deer losses could be mitigated by about 50 percent through preservation of some major drainageways now included in the proposed project area but in public ownership. Part of the estimated 5,000 acres of deer habitat which would be lost is in that part of the proposed project which does not appear farmable due to poor soils and topography. If as much as 1,000 acres of this land were to be retained in public ownership and intensive habitat improvement achieved, nearly all deer losses could be mitigated. This would require that the BLM and the irrigation association ensure water for desirable vegetation and funds and manpower for development and maintenance of the improvements. This effort could be expanded to reduce losses of or enhance habitat for several other species of wildlife. Extension of benefits to other wildlife would require more intensive habitat development, not necessarily more acreage. Opportunities for use of project water and initiation of a cooperative habitat improvement program with the state Game and Fish Dept. would need to be investigated and, if feasible, implemented. The possibilities of using Sykes Act funding here would also need to be explored.

Birds and small animals

Should project water be available for some wildlife habitat development, these areas could be more intensively improved and would mitigate losses to a greater extent. In some instances, for example with ringneck pheasants, populations could be increased above present levels.

Waterfowl, fish and amphibians

Project activities resulting in reduction of suitable goose nesting sites could be mitigated by construction of artificial goose nesting sites. Only a few sites with such a potential occur on national resource land along the river, so most construction would have to be done by other agencies. Should project water be available, marsh areas could be developed along some drainage bottoms. Small retention dams would have to be developed to trap natural runoff and waste water from the proposed project. This would allow development of a small amount of marsh habitat for aquatic plants (cattails, etc.), amphibians, shore birds and ducks. The only mitigating measure which would significantly alleviate the impact upon fish in the river including sturgeon chub and shovelnose sturgeon would be a minimum low requirement for the river below Worland. The Fish and Wildlife Service has recommended minimum flow of about 672 c.f.s. during June, July and August to maintain fish and other biological activity. Another suggested minimum is 20 percent of the average monthly streamflow. This amounts to approximately 481 c.f.s during June, July and August. If either of these minimums were to be invoked, the project could not be developed.

Domestic livestock and wild horses

Some potential for mitigation of livestock forage losses may exist. If water development would permit additional grazing in allotments west of the proposed project area, efforts to secure such project water could be made. Potential for such mitigation is not high in relation to the projected total loss of AUMs of grazing, however. Water development of national resource lands to the west of the project could seasonally benefit wild horses displaced by the project.

Human Values

Landscape

The following measures could be taken to lessen the damaging effects of the proposed project on the environment and enhance the scenic quality of the new landscape replacing the present cold desert landscape.

- Landscape substations and river pump sites.
- Locate powerlines and river pumps in hidden or scenically inobtrusive areas, preferably out of travel corridors.
- Enhance scenic value and provide wildlife cover by planting trees and shrubs on roads, ditches, canals and fencelines.
- Break up farm units and fields by internal fencing.

Cultural values

Recreational values

In addition to mitigating measures above -- which benefit recreation -- these additional mitigating measures are feasible.

- Provide public access for hunting and fishing along roads to river pump stations.

-- Measures which were previously mentioned as enhancing the wildlife would also enhance recreation potential.

RECOMMENDATIONS FOR MITIGATION

The following are measures which are recommended by the team for mitigation of adverse impacts and enhancement of the quality of the environment. Only those measures which the BLM has the capability of bringing about through enforcement of existing regulations are listed here. Many of the possibile mitigating measures listed as not enforceable by BLM are also sound measures.

Land

Use compatibility

Do not classify as suitable for agricultural entry those areas where major conflicts in land use exist.

Living Components

Plants

Terrestrial

Place stipulations in all powerline and other rights-of-way across national resource land requiring rehabilitation with vegetation similar to that which previously existed.

Animals

Fish and wildlife

Threatened species

Survey potential black-footed ferret populations using individuals trained to recognize signs of ferret presence. Do not classify as suitable for agricultural entry areas having a confirmed population of black-footed ferrets.

Big game animals

Investigate thoroughly the potential for antelope habitat expansion through off-project water development and the possibilities for use of project water. Should this prove feasible in all aspects, it will be done. Retain in public ownership an estimated 600 to 1,000 acres of intermittent streambeds and draws containing relatively high-value wildlife habitat and potential for habitat improvement. Manage these areas primarily for wildlife habitat including fencing and exclusion of wildlife use. Investigate opportunities for the use of project water and the initiation of the cooperative habitat improvement program with the state Game and Fish Dept., and if feasible, implement. Explore the possibilities of using Sykes Act funding.

Birds and small animals

As recommended previously for big game animals, drainages suitable for management and improvement as wildlife habitat should be retained in public ownership and the potential for use of project water in habitat development explored.

Waterfowl, fish and amphibians

Build small retention dams in natural drainage areas retained in public ownership. Develop and revegetate them to pond marsh habitat to benefit ducks, amphibians, shore birds and other aquatic life. Explore the possibility of using project water for some aquatic habitat development.

Human Values

Landscape

Locate powerlines and road right-ofways built on federal land off proposed project land in hidden or scenically inobtrusive areas. Prohibit construction of major cross-country utility lines such as the 115 KV line from Thermopolis in travel corridors. That is, allow such rights-of-way only where they cannot be seen from highways. Reserve county road rights-of-way which in their location enhance scenic qualities of the area.

Cultural Values

Recreational values

Retain leave areas in and around proposed project lands for wildlife habitat. Insure continued recreational access by keeping open major access routes to land beyond the proposed project as well as national resource lands within the project.

Archaeology and paleontology

A present survey of proposed project lands does not suggest the presence of sites significant enough to warrant either salvage or withdrawal. Also, none of the sites are significant enough to justify enhancing measures. It should be noted, however, that 47 percent of the project has not undergone archaeological or paleontological survey. The following measures are recommended. Do further survey work to insure that all significant sites are identified and protected. Land suspected of containing a higher probability of significant sites should undergo Class III (intensive) survey. Remaining lands should undergo survey of at least Class II (reconnaissance) intensity. Land which has so far received a Class I (assessment) survey should be upgraded to at least a Class II. Upon finding significant sites, test at least 10 percent of those sites to determine size, age and cultural affiliation. Excavate or salvage those sites which appear to be of high enough significance to display pertinent scientific and educational values. List on the National Register those sites which are found to contain materials of high significance and do not classify as suitable for entry the lands, including appropriate buffer areas around the sites.

Socio-economic

The Bureau should make every effort to keep the public informed of probable development through public meetings, contact with city and county planning staffs and through the news media.

RESIDUAL IMPACTS

Assuming recommended mitigating measures have been applied, some impacts -- both adverse and beneficial -- will remain.

Air

Particulate matter in the form of dust caused by initial land clearing, construction and farming practices will cause some pollution. Smoke from burning crop residues and other vegetation, as well as smoke from vehicular use, will also add particulate matter to the air. Dust levels during the irrigation season when crops are growing will be somewhat less than at present, thus improving the atmospheric conditions. All impacts will occur in insignificant amounts.

Land

Use compatibility

Livestock grazing under BLM licenses will be greatly reduced, and some range users may be greatly impacted. Continuing oil field operations will inconvenience farm operations and take some land out of production. Some recreation opportunities on the project lands will be lost to the public. All remaining impacts from incompatibility of uses will be minor, with the exception of grazing losses.

Soil

Assuming proper irrigation techniques will be used, much of the potential impact on soils can be avoided. Some will, nevertheless, persist. Some very wet field areas will occur, combined with surface salt accumulations. These areas will have low productivity for crops. Saline water from these seep areas may flow into nearby drainageways. Seepage water may create hazards to productivity in downslope fields. It could also be hazardous to wildlife, livestock, and potentially humans, because of chemical compounds contained in it. Light textured, sandy soils in the project will be effected by wind erosion. It may be redeposited in some cases in downwind areas as sand dunes.

Living Components

Vegetation

River-bottom land vegetation will be replaced by plants requiring less water over a period of time. Native vegetation will be completely removed on most of the project land.

Animals

Nesting habitat and part of the food supply of the western burrowing owl will be reduced by the project. The western burrowing owl is a threatened species listed for the state of Wyoming. If present in the study area, the shovelnose sturgeon and the sturgeon chub will be eliminated below river pumps. Other game and non-game species will be eliminated below the river pumps. In remaining areas of the river, habitat quality will be reduced by runoff contaminants. Habitat for approximately 35-45 deer and 45-55 antelope will be lost. The deer herd will be reduced by about 50 percent in the area, and the antelope herd will be completely displaced from the area. Habitat losses both on the project and on the Big Horn River will reduce the number of fur-bearers, small mammals and predators. Among non-game birds, golden eagles, rough-legged hawks and great horned owls will be most severely impacted, again by habitat and food loss. Other species will be both adversely and beneficially affected after mitigation. Of the game bird species, only sage grouse are expected to decline after mitigation. Grazing of domestic livestock under BLM licenses will cease in the project area, and the AUM loss will only be partially mitigated. Wild horses will be displaced from the project area.

Human Values

Landscape

The existing landscape will be changed from desert to irrigated agricultural lands. Depending on the values of the viewer, this may be an adverse or a beneficial impact. Improvements placed on the land in connection with agriculture will be an intrusion on the scenery.

Recreation

Recreation values such as hunting, rock collecting and off-road vehicle use will be lost on the lands which are changed to private ownership.

Archaeology and paleontology

Sites which are not significant enough to warrant either salvage or protection from agricultural entry will be lost. It is possible that some sub-surface sites will not be identified and will be lost.

Socio-economic

Increased demand for services from the communities resulting from an increase in population will be an adverse impact until the communities are able to meet the new demand. A significant beneficial impact will result from the increased production of the land and the resulting increase in the flow of goods and services in the community.

SHORT TERM VS. LONG TERM

Introduction

Short-term uses under terms of the proposal would consist of conversion of native rangeland to irrigated cropland. This would take the first few years of farming (two to five) until a cropping pattern was established and facilities such as roads, fences and buildings constructed.

Long-term use would be continued farming, far into the future. It might also include future use of this land for purposes such as commercial or residential development. Long-term uses would occur up to 50 years into the future.

Air

There would be both short-term and long-term impact on air quality. Primary pollutants would be smoke from burning crops, wind-borne dust particles, water soluable sprays and farm-equipment exhaust. Secondary air pollutants would be commercial and industrial plants producing agricultural equipment or processing crops. Demand for electrical power for pumping water would increase air pollution from coal-fired power plants.

Land

Agricultural development constitutes a long-term commitment of the land.

There are two main reasons for land to be taken out of agricultura production: loss of water supply or conversion to a use yielding higher capital returns such as residential, commercial or industrial use.

Because of the high capital investment required, and increasing demand for food, we anticipate that most of the proposed project land would remain in agricultural production indefinitely.

Once developed, we project that less than 10 percent of such land would be taken out of agricultural production in the foreseeable future. Once public land is put to private agricultural use many short and long term uses are lost. The most immediate loss is that of public values and uses which can only be assured by retention of such land in public ownership. Some of these uses are discussed in the following sections.

Water

Irrigation of cropland creates a long-term demand for water. Use of surface water has long-term effects on the quality of streams and impoundments, water based recreation, aquatic and terrestrial wildlife and all other water and its use. Specific long-term impact of the proposed project cannot be predicted because future demand for the present surface water supply is not known.

Energy

Irrigated farming requires large amounts of fossil fuels and electrical energy. Long-term agricultural production depends upon reliable sources of both. Electrical plants supplying this energy, of course, would have short and long term impacts of their own.

Vegetation

All plants in the area proposed for development would be affected either directly or indirectly. Most native terrestrial plant species would be eliminated except for some along fence rows and areas unsuitable for cultivation. The plant community would change from the present native community to one of the introduced species (crops) that are adaptable to the area and presently in high demand. Since reestablishment of the original conditions would be impractical and uneconomical, it can be assumed that this loss of native plant species would be permanent. There would also be long-term degradation of the aquatic and riparian vegetation.

Ecological relationships

Agricultural production is oriented toward creating mono-cultures or a series of different mono-cultures. That is, any vegetation other than the desired crop is looked upon as a nuisance and is eliminated. Only where a vegetative community does not conflict with good farming practices is it allowed to remain.

For this reason, agricultural ecosystems are relatively simple compared to natural ecosystems. Total biomass production would increase over the long term, since the volume of vegetation produced by irrigation and fertilization is much higher than that produced under natural conditions. Perhaps as much as 90 percent of this biomass is removed, however, and is not available to restore soil fertility. Natural nutrient and energy cycles are disrupted and must be supplemented by artificial means such as fertilizers.

Human values

The landscape would be permanently altered by development, service facilities and road and pipeline construction. Once disturbed, archaeological and historical values could never be recovered. There would be a benefit to local communities through increased employment, greater capital and a broadened tax base. There would be an expansion of agriculture-related industries and an increase in food production. Certain recreational opportunities would be lost and some wildlife populations would be lost. Grazing of livestock on the open range in the proposed-project area would be eliminated. Whether these long-term impacts enhance man's environment is, of course, a matter for individual value judgements. Future generations may gain or lose, depending upon the point of view.

IRREVERSIBLE COMMITMENTS

This section will examine those resource which would be consumed or irreversibly altered by the project.

Land

The conversion of 25,000 acres of national resource land to private ownership would constitute a permanent loss of public lands. This would reduce land-use options available to future generations. Some present land uses including public-land grazing would be eliminated.

