REVISED JULY 1976

JENSEN UNIT

CENTRAL UTAH PROJECT
DEFINITE PLAN REPORT

DECEMBER 1975

APPENDIX C

PROJECT LANDS
DRAINAGE
GROUND WATER

DEPARTMENT OF THE INTERIOR
THOMAS S. KLEPPE, SECRETARY

Bureau of Reclamation
Gilbert G. Stamm, Commissioner

JENSEN UNIT

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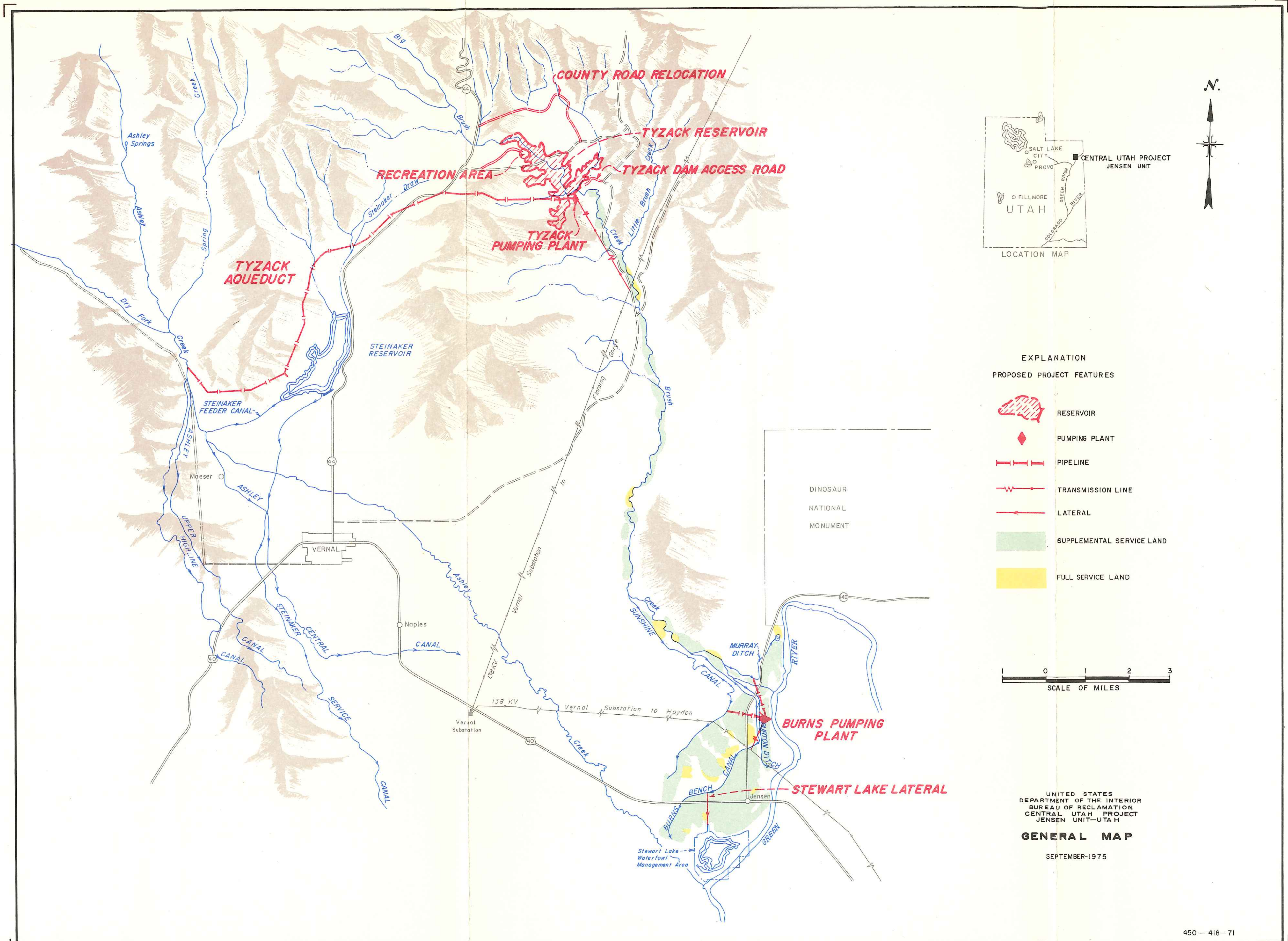
PROJECT LANDS
DRAINAGE
GROUND WATER