Human Values

Large amounts of manpower would be committed to development and operation of the proposed project. We estimate that once the project was established a total of 190,000 manhours of work would be needed annually for farming.

Cultural Values

The amount of public lands available for recreation purposes would be reduced. Those presently using the area would have to find new areas. Archaeological sites would be destroyed by farming. Any significant cultural resource sites identified before construction of the project would be preserved. Present esthetic values associated with the rangeland would be permanently lost.

Water

The project would require 63,000 acre-feet of water a year from the River. This water would be used as long as the proposed project is in operation. Although not permanently removed from the hydrologic cycle, most of this water would not be available for other uses.

Energy

Large quantities of energy would be consumed during development and operation of the proposed project. About 45 million kilowatt hours annually would be needed to run the river and canal pumps. A small amount of additional electricity would be needed for domestic use. This energy would be supplied by existing coal-fuel and hydroelectrical generating plants.

An estimated 800,000 gallons of fuel would be needed annually to operate the farms. Additional energy would be needed for transportation and for heating new homes and other buildings.*

Other Materials

There would also be a commitment of other resources related directly to development and operation. Material for a total of 230 miles of buried pipelines would be needed to get the water to the project. Individual farmers would need a total of 330 miles of aluminum pipe for irrigation. Material for machinery, buildings, powerlines, and fences would all be committed to the project.

* Costs of Producing Crops, Big Horn Basin Area, Wyoming 1974 Agriculture Extension Service, University of Wyoming, January 1975.

ENTITIES CONSULTED

The following were consulted for technical advice in preparation of this environmental analysis.

Groups	Input
Local businessmen of Worland	Socio-economic information
Hunters' Range (sportsmen's group)	Present land use
Companies	
Holly Sugar Corporation	Farming techniques
Pacific Power and Light	Electrical power
Big Horn Rural Electric	Electrical power
Clyde, Criddle, Woodward Inc.	Feasibility study
County Governments	
Agricultural extension services	Farming techniques
Washakie and Big Horn County planning staffs	Socio-economic information
County welfare agencies	Socio-economic information
State Government	
Wyoming State Engineer	Water information
State Historical Preservation Office	Information on Bridger Trail & other sites
Wyoming Game and Fish Dept.	Information on wildlife
Federal Government	
Bureau of Reclamation	Study on Big Horn River
U.S. Geological Survey	Flow information on Big Horn River
Fish and Wildlife Service	Information on wildlife

INDEX OF APPENDIX

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WestSide Irrigation Project
LEGEND
PROPOSED PROJECT BOUNDARY
PRIVATE LANDS WITHIN PROJECT
OIL AND GAS PIPELINES
POWERLINES
ARCHEOLOGICAL SURVEY REFERENCE A
A
B
C
D
E
E
F
G
H
I
J
K
L
M


WestSide Irrigation Project
LEGEND
PROPOSED PROJECT BOUNDARY
PRIVATE LANDS WITHIN PROJECT
PROPOSED PIPELINE
PUMP
PIPELINE REFERENCE POINTS
R1
R2
R3
R4 (ALT)

CAPABILITY UNIT

IVe4

Soil Description: Soils more than 20 inches deep with loamy sand or loamy fine sand surface layers that take water readily and have good or low water holding capacity. Slopes are moderately steep (6-10%).

Needs: The sandy surface needs protection from wind erosion either by vegetative cover or rough tillage. Careful irrigation and close growing crops to minimize water erosion on these moderately steep slopes. Incorporation of crop residue and manures will help stabilize these soils.

Use: Fairland that is best maintained in perennial vegetation but can be cultivated occasionally with good management and conservation practices .

Included Soils:

CAPABILITY UNIT

IVs2

Soil Description: Very fine sandy loam to silty clay loam soils underlain by slowly permeable bedrock at depths in excess of 20 inches. These soils take water quite readily but have poor subsurface drainage and tend to seep when irrigated. Slopes are level to nearly level (0-3%)

Needs: Proper irrigation water management is necessary to avoid seeping these and nearby soils.

Use: Fair land best adapted to small grain, hay or pasture.

Included Soils:

CAPABILITY UNIT

IVe5

Soil Description: Fine sandy loam soils more than 20 inches deep that take water readily and have good water holding capacity. Soils less than 40 inches deep are underlain by gravel or bedrock. Slopes are moderately steep (6-10%).

Needs: Use crop residue, emergency tillate, and cover crops to reduce wind erosion. Irrigation water should be applied in short runs from contour ditches or across slopes to help control water erosion.

Use: Fair land that is best maintained in perennial vegetation but can be cultivated occasionally with good management and conservation practices.

Included Soils:

CAPABILITY UNIT

IVs5

Soil Description: Soils over 20 inches deep with fine sandy loam or sandy loam surface textures that are underlain by slowly permeable bedrock. These soils take water readily but have poor subsurface drainage and tend to seep when irrigated. Slopes are level to nearly level (0-3%).

Needs: Proper irrigation water management is necessary to prevent seeping these and nearby soils.

Use: Fair land suited best for small grain, orhay and pastureland.

Included Soils:

CAPABILITY UNIT

IVs9

Soil Description: These are very gravelly soils. The gravel hampers seedbed preparation and tillage. Water holding capacity is moderate. Slopes are nearly level to gently sloping (0 to 6%).

Needs: This land should be tilled only when necessary to re-establish permanent vegetation.

Use: Fair land that is best suited to hay or pasture.

Included Soils:

VIe9

Same as above, except slopes are steeper - 7 to 15 percent

CAPABILITY UNIT

IVs6

Growing Season 60-120+

Soil Description: Clayey, loamy or sandy soils from 10 to 20 inches deep, underlain by gravel. Some of these soils have high lime accumulations. Nearly level to gentle slopes (1-2%).

Needs: These soils are usually droughty because they are shallow and have good drainage. Light, frequent irrigations are necessary for optimum moisture conditions. Fertilization is usually necessary because these shallow soils have a low reserve of plant nutrients.

Use: Fair land suitable for shallow rooted crops, hay or pasture.

Soil Mapping Units;

CAPABILITY UNIT

IVs12

Soil Description: Deep, sandy to clayey soils, which contain moderate amounts of salts or alkali. Some strongly alkaline soils are included if they contain natural gypsum. The alkali in these soils makes them "puddle" when wet, form hard surface crusts when they dry out, and erode easily when they are irrigated. Slopes are level to moderate (0-6%).

Needs: Reduction of harmful salts and alkalinity is needed. Applying gypsum or sulphur may speed up reclamation. The seedbed should be kept moist during germination and the seedling stage of plants. On slopes greater than 1%, careful control of irrigation water is needed to prevent erosion.

Use: Fair land, suitable for saline and alkali tolerant plants. Small grain, tall fescue, sweet clover and tall wheatgrass are some adapted crops

Included Soils:

CAPABILITY UNIT

IVe12

Soil Description: Deep, sandy to clayey soils, which contain moderate amounts of salts or alkali. Some strongly alkaline soils are included if they contain natural gypsum. The alkali in these soils makes them "puddle" when wet from hard surface crusts when they dry out, and erode easily when they are irrigated. Slopes are moderately steep (6-10%).

Needs: Reduction of harmful salts and alkalinity is needed. Applying gypsum or sulphur may speed up reclamation. The seedbed should be kept moist during germination and seedling stage of plants. Application of irrigation water from contour ditches with short runs, is necessary to control erosion.

Use: Fair land, suitable for saline and alkali tolerant plants. Small grain, tall fescue, sweet clover and tall wheatgrass are some adapted plants.

Included Soils:

CAPABILITY UNIT

IVe14 Growing Season 60-120+

Soil Description: Sandy or loamy soils that are 10 to 20 inches deep and underlain by bedrock other than shale. Slopes are nearly level to gentle (1-6%).

Needs: Good control of irrigation water is necessary to prevent seepage areas and perched watertables. The sandy soils are subject to wind erosion if left unprotected. Greater rates of fertilizer are necessary as these shallow soils have a low reserve of plant food.

Use: Fair land suitable for limited cultivation and shallow rooted crops.

Soil Mapping Units:

CAPABILITY UNIT

IVs13

Soil Description: Clayey soils underlain by slowly permeable bedrock at depths in excess of 20 inches. These soils take water slowly, have poor subsurface drainage, and tend to seep when irrigated. Slopes are level to nearly level (0-3%).

Needs: Good irrigation water management is necessary to avoid seeping these soils and those nearby.

Use: Fair land, best suited for small grain, hay or pasture

Included Soils:

CAPABILITY UNIT

VIe2

Soil Description: Soils 20 inches or more in depth with loamy to clayey surface layers. Water intake is slow to rapid. Soils less than 40 inches deep are underlain by gravel. Slopes are steep (10-15%) Soil is subject to water erosion.

Needs: Proper irrigation water management to prevent severe erosion on these steep slopes. Keep in close growing cover crops with good management to prolong production. Use limited tillage in re-establishing stands.

Use: Poor land suitable for permanent grassland.

Included Soils:

CAPABILITY UNIT

VIe1

Soil Description: Clayey soils over 20 inches deep. Soils less than 40 inches deep are underlain by bedrock. These soils have poor tilth, take water very slowly, and crust and crack severely when dry. Waterholding capacity is high. Slopes range from moderate to steep (3-15%).

Needs: Till only when necessary to re-establish permanent vegetative cover. Fall plowing is necessary. Plow under crop residue and manures, and grow deep-rooted crops to improve tilth and water intake. Irrigation water is best applied in short runs and on the contour or across slope.

Use: Poor land that is best maintained in permanent vegetative cover.

Included Soils:

CAPABILITY UNIT

VIs9

Soil Description: Cobbly, stony soils which take water readily and have a very low water holding capacity. Some of these soils have water tables which rise into the root zone during the growing season. Slopes are usually nearly level (0-3%).

Needs: This soil is too stony to cultivate regularly. It should be kept in permanent pasture. Frequent, light irrigations are necessary.

Use: Poor land, suitable only for permanent pasture.

Included Soils:

CAPABILITY UNIT

VIe5

Soil Description: Soils 20 inches or more in depth with sandy loam to fine sandy loam surface layers. Water intake is moderate to rapid. Soils less than 40 inches deep are underlain by gravel. Slopes are steep (10-15%). Soils are subject to wind and water erosion.

Needs: Proper irrigation water management to prevent severe erosion on these steep slopes. Keep in close growing cover crops with good management to prolong production. Use very limited tillage in re-establishing stands.

Use: Poor land suitable for permanent grassland.

Included Soils:

Feasibility Study
of
Bighorn Westside Irrigation District
for
The Bighorn Basin Irrigation
& Development Assoc.

June 1975

FEASIBILITY STUDY

of

BIGHORN WESTSIDE IRRIGATION PROJECT

for

The Bighorn Basin Irrigation and Development Association

by

Clyde-Criddle-Woodward, Inc.

Salt Lake City, Utah

June 1975

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BIGHORN WESTSIDE IRRIGATION PROJECT

Introduction

The Bighorn River drains much of north central Wyoming and flows northwards into the Yellowstone River in Montana as a part of the Missouri River drainage. Waters of the Bighorn River are used to irrigate about 275,000 acres of land in Wyoming, but about 1,700,000 acre feet per year flows out of the State.

The City of Worland, lying about 80 miles south of the State line, is the commercial center of an extensive irrigated agricultural development along the river from Thermopolis to Greybull. Most of the irrigated land is served water by gravity diversions from the river. Some relatively low head pumps are used to lift the water to some areas. However, a significant amount of good irrigable soil lies above the existing systems and such lands are now considered as being susceptible and feasible for irrigation.

Because of the availability of water and potentially irrigable land in Bighorn and Washakie counties, a group of residents from the two counties, encouraged by officials of the State and University, organized themselves into the Bighorn Basin Irrigation and Development Association. The Association has been working with the Bighorn Canal Company, which in turn has filed with the State Engineer of Wyoming for water to irrigate lands lying immediately above their canal. This report was prepared to show the engineering and economic feasibility of irrigating some of the higher lying bench lands west of the Bighorn River between Worland and Greybull.

Climate

The project lands lie at elevations from 4,000 to 4,300 feet. Based on existing weather stations, the average frost-free period in the valley runs from about May 10 to September 25. however, irrigation begins early in the Basin with sugar beets being planted in late March and "irrigated up" in April

... frosts caused the

replanting of many acres of beets; some areas replanted twice. January temperatures are cold averaging about $14^{o}F$. and July temperatures average about $70^{o}F$. with extremes of $104^{o}F$. and $-51^{o}F$.

Annual precipitation is less than 8 inches per year but rather well distributed throughout the year with the highest rates occurring in May and June. Irrigation is necessary for any significant production in the area.

Agriculture

At the present time, the major crops grown in the Bighorn Basin are Alfalfa, Barley, Corn and Sugar beets. Sugar beets usually represent the greatest cash returns to the farmers but malt barley is becoming of considerable economic importance to the valley. With irrigation water available and fully under control, it would seem likely that many other crops, such as potatoes, might be desirable in the cropping pattern.

Soils

The soils of the area have been mapped recently by the Soil Conservation Service and classified as to irrigability. Although it would appear that soils of most any texture and depth can be found in the general project area, most of those tentatively selected for irrigation are from medium to fine-textured with relatively good water holding capacities. Many acres of land have small rocks or pebbles showing on the surface. However, such pebbles are usually small in size and numbers and they should not seriously affect agriculture.