BUREAU OF RECLAMATION
GILBERT G. STAMM, COMMISSIONER

Upper Colorado Region
David L. Crandall, Regional Director


COUNTY ROAD RELOCATION
TYZACK RESERVOIR
TYZACK DAM ACCESS ROAD
RECREATION AREA
TYZACK PUMPING PLANT
TYZACK AQUEDUCT
STEINAKER RESERVOIR
STEINAKER FEEDER CANAL
Ashley Springs
Ashley
Spring
Creek
Dry Fork Creek
Big Brush
Steinaker Draw
Little Brush Creek
Fleming Gorge
Brush
Moaser
ASHLEY
UPPER HIGHLINE
VERNAL
Naples
CANAL
STEINAKER CENTRAL CANAL
SERVICE CANAL
Ashley Creek
Vernal Substation
138 KV Vernal Substation to Hayden
SUNSHINE CANAL
MURRAY DITCH
RIVER
BURNS PUMPING PLANT
BURTON DITCH
STEWART LAKE LATERAL
BENCH CANAL
BURNS
Jensen
GREEN
Stewart Lake Waterfowl Management Area
DINOSAUR NATIONAL MONUMENT
SALT LAKE CITY
PROVO
FILLMORE
UTAH
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SUPPLEMENTAL SERVICE LAND
FULL SERVICE LAND
0 1 2 3
SCALE OF MILES
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT—UTAH
GENERAL MAP
SEPTEMBER-1975
450 — 418 — 71

SUMMARY SHEETS

Jensen Unit

LOCATION

Uintah County, northeastern Utah, in Uinta Basin of Upper Colorado River Basin.

AUTHORIZATION

Initial Phase of the Central Utah Project, including Jensen Unit, authorized as a participating project of the Colorado River Storage Project by act of April 11, 1956 (70 Stat. 105).

PLAN OF DEVELOPMENT

The Jensen Unit will provide municipal and industrial water to augment existing supplies throughout the project area and water for irrigation in the vicinity of Jensen. It also will benefit fish and wildlife, recreation, and flood control.

The main project feature will be Tyzack Reservoir to be constructed on Big Brush Creek. Project water will be pumped from the reservoir to Ashley Creek by the Tyzack Pumping Plant and Aqueduct and exchanged with Ashley Spring for municipal and industrial use. Tyzack Reservoir operation will be coordinated with operation of Steinaker Reservoir of the Vernal Unit to avoid winter operation of the Tyzack Aqueduct. Treatment and distribution of the municipal and industrial water will be the responsibility of the water users.

Storage water to be used for irrigation below Tyzack Reservoir will be released from the reservoir to Big Brush Creek and conveyed in the Brush Creek channel to points of diversion. The project Burns Pumping Plant will pump water from Green River for the irrigation of lands near Jensen and for municipal and industrial purposes by exchange with water from Big Brush Creek. The irrigation water, whether supplied from the reservoir or the pumping plant, will be distributed by existing canals. Only minor extensions of existing irrigation distribution facilities will be required and these will be provided by the water users. Project drainage will be provided as necessary. Power for operation of the project pumping plants will be obtained from the Colorado River Storage Project system.

Specific recreational facilities will be provided at Tyzack Reservoir. Measures for fish and wildlife will include a fishery pool in Tyzack Reservoir and rehabilitation of public lands as big game range to compensate for range lands that will be inundated by the reservoir. Also improvements will be made in the methods of water deliveries to the Stewart Lake Waterfowl Management Area, permitting improved operation of the area.

IRRIGATION SERVICE AREA (acres)

Full service land	440
Supplemental service land	3,640
Total	4,080

WATER SUPPLY (average annual acre-feet)

Project increases in supply	
Municipal and industrial use	18,000
Irrigation	4,600
Total	22,600
Depletion of Colorado River	15,000
Increases in salinity concentration at Imperial Dam (mg/l)	
From stream depletion	1.5
From increase in salt load	.1

COSTS

Construction costs (January 1975 prices, except as noted)	
Tyzack Dam and Reservoir	$18,455,000
Tyzack Pumping Plant and discharge line (aqueduct)	1/ 9,420,000
Burns Pumping Plant and discharge lines	3,290,000
Drains	774,000
Tyzack Pumping Plant switchyard	2/ 121,000
Burns Pumping Plant switchyard	65,000
Facilities to connect with Colorado River Storage Project power system	121,000
Transmission line to Tyzack Pumping Plant	97,000
Transmission line to Burns Pumping Plant	93,000
Recreational facilities	757,000
Fish and wildlife development	43,000
Permanent operating facilities	27,000
Total	33,263,000
Annual operation, maintenance, and replacement costs (1972-74 prices)	177,000

1/ Entire cost at July 1975 prices except $6,000 for acquisition of land and land rights which was estimated at January 1975 prices.

2/ At July 1975 prices.

COST ALLOCATIONS ($1,000)

	Construction costs	Reimbursable interest during construction (5.116 percent)	Annual operation, maintenance, and replacement costs
Reimbursable costs			
Municipal and industrial water	$25,668	$2,338	$120
Irrigation	4,933		6
Recreation			48
Subtotal	30,601	2,338	174
Nonreimbursable costs			
Fish and wildlife			
Enhancement	596		1
Mitigation	20		
Recreation	757		
Flood control	609		2
Highway improvement	680		
Subtotal	2,662		3
Total	33,263	2,338	177

REPAYMENT OF REIMBURSABLE COSTS (50-year repayment period)

Municipal and industrial water			
Prepayment 1/	58		
Water users	16,903	1,543	120
Ad valorem tax revenue	8,707	795	
Subtotal	25,668	2,338	120
Irrigation			
Prepayment 1/	11		
Water users	750		6
Apportioned revenues from Colorado River Storage Project	4,172		
Subtotal	4,933		6
Recreation (State of Utah)			48
Total	30,601	2,338	174

1/ Includes payments made for investigation from Colorado River Development Fund and funds contributed by State of Utah.

MUNICIPAL AND INDUSTRIAL WATER CONSTRUCTION COSTS AND REPAYMENT[1/]

Item	Initial use Block 1 (6,000 acre-feet)	Deferred costs or subsequent construction[2/] Block 2 (6,000 acre-feet)	Deferred costs or subsequent construction[2/] Block 3 (6,000 acre-feet)	Total (18,000 acre-feet)
Tyzack Reservoir	$4,565,000	$4,566,000	$4,566,000	$13,697,000
Tyzack Pumping Plant and related facilities	10,546,000			10,546,000
Burns Pumping Plant and related facilities		2,363,000	1,323,000	3,686,000
Permanent operating facilities		19,000		19,000
Total	15,111,000	6,948,000	5,889,000	27,948,000
Annual payment (50 years)	842,600	387,400	328,400	1,558,400

1/ Costs shown include $2,338,000 in reimbursable interest during construction but exclude $58,000 in prepayments.

2/ "Subsequent construction" refers only to Burns Pumping Plant and related facilities.