Topography over much of the area is very rough but major areas can be selected that are suitable for sprinkler irrigated agriculture. Some 25,000 acres, most of which are under B.L.M. control, have been selected for study.

Drainage of the bench lands should not be needed if sprinklers are used and the water is properly managed. Relatively high costs of pumping the water to the land will encourage its efficient use.

Flooding of the farmlands and erosion does not seem to be of importance to the proposed project lands.

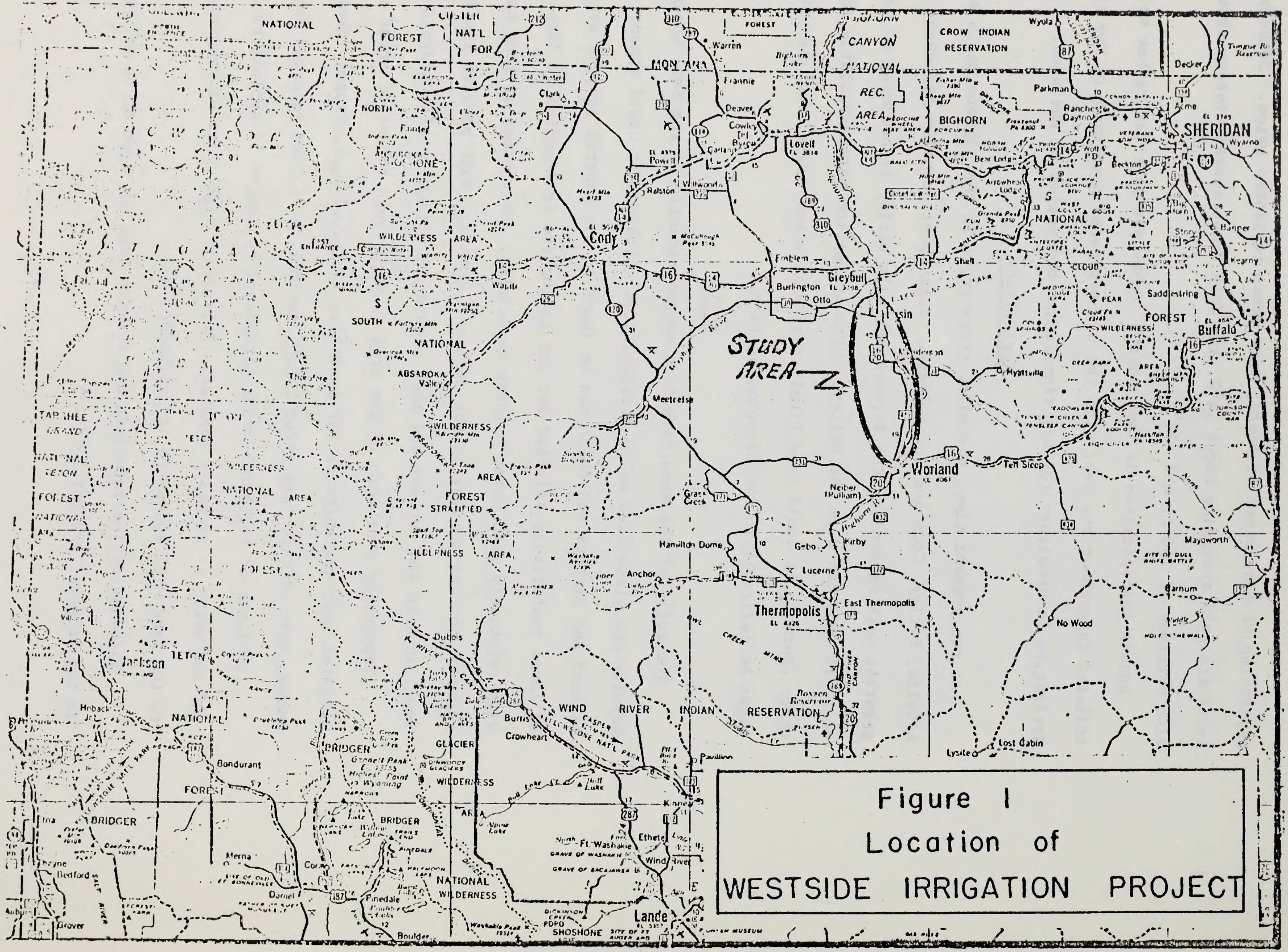

Figure 1
Location of
WESTSIDE IRRIGATION PROJECT

Water Supplies

Water for the project lands must come from the Bighorn River system. The river at Worland is partially controlled by the Boysen Reservoir. According to local people interested in water development, this reservoir was constructed largely for storage of water for irrigation and silt control, and it was hoped that stored water would be available for the proposed project. However, in early 1974 the U. S. Bureau of Reclamation advised that storage water for agriculture was definitely limited and that it probably would not be possible to allocate sufficient water to meet the needs of the proposed project. As a result, alternative ways of getting water for the project were considered and, because of the cooperation of the Bighorn Canal Company officials, a sound and practical way of getting water to the new lands has been worked out.

The key to the feasibility of the new Westside Irrigation Project is the Bighorn Canal that parallels the river past Worland on downstream to Greybull. Many of the old irrigated lands in the Bighorn River Basin with the earliest water rights lie upstream from the bulk of the new lands. Return flows to the river from the old lands make up a dependable source of supply providing the water can be picked up at sites downstream from Worland, pumped into the Bighorn Canal and, by exchange, re-pumped from the canal to the project lands.

Approximately 75,000 acres of irrigated land lie under the canals between Boysen Reservoir and Manderson. Records show that about 6 acre feet per acre are diverted for these lands annually. Consumptive use of irrigation water by the crops averages about 2 acre feet per acre. Incidental consumptive uses of the irrigation water may use as much as one-half acre foot per acre per year. Thus, expected return flows of some 3½ acre feet per acre from the 75,000 acres irrigated accounts for more than 250,000 acre feet of return flow to the river and much of this returns to the river during the peak and late part of the growing season when inflow from side drainages is low.

Because these lands have relatively early water rights - earlier than the storage rights in Boysen Reservoir, it can be assumed that even in dry years the return flows to the river will tend to remain fairly constant.

Records of Bighorn River streamflow at Kane and Boysen, since Boysen Reservoir went into operation, show minimum flows occur during the winter period when the streams are frozen and while storage is taking place in the reservoir. In the last seven years during the main irrigation season, May through September, the minimum monthly flow of the Bighorn River above Greybull is estimated to be 34,500 acre feet, which is well above the peak monthly water requirements of the project lands.

At times the water in the Bighorn River below Worland contains a fairly high salt load but not so high as to significantly affect production of most crops that might be grown in the valley. Sugar beets, alfalfa and barley are quite tolerant to salinity. With proper water management salinity should not be a serious problem.

Water Requirements

The normal consumptive water requirements of alfalfa during the growing season between frosts is about two acre feet per acre. Use of water by sugar beets is about the same as alfalfa but use of water by grain and other short season crops is somewhat less. If this period is used as the basis for estimating seasonal water requirements, and if no credit is given for precipitation, then at 70 percent irrigation efficiency the seasonal discharge from the canal would be 2.0 ÷ 0.70 = 2.86 A.F. per acre. Assuming a 6 percent loss of water between the river pumps and the pumps in the canal, a total of slightly over 3 acre feet per acre would be needed annually from the river, or 75,000 acre feet for a 25,000 acre project. It is estimated that not less than 20 percent of that pumped from the river, or 15,000 acre feet, would return to the river largely underground making a net stream depletion by the project of only 60,000 acre feet.

With sprinkler irrigation, it is essential that peak demands be met as well as having available a full seasonal supply. Experience indicates that a peak use rate on the farm using sprinkler irrigation is 7½ g.p.m. per acre or, in other words, each 320 acre tract would require 2,400 g.p.m. or 5.3 c.f.s. flow rate during that period when water use is greatest. For a 25,000 acre project, this would require about 415 c.f.s.

Assuming a 6 percent loss between the river and the sprinkler system during the peak period, mostly as seepage and regulatory loss in the Bighorn Canal, a total river pump capacity would be 8 g.p.m./acre or 445 c.f.s. All of the pumps would not need to be operated continuously. In fact, only about 75,000 acre feet would be needed for the 25,000 acres. Running at full capacity, that much water could be supplied in about 85 days, while the irrigation season will probably last from April 15 to September 30, or 168 days. Thus, the pumps will be used only about 50 percent of the time.

<u>Method of Irrigation</u>

It is proposed that all water for the new lands will be delivered under pressure adequate for sprinkling. Main lines will be of sufficient size that each 320 acre tract will be able to use continuously a stream of 7½ g.p.m./acre (2,400 GPM), or 5.3 c.f.s. during periods of need. However, a basic seasonal use of 3.0 acre feet per acre, or 960 acre feet for each 320 acre tract, will be established and any water desired in excess of this basic allotment will be delivered, if system capacity allows, at an increased unit charge since such excesses will probably require extra pumping and supervisory costs. In no case, will an increase in the flow rate to each tract be permitted by the irrigation district unless and until such time as it is well proven that any increase will not affect rights of other users.

With the system designed for sprinkler irrigation, no allowance will be made to deliver the larger flow rates that might be needed for surface irrigation. Should a land owner wish to use surface irrigation instead of sprinklers, he may have to make his own arrangements for getting water or flow rates adjusted from the design rates, and such may be extremely difficult to make since the piping system will be pressurized and fully used. In other words, this pro is designed to be sprinkler irrigated and economics and operational problems can not readily permit a mixed system of irrigation.

Irrigation System

Water for the Westside Irrigation Project is to be pumped from the river into the Bighorn Canal which will serve somewhat as a regulatory and exchange facility. A series of smaller pumps will then be used to take water from the canal and discharge it into the distribution pipeline under the required pressures. Additional booster pumps will be used along the lines as needed.

An attempt is being made to lay out parallel pipelines spaced one-half mile apart. Along these pipelines at each fifty foot interval will be riser valves. The farmers will be able to attach either wheel sprinkler lines, hand-move sprinklers or solid set lines directly to the valves and begin operation without having to buy a lot of special sprinkler fittings. The supply lines will run generally up the slope at right angles to the canal and the farm sprinkler laterals will be mostly parallel to the canal and generally laid out on the contour.

Pumping plants

Three pumping plants with a combined capacity of about 415 c.f.s. will be used to get the water from the river into the canal. Such an arrangement seems necessary in order to take advantage of irrigation return flows and to be able to replace water in the canal at a point near the places of diversion for the project lands above.

Self-priming pumps will be used to take the water to each sub-irrigation unit. In-so-far as practical, standard size pumps will be used to facilitate repairs and limit the necessary parts inventory.

Booster pumps that will be needed along the water supply lines will also be standardized so far as possible. Automatic controls will be used to maintain pressure in the lines and to assure an ample supply of water in the canal.

Pipe requirements

In general, coated steel pipe will be used to transport the water throughout the system. Consideration must be given to protection against electrolosis if this seems to be a significant problem. If comparative costs indicate substantial savings using asbestos cement pipe or other pipe made of suitable material, consideration will be given to their use.

Sprinkler systems

On most new irrigation projects being developed there is an almost universal adoption of some form of mechanical move sprinkler systems. Where sprinklers are to be used after the land is cleared, only minimum land leveling is done. Gulleys and sharp breaks in the land surface must be smoothed but the objective is to not disturb the top soil. This in turn permits an almost 100 percent crop the first year. Large areas of sterile subsoil which takes years to make productive, are not exposed as often happens with heavy leveling for surface irrigation.

With a pipeline distribution system properly laid out, it is possible to use any of the generally accepted sprinkler systems whether hand moves, wheel moves, pivot systems, or solid sets. Each farmer can select the kind of system he feels best meets his needs and, if after a few years, he wishes to change his type of sprinkler system, he can readily do so without having to change the underground pipe system.

Costs of system

Costs of bringing the lands under irrigation may be divided into two general categories, i.e. (1) project costs, and (2) farm costs.

Project costs will include forming the necessary management and operational organization, arrangements with the Bighorn Canal Company for use of their water filings and their existing canal system, all pumping plants, underground pipelines, power facilities, and access roads to get the water from the river to each tract of land. All of the system will be operated and maintained by the project.

Water will be delivered to the farmers under pressures adequate for sprinkling. All project costs will be paid for by assessing the farmers on the amount of water they receive. A summary of project costs are given in Table 1 .

Farm development costs will include supplying the sprinkler system, clearing the land and doing any land smoothing needed.

As a rough guide on farm development costs, it might be assumed that clearing and filling of gullies, etc. will average $25 per acre. Cost of farm sprinkler systems vary widely dependent upon the type selected. As guidelines only, the following costs are suggested.

Type of system	$/Acre
Hand move sprinkler laterals	75
Wheel moves	210
Pivot	250
Solid set	450

Staging of construction

It is assumed that because of delays in obtaining materials and in comp-ing construction, perhaps about 8,000 acres might be brought in each year during a three year period. However, if it is possible to get power lines and transformers, pumps and steel pipe, the construction period might be shortened.

TABLE 1

CONSTRUCTION COST SUMMARY

28,580 Ac Gross (90-320 Ac units)

Item	Cost - $ Total	Per Acre	% of Total
A. Pipe installed:			
1. Steel @$500/Ton	7,053,000	-	-
2. Trenching	241,000	-	-
3. Welding	233,000	-	-
4. Sub-total	7,527,000	263	69
B. Risers & valves (13,000 @$17.00)	221,000	8	2
C. Pumps & motors:			
1. River units with valves 10,900 HP @$45.00 HP	490,500	-	-
2. River pump bases 3@$90,000	270,000	-	-
3. Canal units w/valves & bases 28,435 HP @$32.00 HP	909,920	-	-
4. Sub-total	1,670,420	58	15
D. Part inventory: motors, pumps, etc.	200,000	7	2
E. Total installation	9,418,420	330	87
F. Engineering: Preparation of bid documents & inspection of construction (5%) 1/	470,900	16	4
G. Escallation of costs & contingencies (10%) 2/	941,800	33	9
H. GRAND TOTAL	10,831,120	379	100
I. Cost per farm unit	10,331,120 / 90 units =	$120,345/unit	

1/ This may be substantially reduced depending upon the experience and integrity of the contractor selected to make the installation.

2/ Item G will depend largely on the price of steel since pipe represents about two-thirds of the total cost of the project.

Economics of Westside Irrigation Project

In 1974 the University of Wyoming intensively studies costs of production and returns from raising crops in the Big Horn Basin of Wyoming. (See Appendix). The following table gives the costs and anticipated yields for six of the more common crops grown in the valley taken from their report.

Table 2

Production costs, yields and selling prices on crops grown in the Big Horn Basin of Wyoming

Crop	Productions Costs/Ac	Expected Yield/Ac	Selling Price Per unit of yield	Selling Price Total/Ac
	$	cwt/Tons	$	$
Alfalfa hay	222	4.5 T.	50.00	225
Barley, Malting	188	40 cwt	4.70	188
Beans, Dry	265	20 cwt	20.00	[illegible]
Corn:				
Silage	222	22 T.	15.00	[illegible]
Grain	201	55 cwt	6.00	345
Potatoes	389	250 cwt	2.50	625
Sugar beets	496	22 T.	40.00	880

In general, alfalfa hay and barley return only the costs of production which includes 5 percent of gross production for management under the assumptions used by the University. However, all of the other crops studies show substantial returns above costs, ie in the case of sugar beets, the profit would be $880-$496= $384 per acre.

Looking to the future, gross returns from various crops may increase but costs of production tend to keep pace. Costs of water per acre foot on the West Side Project should be greater than for water used on the older irrigated lands, but the amount of water used for each acre will be less and drainage and tillage costs may be considerably less. Thus, overall costs might tend to equalize out between the old and the new lands. Using these assumptions and a typical cropping patter, the probable returns from a 320 acre entry show in Table 3

Table 3

Returns from an
Assumed Cropping Pattern - 320 acre farm

Crop	Acres	Returns Net/Ac	Returns Total
Alfalfa	120	$ 3	$ 360
Barley	40	0	0
Beans	20	135	2,700
Corn, grain	20	144	2,800
Potatoes	40	236	9,440
Sugar beets	80	384	30,720
Total	320		$46,100

The $46,100 shown in table might be considered as reasonable net income for project lands, however when added to the management return of some $20/acre or $6,400 for the 320 acre farm used in the University of Wyoming economic study, the total net return to the farmers would be $46,100 + $6,400 = $52,500/year.

APPENDIX A

- Pumping plant requirements -

Table_____

Pumping Plant Requirements

WESTSIDE IRRIGATION PROJECT

Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
			H. Friction	H. Elevation	H. Pressure	TDH		
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
47N								
5	120	900	15	120	140	275	80	
6	280	2100	30	170	140	340	230	
7	240	1800	25	190	140	355	200	
8	320	2400	30	220	140	390	300	
9	480	3600	25	160	140	325	390	
10	480	3600	25	165	140	330	400	
11	640	4800	30	175	140	345	550	
12	640	4800	30	165	140	335	530	
Boosters								
9B	(160)	1200	10	60	-	70	25	
10B	(160)	1200	10	60	-	70	25	
11B	(320)	2400	30	70	-	100	80	
12B	(320)	2400	30	100	-	130	100	
Total	3200						2910	

Table_____

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
			H. Friction	H. Elevation	H. Pressure	TDH		
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
T48N								
2	240	1800	30	145	140	315	180	
3	520	3900	35	125	140	300	390	
4	760	5700	40	145	140	325	600	
5	960	7200	40	145	140	325	780	
6	1200	9000	40	150	140	330	990	
7	840	6300	50	170	140	360	750	
8	860	6450	50	190	140	380	800	
9	1020	7650	50	195	140	385	980	
10	1020	7650	50	175	140	365	930	
11	1000	7500	40	205	140	385	950	
12	1000	7500	40	195	140	375	925	
Boosters								
3B	(80)	600	10	50	-	60	10	
4B	(240)	1800	20	90	-	110	60	
5B	(400)	3000	35	80	-	115	115	
6B	(640)	4800	50	165	-	215	340	
7B	(240)	1800	50	160	-	210	125	
8B	(320)	2400	45	100	-	145	115	
9B	(480)	3600	45	100	-	145	175	
10B	(400)	3000	45	140	-	185	185	
11B	(440)	3300	45	130	-	175	190	
12B	(520)	3900	40	140	-	180	230	
Total	9420						9820	

Table_____

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift: H. Friction	Pumping lift: H. Elevation	Pumping lift: H. Pressure	Pumping lift: TDH	Power required	Misc. notes
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
T48N								
2	240	1800	30	145	140	315	180	
3	520	3900	35	125	140	300	390	
4	760	5700	40	145	140	325	600	
5	960	7200	40	145	140	325	780	
6	1200	9000	40	150	140	330	990	
7	840	6300	50	170	140	360	750	
8	860	6450	50	190	140	380	800	
9	1020	7650	50	195	140	385	980	
10	1020	7650	50	175	140	365	930	
11	1000	7500	40	205	140	385	950	
12	1000	7500	40	195	140	375	925	
Boosters								
3B	(80)	600	10	50	-	60	10	
4B	(240)	1800	20	90	-	110	60	
5B	(400)	3000	35	80	-	115	115	
6B	(640)	4800	50	165	-	215	340	
7B	(240)	1800	50	160	-	210	125	
8B	(320)	2400	45	100	-	145	115	
9B	(480)	3600	45	100	-	145	175	
10B	(400)	3000	45	140	-	185	185	
11B	(440)	3300	45	130	-	175	190	
12B	(520)	3900	40	140	-	180	230	
Total	9420						9820	

Table_____

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
				H. Friction	H. Elevation	H. Pressure	TDH		
Twp.	No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
T49N									
	1	1140	8550	35	135	140	310	880	
	2	80	600	10	45	140	195	40	
	3	360	2700	35	105	140	280	250	
	4	520	3900	30	105	140	275	350	
	5	640	4800	30	145	140	315	500	
	6	720	5400	20	105	140	265	475	
	7	700	5250	20	110	140	270	470	
	8	520	3900	15	75	140	230	300	
	9	360	2700	10	155	140	305	275	
	10	100	750	15	115	140	270	65	
	11	800	6000	40	100	140	280	560	
	12	240	1800	20	65	140	225	135	
Boosters									
	1B	(640)	4800	65	100	-	165	260	
	4B	(80)	600	10	40	-	50	10	
	5B	(240)	1800	20	40	-	60	35	
	6B	(400)	3000	30	100	-	130	130	
	7B	(400)	3000	30	100	-	130	130	
	8B	(280)	2100	20	100	-	120	85	
	9B	(200)	1500	15	100	-	115	55	
	11B	(320)	2400	15	50	-	65	50	
	Total	6180						5055	

Table_____

Pumping Plant Requirements

WESTSIDE IRRIGATION PROJECT

Bighorn River Basin, Wyoming

Station		Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
				H. Friction	H. Elevation	H. Pressure	TDH		
Twp.	No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
50N									
	1	80	600	10	40	140	190	40	
	1.5	4480	33600	75	370	-	445	5000	
Booster	AB	(520)	3900	35	-	120	155	200	
	BNB	(560)	4200	55	-	140	195	270	
	BSB	(120)	900	25	-	140	165	50	
	CNB	(440)	3300	60	-10	140	190	200	
	CSB	(400)	3000	60	-100	140	100	100	
	DNB	(320)	2400	100	-40	140	200	160	
	DSB	(560)	4200	115	-140	140	115	160	
	ENB	(200)	1500	90	-80	140	150	75	
	ESB	(1040)	7800	175	-100	140	215	550	
	2	240	1800	15	30	140	185	100	
	3	280	2100	20	35	140	195	130	
	4	120	900	10	65	140	215	65	
	6	240	1800	20	10	140	170	100	
	7	160	1200	15	25	140	180	70	
	8	80	600	5	25	140	170	35	
	9	160	1200	10	90	140	240	90	
	10	80	600	5	115	140	260	50	
	11	240	1800	10	215	140	365	220	
Total		6160						7665	

Table_____

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Land Served	Pumping rate	Pumping lift: H. Friction	H. Elevation	H. Pressure	TDH	Power required	Misc. notes
Twp.	No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
51 N									
	1	320	2400	25	130	140	295	230	
	2	320	2400	25	135	140	300	240	
	3	2240	16800	105	145	140	390	2200	
	12	40	300	10	70	140	220	20	
Boosters									
	WB	(360)	2700	35	50	-	85	75	
	XB	(400)	3000	35	-	-	35	35	
	YB	(250)	2100	25	-	-	25	15	
	ZB	(160)	1200	25	-	-	25	10	
Total		2920						[illegible]	
52 N									
	1	80	600	10	70	140	220	40	
	2	120	900	15	70	140	225	65	
	3	80	600	10	75	140	225	45	
Total		280						150	
Total 51 & 52		3200						2985	

Table_____

Pumping Plant Requirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Land Served	Pumping rate	Pumping lift				Power required	Misc. notes
				H. Friction	H. Elevation	H. Pressure	TDH		
Twp.	No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
River Pump									
	R1	(12620)	100960	20	125	-	145	4900	
	R2	(5040)	40320	30	150	-	180	2400	
	R3	(10500)	84000	20	110	-	130	3600	
		28160							
								10,900	0.39 HP/AC

Table_____

SUMMARY
Pumping Plant Lequirements
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Land Served	Pumping rate	Pumping lift H. Friction	H. Elevation	H. Pressure	TDH	Power required	Misc. notes
Twp. No.	Acres	G.P.M.	Ft.	Ft.	Ft.	Ft.	B.H.P.	
47N	3200						2910	
48N	9420						9820	
49N	6180						5055	
50N	6160						7665	
51N	2920						2835	
52N	280						150	
(88 Entries)	28160						28,435	= 1.01 HP/AC
River								
R1	(12620)						4900	
R2	(5040)						2400	
R3	(10500)						3600	
Total	28160						10900	= 0.39 HP/AC
Gr. Total	28160						39,335	1.40 HP/AC

APPENDIX B

- Pipeline requirements -

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Pipe diameter in inches														
		54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp.	No.					Length of pipe - Feet										
T47N																
	5													3300	660	
	6											2440	1320	1320	1320	
	7											2300	1320	1320	660	
	8											2900	1320	1320	660	
	9										2920	1980	1320	1320	660	
	10										3120	1980	1320	1320	660	
	11									4060	2640	1980	1320	1980	1320	
	12									3760	2640	1980	1320	1980	1320	
										7820	11320	15560	9240	13860	7260	

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Pipe diameter in inches														
		54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp.	No.						Length of pipe - Feet									
T48N																
	2											2080	1320	1980	1320	
	3									1560	2640	1980	1320	1980	1320	
	4								2520	2640	2640	1980	1320	1980	1320	
	5							2220	3300	2640	2640	1980	1320	1980	1320	
	6						1460	4620	3300	2640	2640	1980	1320	1320	660	
	7								3540	2640	2640	5280	2640	2640	1320	
	8								4160	2640	2640	7260	1320	1320	660	
	9							3700	3300	2640	5280	1980	1320	1320	660	
	10							3700	3300	2640	2640	2640	1320	2640	1320	
	11							2760	3300	2640	2640	1980	1320	2640	1320	
	12							3360	3300	3960	2640	1980	1320	1320	1320	
							1460	20360	30020	26640	29040	31120	15840	21120	12540	

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station		Pipe diameter in inches 54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp.	No.					Length of pipe - Feet										
49N																
	1							4400	3300	3960	2640	3960	1320	1320	1320	
	2													660	1980	
	3										940	1980	1320	2640	1320	
	4									660	2640	1980	1320	1320	660	
	5									2460	2640	1980	1320	1980	1320	
	6								1240	2640	2640	1980	1320	1320	660	
	7								940	2640	2640	1980	1320	1320	660	
	8									720	2640	1980	1320	1320	1320	
	9										560	1980	1320	1320	1320	
	10													2080	1320	
11-N									2400							
N-North														660	660	
N-O										1320						
O-11B										2640	2640					
11B North														1320	1320	
11B-P												2640				
P North												660	1320	1320	660	
12												4840	1980	1320	660	
								4400	7880	17040	19980	25960	13860	19900	15180	

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

(Cont)

Station	Pipe diameter in inches: 54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. No.	Length of pipe - Feet														
T 50 N															
1													1320	1320	
15 - M		1700													
M (North)												660	1320	660	
M - L		3800													
L (South)												660	1320	660	
L - A		7600													
A - J									660	1980					
J North										1320	1980	1320	1320	660	
J K													1320		
K North													1320	1320	
A - B			2640												
B North									1320	2640	1980	1320	1320	660	
B South													1320	1320	
B - C			2640												
C North									1320	2640	1980	1320	1320	1320	
C South										1320	1980	1320	1980	1320	
C - D				2640											
D North											1980	1320	1320	660	
D South									1320	2640	1980	1320	1980	1320	
D - E						2640									
E North												1980	1320	660	
E - F							5280	1320							
F South											660	1320	1320	660	
F - G									2640						
G - H									1320						

(Continued)

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Pipe diameter in inches													
	54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. : No.					Length of pipe - Feet										
T-50N(Cont)															
H-South												660	1320	660	
H-I											2640				
I South											3300	1320	1320	660	
2											1000	1320	1320	660	
3											1300	1320	1320	660	
4													2130	1320	
6											2130	1320	3300	1320	
7												1960	1320	1320	
8													1660	1320	
9												820	1320	660	
10													1440	660	
11											2640	1980	1320	660	
2 Sheets Total		13100	5280	2640		2640	5230	1320	8580	12540	25600	23140	37640	22440	

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Pipe diameter in inches														
	54	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. No.						Length of pipe - Feet									
T51N															
1											3300	1320	1320	660	
2											1320	1320	1320	1320	
6-S				8400											
S-T							2640								
T-U							2640								
U-Z											6600	1320			
Z North												1320	2640	1320	
U-Y									1980	2640	660				
Y North											1320	1320	1320	1320	
S-V						1320	3960								
V-X									1320	1320					
X North										1320	1980	1980	1980	660	
V-W										2640					
W-Z										2640					
Z North										660	1980	2640	1320	1320	
12														1320	
Total				8400		1320	9240-	-	3300	11220	17660	11220	10560	8580	
T 52N															
1													740	660	
2													1640	660	
3													1040	660	
Total													3420	1980	

Length of Pipe Required
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin, Wyoming

Station	Pipe diameter in inches														
	60	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. : No.					Length of pipe - Feet										
R-1	3300														
R-2		5500													
R-3	4800														
Total	8,100	5,500													

Summary by Townships
Length of Pipe Required and estimated costs
WESTSIDE IRRIGATION PROJECT
Bighorn River Basin,Wyoming

Summary (Pipe)

Station	Pipe diameter in inches														
	60	42	36	30	26	24	22	20	18	16	14	12	10	8	6
Twp. | No.					Length of pipe - Feet										
47N									7820	11320	15560	9240	13860	7260	
48N						1460	20360	30020	26640	29040	31120	15840	21120	12540	
49N							4400	7800	17040	19980	25960	13860	19900	15180	
50N		13100	5280	2640		2640	5280	1320	8580	12540	25600	23140	37640	22440	
51N				8400		1320	9240		3300	11220	17660	11220	10560	8580	
52N													3420	1980	
R1	3300														
R2		5500													
R3	4800														
Total	8100	18,600	5,280	11,040	-	5,420	39,280	39,140	63,380	84,100	115,900	73,300	106,500	67,980	-
Wt/ft-lbs	200	167	145	118	-	63	58	52	47	42	37	33	25	13	-
Total Tons	810	1553	383	651		171	1139	1018	1489	1766	2144	1209	1331	442	Total 14,10

APPENDIX C

- Costs of producing crops -

Table 6. Costs of producing malting barley, Big Horn Basin, Wyoming, 1974.
(Following sugarbeets, tops plowed under, yield goal 40 cwt (80 bu)/acre)

Operation(s)	Tractor (hp)	Implement	Per acre physical data: Materials description	Truck miles	Tractor hours	Man hours	Per acre cash costs: Materials & custom	Fuel, lube, repair	All labor	All per acre costs: Cash	Fixed	Total
							$	$	$	$	$	$
Preplant:												
Plow	125	3-18's	--	--	.50	.50	--	2.73	1.63	4.36	2.98	7.34
Spread fertilizer	80	custom	40N, 40P, 20K	--	.17	.17	20.00	.42	.55	20.97	.55	21.52
Disc	125	15 ft	--	--	.25	.25	--	1.15	.81	1.96	1.43	3.39
Roller harrow	125	15 ft	--	--	.25	.25	--	1.09	.81	1.90	1.43	3.33
Level	125	14 ft	--	--	.22	.22	--	1.01	.72	1.73	1.31	3.04
Subtotal, preplant				--	1.39	1.39	20.00	6.40	4.52	30.92	7.70	38.62
Plant:												
Haul seed	--	2 ton	--	.5	--	.05	--	.12	.16	.28	.18	.46
Plant & corrugate	80	12 ft	100# seed @ $6.50	--	.33	.33	6.50	1.26	1.07	8.83	1.95	10.78
Subtotal, plant				.5	.33	.38	6.50	1.38	1.23	9.11	2.13	11.24
Grow:												
Spray weeds	80	28 ft	2, 4-D; 3/4# active	--	.17	.17	1.05	.50	.55	2.10	.89	2.99
Survey ditches	--	--	--	--	--	.12	--	--	.39	.39	--	.39
Make ditches, season	100	ditcher	--	--	.15	.15	--	.48	.49	.97	.73	1.70
Make ditches & fill, season	80	blade	--	--	.15	.15	--	.43	.49	.92	.64	1.56
Irrigate, 1st time	--	--	Canvas & tubes	--	--	.50	.33	--	1.63	1.96	1.20	3.16
Irrigate, 3 times	--	--	--	--	--	.45	--	--	1.46	1.46	--	1.46
Pickup	--	½ ton	--	16.0	--	--	--	1.86	--	1.86	1.82	3.68
Subtotal, grow				16.0	.47	1.54	1.38	3.27	5.01	9.66	5.28	14.94
Harvest:												
Swath	--	12 ft	--	--	--	.25	--	1.31	.81	2.12	3.56	5.68
Combine	--	12 ft	--	--	--	.40	--	2.63	1.30	3.93	6.42	10.35
Haul grain, 2 trucks	--	2 ton	18 mi, 7 tons/load	5.1	--	.80	--	1.24	2.60	3.84	1.81	5.65
Subtotal, harvest				5.1	--	1.45	--	5.18	4.71	9.89	11.79	21.68
Subtotal, preplant through harvest			Pu 16.0, Tk	5.6	2.19	4.76	27.88	16.23	15.47	59.58	26.90	86.48

Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Water & drainage	Insurance	Other	Cash	Fixed	Total
Land & irrigation system	$575	$--	$51.75	$2.68	$5.75	$--	$--	8.43	51.75	60.18
Shop & machine sheds	25	1.20	1.62	.32	--	.18	.46	2.82	.96	3.78
Labor housing	40	2.00	3.60	.70	--	.24	3.68	5.60	4.62	10.22
Subtotal, real estate	640	3.20	56.97	3.70	5.75	.42	4.14	16.85	57.33	74.18
Subtotal, preplant through real estate overhead								76.43	84.23	160.66
General overhead:										
Miscellaneous costs at 5% of above subtotal								3.82	4.21	8.03
Interest on cash costs at 9% for 6 months								3.61	--	3.61
Subtotal, general overhead								7.43	4.21	11.64
Management: At 5% of expected gross receipts (40 cwt (80 bu) @ $7.82 = $312.80 x .05)								15.64	--	15.64
TOTAL PRODUCTION AND OPPORTUNITY COSTS								99.50	88.44	187.94
Cost/cwt, or breakeven selling price at: 40 cwt (80 bu)/acre								2.49	2.21	4.70
45 cwt (90 bu)/acre								2.21	1.97	4.18
35 cwt (70 bu)/acre								2.84	2.53	5.37

Table 2. Costs of producing alfalfa hay, Big Horn Basin, Wyoming, 1974.
(Yield goal 4.5 tons per acre, cut 3 times, swathed, baled and stacked with bale wagon)

Operation(s)	Tractor (hp)	Implement	Per acre physical data: Materials description	Truck miles	Tractor hours	Man hours	Per acre cash costs: Materials & custom $	Fuel, lube, repair $	All labor $	All per acre costs: Cash $	Fixed $	Total $
Plant:												
Depreciation of stand	--	--	--	--	--	--	--	--	--	--	13.67	13.67
Interest, stand	--	--	--	--	--	--	--	--	--	--	3.08	3.08
Subtotal, annual stand				--	--	--	--	--	--	--	16.75	16.75
Grow:												
Spread fertilizer	80	custom	100# P_2O_5	--	.17	.17	25.00	.42	.55	25.97	.55	26.52
Roller harrow	100	15 ft	--	--	.25	.25	--	.99	.81	1.80	1.29	3.09
Make ditches, season	100	ditches	--	--	.15	.15	--	.48	.49	.97	.73	1.70
Fill ditches, season	80	blade	--	--	.15	.15	--	.43	.49	.92	.64	1.56
Irrigate, 1st time	--	--	Canvas & tubes	--	--	.30	.33	--	.98	1.31	1.20	2.51
Spray for weevil	--	--	Air	--	--	--	4.00	--	--	4.00	--	4.00
Irrigate, 4 times	--	--	--	--	--	.60	--	--	1.95	1.95	--	1.95
Pickup, season	--	½ ton	--	20.0	--	--	--	2.32	--	2.32	2.28	4.60
Subtotal, grow				20.0	.72	1.62	29.33	4.64	5.27	39.24	6.69	45.93
Harvest:												
Swath, 3 times	--	12 ft	--	--	--	.66	--	3.45	2.14	5.59	9.41	15.00
Bale, 3 times	80	14 x 18	Twine @ $3/ton hay	--	1.00	1.00	13.50	4.15	3.25	20.90	7.29	28.19
Stack bales, 3 times	100	3 ton	--	--	1.00	1.00	--	4.75	3.25	8.00	9.35	17.35
Subtotal, harvest				--	2.00	2.66	13.50	12.35	8.64	34.49	26.05	60.54
Subtotal, plant through harvest				Pu 20.0	2.72	4.28	42.83	16.99	13.91	73.73	49.49	123.22

Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Water & drainage	Insurance	Other	Cash	Fixed	Total
Land & irrigation system	$575	$--	$51.75	$2.68	$5.75	$--	$--	8.43	51.75	60.18
Shop & machine sheds	25	1.20	1.62	.32	--	.18	.46	2.82	.96	3.78
Labor housing	40	2.00	3.60	.70	--	.24	3.68	5.60	4.62	10.22
Subtotal, real estate	640	3.20	56.97	3.70	5.75	.42	4.14	16.85	57.33	74.18
Subtotal, plant through real estate overhead								90.58	106.82	197.40
General overhead:										
Miscellaneous costs at 5% of above subtotal								4.53	5.34	9.87
Interest on cash costs at 9% for 6 months								4.28	--	4.28
Subtotal, general overhead								8.81	5.34	14.15
Management: At 5% of expected gross receipts (4.5 tons at $50 = $225 x .05)								11.25	--	11.25
TOTAL PRODUCTION AND OPPORTUNITY COSTS								110.64	112.16	222.80
Cost/ton, or breakeven selling price at: 4.5 tons/acre								24.59	24.92	49.51
5.0 tons/acre								22.13	22.43	44.56
4.0 tons/acre								27.66	28.04	55.70

Table [illegible] Cost of producing potatoes under circular sprinklers, southeastern Wyoming, 1974.

Operation(s)	Tractor (HP)	Implement	Materials description	Truck miles	Tractor hours	Man hours	Materials & custom	Fuel, lube, repairs	Labor	Cash	Fixed	Total
			Per acre physical data				Per acre cash costs			All per acre costs		
							$	$	$	$		
Preplant:												
Spread fertilizer	80	Custom	50#N, 135#P_2O_5	--	.10	.10	39.50	.25	.30	40.05	.33	40.38
Disc	80	14 ft.	--	--	.17	.17	--	.66	.51	1.17	.90	2.07
Plow and pack	120	4-18's	--	--	.33	.33	--	1.89	1.00	2.89	2.28	5.17
Subtotal, preplant				--	.60	.60	39.50	2.80	1.81	44.11	3.51	47.62
Plant:												
Cut and treat seed	--	cutter	Polyram, 10¢/cwt	--	--	.79	1.70	1.01	2.37	5.08	1.68	6.76
Haul seed	--	2 ton	6 mi/108 cwt	1.0	--	--	--	.23	--	.23	.20	.43
Plant (2 men)	120	4 row	17 cwt @ $7	--	.40	.80	119.00	2.28	2.40	123.68	4.22	127.90
Subtotal, plant				1.0	.40	1.59	120.70	3.52	4.77	128.99	6.10	135.09
Grow:												
Cultivate 2X	80	4 row	Thimet 15#	--	.50	.50	5.00	3.41	1.50	9.91	2.19	12.10
Cultivate-harrow	80	4 row	--	--	.25	.25	--	.92	.75	1.67	1.24	2.91
Spray on herbicide	80	28 ft.	Treflan 1.5 pints	--	.25	.25	5.43	.76	.75	6.94	1.61	8.55
Sidedress fertilizer	80	rented	100# N @ 25¢	--	.25	.25	26.50	.62	.75	27.87	.82	28.69
Irrigate, sprinkle 12X	--	circle	Electricity	--	--	.64	12.00	7.17	1.92	21.09	28.32	49.41
Spray for blight 3X	Custom	air	Chemical & apply	--	--	--	15.00	--	--	15.00	--	15.00
Pickups (season)	--	½ ton	--	25.0	--	--	--	2.90	--	2.90	2.85	5.75
Spray to kill vines	Custom	air	1/3 of acres	--	--	--	1.65	--	--	1.65	--	1.65
Subtotal, grow				25.0	1.25	1.89	65.58	15.78	5.67	87.03	37.03	124.06
Harvest:												
Dig and windrow	80	2 row	½ of acres	--	.55	.55	--	2.77	1.65	4.42	4.24	8.66
Harvest and load	120	2 row	½ of acres, 3 pkrs.	--	.55	2.20	--	4.74	6.60	11.34	6.58	17.92
Haul to plant (10 mi)	--	2 ton	125 cwt/load	20.0	--	3.00	--	4.58	9.00	13.53	4.02	17.60
Subtotal, harvest				20.0	1.10	5.75	--	12.09	17.25	29.34	14.84	44.18
Post harvest:												
Disc vines	80	14 ft.	--	--	.17	.17	--	.66	.51	1.17	.90	2.07
List soil	80	4 row	--	--	.20	.20	--	.78	.60	1.38	.87	2.25
Subtotal, post harvest				--	.37	.37	--	1.44	1.11	2.55	1.77	4.32
Subtotal, preplant through post harvest			Pu 25, Tk	21	3.72	10.20	225.78	35.63	30.61	292.02	63.25	355.27

Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Insurance	Cash	Fixed	Total
Land	$250	$--	$22.50	$1.75	$--	1.75	22.50	24.25
Well & electric service	50	--	4.50	--	--	--	4.50	4.50
Buildings	50	1.75	2.25	.44	.50	.94	4.00	4.94
Subtotal, real estate	350	1.75	29.25	2.19	.50	2.69	31.00	33.69
Subtotal, preplant through real estate overhead						294.71	94.25	388.96
General overhead:								
Miscellaneous costs at 5% of above subtotal						14.74	4.71	19.45
Interest on cash costs at 9% for 6 months						13.93	--	13.93
Subtotal, general overhead						28.67	4.71	33.38
Management: At 5 percent of expected gross receipts (250 cwt @ $2.50 = $625 x .05)						31.25	--	31.25
TOTAL PRODUCTION AND OPPORTUNITY COSTS						354.63	98.96	453.59
Cost per hundredweight at: 250 cwt per acre						1.42	.39	1.81
200 cwt per acre						1.77	.49	2.26
275 cwt per acre						1.29	.36	1.65

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Table 5. Costs of producing dry beans, Big Horn Basin, Wyoming, 1974.
(Yield goal 20 cwt/acre)

Operation(s)	Tractor (hp)	Implement	Per acre physical data: Materials description	Truck miles	Tractor hours	Man hours	Per acre cash costs: Materials & custom	Fuel, lube, repair	All labor	All per acre costs: Cash	Fixed	Total
							$	$	$	$	$	$
Preplant:												
Spread fertilizer	80	custom	80N, 40P, 20K	--	.17	.17	30.00	.42	.55	30.97	.55	31.52
Disk	100	15 ft	--	--	.25	.25	--	1.06	.81	1.87	1.28	3.15
Plow, sandy	100	3-18's	--	--	.63	.63	--	3.19	2.05	5.24	3.39	8.63
Roller harrow, 2 times	100	15 ft	--	--	.50	.50	--	1.99	1.63	3.62	2.58	6.20
Spray on herbicide	80	28 ft	1ptTref + 1/3gal Ept	--	.17	.17	8.90	.50	.55	9.95	.89	10.84
Level, 2 times	100	14 ft	--	--	.50	.50	--	2.11	1.63	3.74	3.20	6.94
Subtotal, preplant				--	2.22	2.22	38.90	9.27	7.22	55.39	11.89	67.28
Plant:												
Haul seed	--	2 ton	20 mi, 3 tons/load	.25	--	.04	--	.06	.13	.19	.09	.28
Plant & ditch	80	6 row	75# seed @ 58¢	--	.45	.45	43.50	2.31	1.46	47.27	3.60	50.87
Subtotal, plant				.25	.45	.49	43.50	2.37	1.59	47.46	3.69	51.15
Grow:												
Make ditches, season	100	ditcher	--	--	.30	.30	--	.96	.98	1.94	1.46	3.40
Make & fill ditches, season	80	blade	--	--	.30	.30	--	.86	.98	1.84	1.28	3.12
Irrigate, 1st time	--	--	Canvas & tubes	--	--	1.50	.67	--	4.88	5.55	1.20	6.75
Cultivate, 2 times	80	6 row	--	--	.74	.74	--	2.69	2.40	5.09	3.27	8.36
Irrigate, 4 times	--	--	--	--	--	2.00	--	--	6.50	6.50	--	6.50
Pull weeds, .5 acres	--	--	Hand labor	--	--	--	7.00	--	--	7.00	--	7.00
Pickup, season	--	½ ton	--	24.0	--	--	--	2.78	--	2.78	2.74	5.52
Subtotal, grow				24.0	1.34	4.84	7.67	7.29	15.74	30.70	9.95	40.65
Harvest:												
Cut (cutter & rod w'dr)	80	6 row	--	--	.45	.45	--	2.15	1.46	3.61	3.13	6.74
Rake (side rake)	80	8 ft	--	--	.45	.45	--	1.49	1.46	2.95	2.06	5.01
Combine, SP	--	12 ft	--	--	--	.55	--	3.61	1.79	5.40	8.83	14.23
Haul beans	--	2 ton	21 mi/140 cwt	3.0	--	.55	--	.73	1.79	2.52	1.06	3.58
Subtotal, harvest				3.0	.90	2.00	--	7.98	6.50	14.48	15.08	29.56
Post harvest:												
Disc straw	100	15 ft	--	--	.25	.25	--	1.06	.81	1.87	1.28	3.15
Subtotal, preplant through post harvest				Pu 24.0, Tk 3.25	5.16	9.80	90.07	27.97	31.86	149.90	41.89	191.79

Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Water & drainage	Insurance	Other	Cash	Fixed	Total
Land & irrigation system	$575	$--	$51.75	$2.63	$5.75	$--	$--	8.43	51.75	60.18
Shop & machine sheds	25	1.20	1.62	.32	--	.18	.46	2.82	.96	3.78
Labor housing	40	2.00	3.60	.70	--	.24	3.68	5.60	4.62	10.22
Subtotal, real estate	640	3.20	56.97	3.70	5.75	.42	4.14	16.85	57.33	74.18
Subtotal, preplant through real estate overhead								166.75	99.22	265.97
General overhead:										
Miscellaneous costs at 5% of above subtotal								8.34	4.96	13.30
Interest on cash costs at 9% for 6 months								7.88	--	7.88
Subtotal, general overhead								16.22	4.96	21.18
Management: At 5% of expected gross receipts (20 cwt @ $20 = $400 x .05)								20.00	--	20.00
TOTAL PRODUCTION AND OPPORTUNITY COSTS								202.97	104.18	307.15
Cost per cwt, or breakeven selling price at: 20 cwt/acre								10.15	5.21	15.36
24 cwt/acre								8.46	4.34	12.80
16 cwt/acre								12.68	6.51	19.19

Table 3. .osts of producing corn for grain, Big Horn Basin, Wyom. , 1974.
(Yield goal 55 cwt or 98 bu per acre)

Operation(s)	Tractor (hp)	Implement	Per acre physical data: Materials description	Truck miles	Tractor hours	Man hours	Per acre cash costs: Materials & custom	Fuel, lube, repair	All labor	All per acre costs: Cash	Fixed	Total
							$	$	$	$	$	$
Preplant:												
Spread fertilizer	80	custom	120 N; 40 P; 2)K	--	.17	.17	40.00	.42	.55	40.97	.55	41.52
Disc	125	15 ft	--	--	.17	.17	--	.78	.55	1.33	.97	2.30
Plow	125	3-18's	--	--	.63	.63	--	3.43	2.05	5.48	3.75	9.23
Roller harrow, 2 times	125	15 ft	--	--	.50	.50	--	2.18	1.62	3.80	2.86	6.66
Level	125	14 ft	--	--	.22	.22	--	1.01	.72	1.73	1.31	3.04
Subtotal, preplant				--	1.69	1.69	40.00	7.82	5.49	53.31	9.44	62.75
Plant:												
Plant corn	80	6 row	20# seed @ 40¢	--	.33	.33	8.00	1.50	1.07	10.57	2.03	12.60
Grow:												
Cultivate, 3 times	80	6 row	--	--	.75	.75	--	2.73	2.44	5.17	3.33	8.50
Spray weeds	80	28 ft	2, 4-D; 3/4# active	--	.17	.17	1.05	.50	.55	2.10	.89	2.99
Survey ditches	--	--	--	--	--	.12	--	--	.39	.39	--	.39
Make ditches, season	100	ditcher	--	--	.15	.15	--	.48	.49	.97	.73	1.70
Make & fill ditches, season	80	blade	--	--	.15	.15	--	.43	.49	.92	.64	1.56
Irrigate, 1st time	--	--	Canvas & tubes	--	--	.75	.33	--	2.44	2.77	1.20	3.97
Irrigate, 4 times	--	--	--	--	--	1.00	--	--	3.25	3.25	--	3.25
Pickup, season	--	½ ton	--	24.0	--	--	--	2.78	--	2.78	2.74	5.52
Subtotal, grow				24.0	1.22	3.09	1.38	6.92	10.05	18.35	9.53	27.88
Harvest:												
Combine, SP	--	6 row	--	--	--	.40	--	3.84	1.30	5.14	11.84	16.98
Haul corn, 2 trucks	--	--	18 mi, 7 tons/load	7.1	--	.80	--	1.73	2.60	4.33	2.51	6.84
Subtotal, harvest				7.1	--	1.20	--	5.57	3.90	9.47	14.35	23.82
Subtotal, preplant through harvest			Pu 24.0, Tk	7.1	3.24	6.31	49.38	21.81	20.51	91.70	35.35	127.05
Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Water & drainage	Insurance	Other					
Land & irrigation system	$575	$--	$51.75	$2.68	$5.75	$--	$--			8.43	51.75	60.18
Shop & machine sheds	25	1.20	1.62	.32	--	.18	.46			2.82	.96	3.78
Labor housing	40	2.00	3.60	.70	--	.24	3.68			5.60	4.62	10.22
Subtotal, real estate	640	3.20	56.97	3.70	5.75	.42	4.14			16.85	57.33	74.18
Subtotal, preplant through real estate overhead										108.55	92.68	201.23
General overhead:												
Miscellaneous costs at 5% of above subtotal										5.43	4.63	10.06
Interest on cash costs at 9% for 6 months										5.13	--	5.13
Subtotal, general overhead										10.56	4.63	15.19
Management: At 5% of expected gross receipts (55 cwt/acre (98 bu) @ $6 + $15 aftermath = $345 x .05)										17.25	--	17.25
TOTAL PRODUCTION AND OPPORTUNITY COSTS										136.36	97.31	233.67
Cost/cwt, or breakeven selling price at:			55 cwt (98 bu)/acre							2.48	1.77	4.25
			50 cwt (89 bu)/acre							2.73	1.94	4.67
			45 cwt (80 bu)/acre							3.03	2.16	5.19
			60 cwt (107 bu)/acre							2.27	1.62	3.89

~~Table 4~~. Costs of producing corn for silage, ~~Big Horn Basin, Wyoming, 1974~~
(Yield goal 22 tons green weight/acre)

Operation(s)	Tractor (hp)	Implement	Materials description	Truck miles	Tractor hours	Man hours	Materials custom	Fuel, lube, repair	All labor	Cash	Fixed	Total
			Per acre physical data				*Per acre cash costs*			*All per acre costs*		
							$	$	$	$	$	$
Preplant:												
Spread fertilizer	80	custom	120 N; 40 P; 20K	--	.17	.17	40.00	.42	.55	40.97	.55	41.52
Disc	125	15 ft	--	--	.17	.17	--	.78	.55	1.33	.97	2.30
Plow	125	3-18's	--	--	.63	.63	--	3.43	2.05	5.48	3.75	9.23
Roller harrow, 2 times	125	15 ft	--	--	.50	.50	--	2.18	1.62	3.80	2.86	6.66
Level	125	14 ft	--	--	.22	.22	--	1.01	.72	1.73	1.31	3.04
Subtotal, preplant				--	1.69	1.69	40.00	7.82	5.49	53.31	9.44	62.75
Plant:												
Plant corn	80	6 row	20# seed @ 40¢	--	.33	.33	8.00	1.50	1.07	10.57	2.03	12.60
Grow:												
Cultivate, 3 times	80	6 row	--	--	.75	.75	--	2.73	2.44	5.17	3.33	8.50
Spray weeds	80	28 ft	2, 4-D, 3/4# active	--	.17	.17	1.05	.50	.55	2.10	.89	2.99
Survey ditches	--	--	--	--	--	.12	--	--	.39	.39	--	.39
Make ditches, season	100	ditcher	--	--	.15	.15	--	.48	.49	.97	.73	1.70
Make & fill ditches, season	80	blade	--	--	.15	.15	--	.43	.49	.92	.64	1.56
Irrigate, 1st time	--	--	Canvas & tubes	--	--	.75	.33	--	2.44	2.77	1.20	3.97
Irrigate, 4 times	--	--	--	--	--	1.00	--	--	3.25	3.25	--	3.25
Pickup, season	--	½ ton	--	24.0	--	--	--	2.78	--	2.78	2.74	5.52
Subtotal, grow				24.0	1.22	3.09	1.38	6.92	10.05	18.35	9.53	27.88
Harvest:												
Chop	125	2 row	--	--	.67	.67	--	3.80	2.13	5.98	6.73	12.71
Haul to pit, 3 trucks	--	2 ton	6 mi/6.5 T load	20.0	--	2.00	--	4.86	6.50	11.36	7.08	18.44
Pack	100	blade	--	--	.67	.67	--	2.31	2.18	4.49	2.59	7.08
Pack	80	--	--	--	.67	.67	--	1.98	2.18	4.16	2.32	6.48
Subtotal, harvest				20.0	2.01	4.01	--	12.95	13.04	25.99	18.72	44.71
Subtotal, preplant through harvest			Pu 24.0; Tk	20.0	5.25	9.12	49.38	29.19	29.65	108.22	39.72	147.94

Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Water & drainage	Insurance	Other	Cash	Fixed	Total
Land & irrigation system	$575	$--	$51.75	$2.68	$5.75	$--	$--	8.43	51.75	60.18
Shop & machine sheds	25	1.20	1.62	.32	--	.18	.46	2.82	.96	3.78
Labor housing	40	2.00	3.60	.70	--	.24	3.68	5.60	4.62	10.22
Subtotal, real estate	640	3.20	56.97	3.70	5.75	.42	4.14	16.85	57.33	74.18
Subtotal, preplant through real estate overhead								125.07	97.05	222.12
General overhead:										
Miscellaneous costs at 5% of above subtotal								6.25	4.85	11.10
Interest on cash costs at 9% for 6 months								5.91	--	5.91
Subtotal, general overhead								12.16	4.85	17.01
Management: At 5% of expected gross receipts (22 tons @ $15/ton = $330 x .05)								16.50	--	16.50
TOTAL PRODUCTION AND OPPORTUNITY COSTS								153.73	101.90	255.63
Cost/ton, or breakeven selling price at: 22 tons/acre								6.99	4.63	11.62
20 tons/acre								7.69	5.09	12.78
18 tons/acre								8.54	5.66	14.20
24 tons/acre								6.40	4.25	10.65

~~Table 7~~. Costs of producing sugarbeets, ~~Big Horn Basin, Wyoming, 1978~~.
(Following barley or corn silage, furrow irrigation, yield goal 22 tons/acre)

Operation(s)	Tractor (hp)	Implement	Per acre physical data: Materials description	Truck miles	Tractor hours	Man hours	Per acre cash costs: Materials & custom	Fuel, lube, repair	All labor	All per acre costs: Cash	Fixed	Total
Preplant: (Fall)							$	$	$	$	$	$
Spread manure, .25 acre	80	loader	Manure	3.75	.16	.32	--	2.05	1.04	3.09	2.85	5.94
Spread fertilizer	80	custom	75N, 50P, 25K	--	.17	.17	31.25	.42	.55	32.22	.55	32.77
Disk, stubble	125	15 ft	--	--	.17	.17	--	.78	.55	1.33	.97	2.30
Plow, clay	125	3-18's	--	--	.63	.63	--	3.43	2.05	5.48	3.75	9.23
Roller harrow, 2 times	125	15 ft	--	--	.50	.50	--	2.18	1.62	3.80	2.86	6.66
Level	125	14 ft	--	--	.22	.22	--	1.01	.72	1.73	1.31	3.04
(Spring)												
Spread fertilizer	80	custom	50N, 50P, 25K	--	.17	.17	25.00	.42	.55	25.97	.55	26.52
Apply nematocide, .7 acre	125	custom	20 gal @ $2.50	--	.23	.23	35.00	.85	.75	36.60	.80	37.40
Disc, plowed ground	125	15 ft	--	--	.25	.25	--	1.15	.81	1.96	1.43	3.39
Roller harrow	125	15 ft	--	--	.25	.25	--	1.09	.81	1.90	1.43	3.33
Level	125	14 ft	--	--	.22	.22	--	1.01	.72	1.73	1.31	3.04
Subtotal, preplant				3.75	2.97	3.13	91.25	14.39	10.17	115.81	17.81	133.62
Plant:												
Plant (cultivator, 2 sets chemical boxes, bed shaper, incorporator, planting units)	100	6 row	Seed 1.5# @ $3.30	--	.45	.45	4.95	3.03	1.46	9.44	6.25	15.69
			Herbicide 15# @ $.525		--	--	7.88	--	--	7.88	--	7.88
			Insecticide 12# @ $.36		--	--	4.32	--	--	4.32	--	4.32
Subtotal, plant					.45	.45	17.15	3.03	1.46	21.64	6.25	27.89
Grow:												
Survey ditches	--	--	--	--	--	.12	--	--	.39	.39	--	.39
Make ditches, season	100	ditcher	--	--	.30	.30	--	.96	.98	1.94	1.46	3.40
Make & fill ditches, season	80	blade	--	--	.30	.30	--	.86	.98	1.84	1.28	3.12
Irrigate, 1st time	--	--	Canvas & tubes	--	--	1.50	.67	--	4.88	5.55	1.20	6.75
Moss trap	--	--	--	--	--	--	--	.60	--	.60	1.44	2.04
Postemerge herbicide .2 acre	80	6 row	Betanol & Pyramin+	--	.09	.09	2.40	.25	.29	2.94	.38	3.32
Cultivate, 4 times	80	6 row	--	--	1.48	1.48	--	5.38	4.81	10.19	6.54	16.73
Roll, one time	80	6 row	--	--	.25	.25	--	.67	.81	1.48	1.13	2.61
Hand labor	--	--	Thin, long hoes	--	--	--	25.50	--	--	25.50	--	25.50
Hand labor	--	--	Weed, 2 times	--	--	--	29.00	--	--	29.00	--	29.00
Housing & supplies	--	--	--	--	--	--	1.00	--	--	1.00	2.00	3.00
Lay by herbicide, .1 acre	80	28 ft	Treflan or Eptam	--	.03	.03	.40	.07	.09	.56	.13	.69
Irrigate, 6 times	--	--	--	--	--	3.00	--	--	9.75	9.75	--	9.75
Leaf hopper program	--	--	--	--	--	--	1.25	--	--	1.25	--	1.25
Spray waste areas	80	28 ft	Herbicide & insecticide		.10	.10	.60	.29	.33	1.22	.52	1.74
Webworm control, .5 acre	--	air	Apply & insecticide	--	--	--	2.75	--	--	2.75	--	2.75
Pickups, season	--	½ ton	--	32.0	--	--	--	3.71	--	3.71	3.65	7.36
Subtotal, grow				32.0	2.55	7.17	63.57	12.79	23.31	99.67	19.73	119.40

Continued

Table 7. (Continued) Costs of producing sugarbeets, ~~Big Horn Basin, Wyoming, [illegible]~~

Operation(s)	Tractor (hp)	Implement	Per acre physical data: Materials description	Truck miles	Tractor hours	Man hours	Per acre cash costs: Materials & custom	Fuel, lube, repair	All labor	All per acre costs: Cash	Fixed	Total
Harvest:							$	$	$	$	$	$
Top, flail type	100	6 row	--	--	.77	.77	--	3.37	2.50	5.87	9.65	15.52
Pull and load	125	6 row	--	--	.77	.77	--	5.62	2.50	8.12	13.90	22.02
Haul, 3 trucks	--	2 ton	--	30.0	--	2.31	--	7.29	7.51	14.80	10.62	25.42
Subtotal, harvest				30.0	1.54	3.85	--	16.28	12.51	28.79	34.17	62.96
Subtotal, preplant through harvest			Pu 32, Tk	33.75	7.51	14.60	171.97	46.49	47.45	265.91	77.96	343.87
Real estate overhead: Item	Value per acre	Depreciation	Interest	Taxes	Water & drainage	Insurance		Other				
Land & irrigation system	$575	$--	$51.75	$2.68	$5.75	$--		$--		8.43	51.75	60.18
Shop & machine sheds	25	1.20	1.62	.32	--	.18		.46		2.82	.96	3.78
Labor housing	40	2.00	3.60	.70	--	.24		3.68		5.60	4.62	10.22
Subtotal, real estate	640	3.20	56.97	3.70	5.75	.42		4.14		16.85	57.33	74.18
Subtotal, preplant through real estate overhead										282.76	135.29	418.05
General overhead:												
Miscellaneous costs at 5% of above subtotal										14.14	6.76	20.90
Interest on cash costs at 9% for 6 months										13.36	--	13.36
Subtotal, general overhead										27.50	6.76	34.26
Management: At 5% of expected gross receipts (22 tons @ $40 = $880 x .05)										44.00	--	44.00
TOTAL PRODUCTION AND OPPORTUNITY COSTS										354.26	142.05	496.31
Cost/ton, or breakeven selling price at: 22 tons/acre										16.10	6.46	22.56
20 tons/acre										17.71	7.10	24.81
18 tons/acre										19.68	7.89	27.57
24 tons/acre										14.76	5.92	20.68

RIGHT-OF-WAY STIPULATIONS
POLE POWERLINES AND TELEPHONE LINES

1. The Government reserves the right to tie into the powerline or telephone line constructed should a need for electrical power or telephone service by the Government arise in the area, with the price of the service not to exceed the tariff rate for such service. Cost to the Government of the tie-in will not exceed actual cost for labor, material and supervision necessary to effect such tie-in.

2. This right-of-way shall reserve to the United States and any of its agencies the right to use and occupy parts of the tracts involved at locations and for purposes not inconsistent with the use and occupancy of the grantee and which will not unreasonably interfere with the use of the grantee.

3. Authorized improvements such as fencing or reservoirs within the right-of-way will not be disturbed, if possible, or where disturbance is unavoidable, will be restored to their original or better condition as determined by the District Manager, Bureau of Land Management.

4. Before cutting through any fence on public land, the grantee will brace the fence firmly on both sides of the cut, and after completion of construction, will: (1) install a gate and/or cattle guard in the fence, or (2) replace a standard type fence across the right-of-way, as directed by the District Manager, Bureau of Land Management.

5. In the event it is necessary to remove timber from the right-of-way, all merchantable timber will be purchased by the grantee at the total appraised price that is determined by the District Manager, Bureau of Land Management.

6. Proper precautions will be taken at all times to prevent and suppress fires on public lands caused through negligence of his employees, contractors or sub-contractors. No debris burning will be allowed without specific permission from the District Manager, Bureau of Land Management.

7. The grantee will effect a minimum of vegetative or soil disturbance consistent with practical construction operations and will smooth all disturbed areas to conform as nearly as practical with the adjacent terrain, with the proviso that cut and fill slopes be constructed on as gentle a grade as is practical (recommended slope 3:1 or less).

8. The grantee will construct waterbreaks on all disturbed slopes in accordance with the attached typical plan for waterbreak construction. General guidelines for installation of waterbreaks are: less than 2% grade, 200' interval; 2-4% grade, 100' interval; 4-5% grade, 75' interval;

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W-47613

District Office
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DEC 1 1 1974

Mr. Wayne Criddle
Clyde-Criddle-Woodward, Inc.
2987 South 2nd West
Salt Lake City, Utah 84115

Dear Mr. Criddle:

On December 3, 1974 at a meeting in the BLM District in Worland we discussed with you and Mr. Woodward items that required clarification in regards to the Big Horn Westside Irrigation Project. This information is needed to completely understand the proposed action so an interdisciplinary team can initiate an environmental analysis of the project.

More in-depth information is required on the following:

1. What were the alternatives available to accomplish the action? In our meeting we discussed flood irrigation as an alternative. Would you please elaborate.

2. On a map delineate the areas that you actually believe will be farmed. A list of the criteria used to make this determination would be very beneficial.

3. Using your best estimate provide us with a tentative construction schedule or a plan of implementation for the project.

4. Supply us with a complete description of the water system. We need information on description of pumping stations along with a map showing a layout of the entire irrigation system, including the system the farmers would be attaching to the irrigation pipes. Pictures and drawing would be a big assistance to the team. In this description, a complete explanation of how the system will be placed in the ground would be desirable.

5. In the development of the project certain support requirements are required. We need your best estimates as to the location of access roads, powerlines and other support requirements that you may have identified.

6. Would you supply us with copies of your graphs of the flows for the Big Horn River.

In supplying the above information, use of photographs and drawings would extremely helpful in many instances.

It would be very beneficial if the above information could be supplied to this office by December 30, 1974.

Sincerely yours,

Richard E. Cleveland
District Manager

WLZ
ELEBARRON:sw

-801

TELEPHONE 487-2233

CLYDE-CRIDDLE-WOODWARD, INC.

CIVIL & AGRICULTURAL ENGINEERS
2987 SOUTH SECOND WEST STREET
SALT LAKE CITY, UTAH 84115

GEORGE D. CLYDE, C. E.
W /NE D. CRIDDLE, C. E.
O / O. WOODWARD, A. E.

WATER RESOURCES, PLANNING, UTILIZATION AND MANAGEMENT

December 18, 1974

12-23-74

Mr. Richard E. Cleveland
District Manager
Bureau of Land Management
P. O. Box 119
Worland, Wyoming 82401

Dear Mr. Cleveland:

We have your letter of December 12, 1974 requesting certain information on the Big Horn Westside Irrigation Project. As you are well aware, our studies to date were simply to prepare a general feasibility report, i.e. are the lands and water available, and what might it cost to put them together under a practical system of irrigation that would be satisfactory. We have not gone into the "nuts and bolts" of the design. We assume this will be done after the tracts are tentatively approved for entries and after money becomes available for the detailed design. The development group that employed us as consultants relied on our making a general layout and estimating costs which would permit them to decide whether or not to proceed with the project. We believe they have already made that decision in the affirmative. This was based on the tentative report submitted to them, copies of which were furnished your group by Mr. Dee Benson, our various discussions over the past several months, and their first-hand look at similar projects in Idaho.

Because of our experience and knowledge of irrigation systems, their operation and suitability, and the limited money the development group had available, some of the in-depth information requested by you was not assembled for this feasibility report. However, we would refer you to various publications which we authored that show many of the details requested. Some bulletins are enclosed. A most complete coverage of sprinkler systems and irrigation system layouts is the 444 page textbook entitled "Sprinkler Irrigation," Third Edition, published by Sprinkler Irrigation Association, 1000 Vermont Ave. N.W., Suite 911, Washington, D.C. 20005. This gives a rather complete discussion of most phases of sprinkler system design and layout together with many pictures and diagrams, including large river pumping plants, booster pumping plants, valves, water requirements of crops, soils, etc. Undoubtedly a copy is available at your local library or you may wish to order one for your office files since you may be having numerous questions on sprinkler systems. We refer you to this book rather than trying to send you a lot of uncorrelated notes, pictures and sketches as requested. However, a few pictures are enclosed. Incidently, Mr. Woodward of this firm compiled and edited the 2nd Edition of this book in 1959.

Following are our specific comments on the six questions or requests contained in your letter.

1. The only alternative to sprinkler irrigating the project lands is one of the surface methods (furrows, corrugations, border, or flooding) or the new method being used to a very limited extent, "drip" irrigation.

The methods and their general limitations in use are given on page 10 of Agricultural Information Bulletin No. 8, copy of which is enclosed. Also, Agricultural Handbook No. 82 outlines the various factors influencing the method of irrigation that should be selected (see also page 8 - Water and Irrigation). The above reports, together with the Soil Conservation Service National Engineering handbook, give unquestionable support to the selection of sprinkler irrigation for the project lands.

2. Any further delineation of the lands to be farmed than shown on the project maps already supplied B.L.M. is impractical at this time. As discussed with you in our meeting at the B.L.M. offices earlier this month, we expect farm roads to be constructed along each section line of the land to be developed. Farm buildings and storage yards will use a part of the land, hopefully some of the land that is less desirable from an agricultural standpoint. Locations of such developments cannot be meaningfully located at this time except for the unit across the river from Worland which contains the 5-acre tracts. We have shown several additional farm units at that location. Criteria used as guide for selection of lands included the following:

a. Soils approved by the Soil Conservation Service as irrigable.
b. Limit of slopes to 10% or less.
c. Areas that can be feasibly served by the underground piping system taking water from the storage canal.

3. We have no way of knowing how long it will take to get the necessary tentative approval from your agency to proceed with the next phase. We do suspect that the required time may depend to some extent on how extensive your environmental studies are to be.

It is expected that within the next several months the local people will develop a mutual irrigation company. By the time your office acts on the tentative approval requested, it is hoped they will have prepared a plan for selecting potential stockholders.

Assuming the above can be done during the next 3 or 4 winter months, we would expect that arrangements with the Big Horn Canal Co., Power Company or companies, County Commissioners, and financing agencies could be completed in time to begin construction during the fall of 1975. However, if pipe, transformers, pumps, motors, and other necessary equipment are not available that soon, construction may have to be delayed until the following spring.

It is recommended that once construction begins, about 8,000 acres be installed each year over a period of three years. If the first 8,000 acres could be developed in time to grow a crop during 1976, then the total project should be completed by the summer of 1978.

The project as designed permits considerable flexibility as to which tracts are installed first. We assume this decision will depend to a large extent on the desires of the mutual irrigation company yet to be organized and on ... availability of power, rights of way and other factors.

4. We believe the water distribution system discussed in the tentative report which you have, plus the map gives a quite complete description of the system layout proposed. Tentative pipeline locations, sizes, lengths and estimated costs are given as are the locations and sizes of the motors and pumps proposed. Obviously, the booster canal pressure pumps and river pumps will not be installed underground.

All of the project pipelines above the canal will be buried generally under two feet or more of cover. Riser pipes with valves will rise vertically to about one foot above the general land surface along each pressure pipeline. The farmers will attach sprinkler laterals to these risers. To better understand such a sprinkler layout we would strongly urge that your review team visit an actual installation rather than rely on a written description of what these rather routine installations consist of, and how they are put together.

Regarding our showing a complete layout of the system or sprinkler laterals that each farmer would be attaching to the project distribution system, we don't know yet what type he will select as best fitting his personal desires and his financial ability. We have shown a layout that, except for pivot sprinkler systems, he can select and use any from the least expensive to the most deluxe without any additions or changes in piping. We don't think the irrigation company nor the government would want to impose any specific system on the water users.

5. We propose access roads along each section boundary, power lines along the canal to take care of the pressure pumps taking water from the canal plus certain lines running west from the booster pumps to take care of additional booster pumps that might be needed. Until entries are established and boundaries are surveyed, it is not practical to attempt to locate the several interior booster pumps that might be needed.

Other "support" land use requirements might be farm produce storage areas, processing plants, etc. but the kinds, numbers and locations of such have not been planned nor do we believe they can be at this time.

Undoubtedly the developments on the older irrigated valley lands will handle much of the support needs of the uplands for some years in the future.

A number of access roads will be needed from the valley to the Project lands. Where the new irrigated lands are adjacent to the canal, access along a section line will usually be simple. Tracts lying some distance above the canal may require rights of way across Government lands.

6. Copies of our hydrographs developed for the Big Horn River are enclosed as requested.

If, after reviewing the above, you still have questions that you feel we can answer, please do not hesitate to contact us. In the meantime we are attempting to finalize our feasibility report and hope it will be available in the near future. However, we do not see where any basic changes will be necessary to the plan.

Sincerely,

CLYDE-CRIDDLE-WOODWARD, INC.

Wayne D. Criddle

Wayne D. Criddle

WDC:gp

Enclosures

cc: Dee Benson

[ST]ATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Recreation Commission

604 EAST 25TH STREET CHEYENNE, WYOMING 82002

PAUL H. WESTEDT
Director
777-7695

May 29, 1975

MAY 30 1975

Mr. Richard E. Cleveland
Bureau of Land Management
P.O. Box 119
Worland, WY 82401

Dear Mr. Cleveland:

I write in answer to your letter of May 6, 1975 inquiring about "enrolled or eligible National Register sites located on or near" some 25,000 acres that would be included within "a proposed agriculture development in Washakie and Big Horn counties." Attached to your letter was a map on which the proposed development is outlined.

A correlation of that map with historic files relating to Washakie and Big Horn counties results in the following negative findings:

1. No historic place currently enrolled in the National Register of Historic Places would be affected.

2. No historic place listed in the Wyoming Inventory of Historic Sites which might qualify for future enrollment in the National Register would be affected.

3. Insofar as is known, no historic place currently undergoing nomination to the National Register by any agency of federal or state governments would be affected.

4. The outlined lands appear to be set back from natural water courses and, hence, not particularly attractive as prehistoric habitation sites. Nevertheless the region is rich with evidence of prehistoric and historic aboriginal use, therefore proper archaeological reconnaissance should be a part of your planning studies.

You ask the further question "whether other historical valu[e] exist within the area which may be influenced by agricultural development of the lands shown." Of course, there are. Probably the chief one is the Bridger Road, dating from 1864. It followed the west side of the Bighorn River more or less close[l] from its river ford eight or ten miles above Worland to a locale opposite Manderson where it veered northwestward to cross the Greybull River in the Burlington vicinity. Its exact course in this area is not known to me, but like most early day emigrant wagon roads its route probably varied somewhat from year to year and even season to season. It appears likely that develop ment of some lands west and/or northwest of Manderson, and perhaps even southwest, might here and there affect a recognizable segment of the Bridger Road.

Sincerely,

Paul H. Westedt, Director a[nd]
SHPO

by Ned Frost, Chief
Historic Division

PHW:NF/lml

TATE OF WYOMING

ED HERSCHLER
GOVERNOR

State Engineer's Office

STATE OFFICE BUILDING EAST CHEYENNE, WYOMING 82002

SEP 15 1975

September 12, 1975

United States Department of the Interior
Bureau of Land Management
Worland District Office
P. O. Box 119
Worland, WY 82401

Dear Mr. Cleveland:

The draft of the environmental analysis submitted to this office on August 29, 1975, has been reviewed by personnel of this office and the following comments and suggestions are offered.

On page 8 of the analysis under "Office Of The State Engineer" the statement is made that the canal association has obtained a temporary water permit from the State Engineer. At the present time, the application held by the association is in a pending status only and will require considerable revision before it will be in proper form for action. We would suggest that this section be modified to read as follows:

"The canal association has filed a water right application with the State Engineer, for the project water. At this time no permit has been issued and the water right application is pending processing and final consideration by the State Engineer."

According to page 12 of your analysis, Clyde-Criddle-Woodward Inc. reported on the feasibility of the October, 1974 project. The report we have by Clyde-Criddle-Woodward, Inc. is dated June, 1975. We do not know if this report is the same as that utilized by you or whether ours is an update of an earlier report.

Under "Project Development" on page 14 of the analysis the statement is made that the development association has obtained a water right permit from the State Engineer. We refer you to our previous remarks in this letter dealing with the status of the water right application. It would be our suggestion that this sentence be modified to indicate that no permit has been issued by the State Engineer at this time. Also, in this paragraph we note that the combined pump capacity from the river is given as 500 CFS. According to the Clyde-Criddle-Woodward, Inc. report we have, this capacity would be 415 CFS.

According to the Clyde-Criddle-Woodward report, water will be diverted from the Big Horn River at three pump points on the river and discharged into the Big Horn Canal where it will be exchanged for existing Big Horn Canal appropriations. Also, the canal will be used as a means of regulating the water supply to the 49 pumps used to supply water to the lands to be irrigated. At the present time the development association has pending only an application for Enlargement of the Big Horn Canal to divert from the Big Horn River at the point of diversion of the said canal. Before any diversion could be made at the three pump points from the river either directly to project lands or by exchange with existing Big Horn Canal rights, it would be necessary to file applications and obtain water right permits for these diversions.

We believe the first two sentences in the next to the last paragraph on page 42 should be rewritten pertaining to storage in Boysen Reservoir about as follows: "Boysen Reservoir is allowed to store water in excess of that necessary to satisfy downstream prior rights." Generally, water from Boysen etc. . . . .

On page 100 under the heading "Supply" the third, fourth and fifth paragraphs imply that surplus water would be available in the Big Horn Canal during certain periods of the irrigation season and further that the association could pump an average of 40 to 65 CFS from the canal that formerly had been returned to the Big Horn River. The only water right that the association would have would be under the water right application filed on May, 1974, or for subsequent applications for the 3 pump points when filed and approved. Only water available to these priorities could be diverted and used on the project lands. Water diverted under the earlier Big Horn Canal priorities could not be used to supply water to the project lands unless all of the intervening priorities were being satisfied. We also note in the third paragraph that nine acre feet of water has been diverted annually by the Big Horn Canal during the irrigation season. A check of records on file in this office pertinent to the Big Horn Canal show that between 6 and 7 acre feet would be a more accurate figure. The Clyde-Criddle-Woodward report gives a figure of 6 acre feet for the annual diversion.

Thank you for the opportunity to review your analysis. If you have any questions or we can be of further assistance, please let us know.

Sincerely,

GEORGE L. CHRISTOPULOS
State Engineer

cc: DeVere Hinckley
Water Division No. 3 Superintendent
Box 101
Cowley, WY 82420

Tommie J. King
Hydrographer-Commissioner
240 Deer Avenue
Riverton, WY 82501

William D. Thoren
Big Horn Basin Irrigation Development Association
Box 93
Worland, WY 82401

GLC/vsb

streams, Chapter I of Wyoming Water Quality Rules and Regulations 1974 contains sections 15 and 21 which deal with turbidity and settleable solids. This division would suggest that all river bed work in the form of channel changes, diversions or dams be permanent type structures.

Permanent type structures would be defined as rip-rap, which is securely fastened down or concrete structures which are not susceptable to water current erosions. These structures would have a high initial cost, but the maintenance and re-work saved over an extended period of years would make this initial investment feasible.

The permanent structures would cause a certain amount of turbidity during construction, but this would happen only one time. The river would be free from turbidity and settleable solids, other than from natural causes, at times other than the initial construction.

Low flow periods make turbidity more of a problem to a fishery and a water supply as the volume of water is not present for dilution. This division will allow construction of permanent structures as mentioned above. Any violation of Water Quality Standards for turbidity or settleable solids other than natural origin could and may be enforced.

If any questions arise, feel free to contact us. We apologize for not getting our comments in earlier.

Sincerely,

Jake Strohman

Jake Strohman
Environmental Engineer
Division of Water Quality

JS/mf

Enclosure