BENEFIT-COST ANALYSIS
(100-year period of analysis at 3.25 percent interest)

	Direct	Indirect and public	Total
Average annual benefits			
Municipal and industrial water	$2,055,000		$2,055,000
Irrigation	166,000	$17,000	183,000
Fish and wildlife	24,000		24,000
Recreation	88,000		88,000
Flood control	24,000		24,000
Total	2,357,000	17,000	2,374,000

	Direct effects	Indirect effects	Total
Negative externalities			
Concentrating effects of stream depletion	$282,000	$63,000	$345,000
Increase in salt load	18,800	4,200	23,000

Average annual equivalent costs	1,371,000
Benefit-cost ratios	
Without externalities	
Ratio of total benefits to costs	1.73:1
Ratio of direct benefits to costs	1.72:1
With negative externalities from increased salt load	
Ratio of total benefits to costs	1.71:1
Ratio of direct benefits to costs	1.70:1

PROJECT FEATURES

Tyzack Reservoir	
Capacity (acre-feet)	
Active	24,000
Inactive and dead	2,000
Total	26,000
Surcharge	7,600
Normal water surface area (acres)	520
Tyzack Dam	
Height above streambed (feet)	145
Crest length (feet)	1,640
Volume of dam (cubic yards)	2,030,000
Tyzack Pumping Plant	
Maximum operating head (feet)	587
Design diversion capacity (second-feet)	46
Tyzack Discharge Line (aqueduct)	
Capacity (second-feet)	46
Length (miles)	11.8
Burns Pumping Plant	
Maximum static head at average flow of river (feet)	52 to 195
Design diversion capacity (second-feet)	97.4

Appendixes to the Jensen Unit, Central Utah Project, have been prepared in four volumes with the data grouped as follows.

APPENDIX A
DESIGNS AND ESTIMATES
PLAN FORMULATION

APPENDIX B
WATER SUPPLY

APPENDIX C
PROJECT LANDS
DRAINAGE
GROUND WATER

APPENDIX D
AGRICULTURAL ECONOMY
FINANCIAL AND ECONOMIC ANALYSES

CONTENTS

Project Lands

CONTENTS (Continued)

Project Lands (Continued)

Drainage

CONTENTS (Continued)

Drainage (Continued)

CONTENTS (Continued)

Ground Water

FIGURES

Drainage

Ground Water

TABLES

Project Lands

Drainage

TABLES (Continued)

Ground Water

MAPS AND PLATES

Project Lands

Drainage

Ground Water

PROJECT LANDS

7-1594
(7-66)
Bureau of Reclamation

LAND CLASSIFICATION SUMMARY DATA

(See explanation on reverse side)

DATE July 1975

1. AREA

REGION OR COUNTRY	MAJOR RIVER BASIN	STATE(S)	DIVISION	PROJECT	UNIT
Upper Colorado	Colorado	Utah		Central Utah	Jensen

2. BASE MAPS

	SCALE	CONTOUR INTERVAL
AERIAL PHOTOS, B&W	1" = 400'	
AERIAL PHOTOS, COLOR		
TOPOGRAPHIC		
PHOTO-CONTOUR MAP		
PLANIMETRIC		
OTHER		

3. TYPE OF WORK

SUB-RECONNAISSANCE		MODIFIED DETAILED	
RECONNAISSANCE		DETAILED	X
SEMI-DETAILED			

4. FIELD WORK DATES

INITIAL	COMPLETED
1946	1964
ADJUSTED	**APPENDIX REPORT**
1957-64	1975

5. CLIMATE INCOME DATA

CLIMATE-INCOME ZONE(S): ☐ A ☐ B ☒ C ☐ D ☐ E

WEATHER STATION(S) USED: Vernal Airport

CLIMATE SUMMARY

ITEM	MEAN VALUES	PERIOD OF RECORD	LENGTH OF RECORD
DAYS BETWEEN 32° F	120	1948, 1950-63	15
DAYS WITH TEMP. ≧ 90°	33	1948, 1951-63	14
INCHES SUMMER RAINFALL	1.74	1948, 1950-63	15

PREDOMINATE TYPE OF FARMING	ELEVATION RANGE
Livestock	4,730 to 5,460

GROSS CROP VALUE: $ 135.00 per acre

6. LAND CHARACTERISTICS

CLASS	PRINCIPAL SUBCLASSES	PERCENT OF IRRIGABLE
1		1
2	t	6
2	s	55
2	st	23
3	t	1
3	s	1
3	st	13
4		
4		

7. RESULTS

ARABILITY AND IRRIGABILITY STUDIES

DELINEATIONS	ARABILITY SURVEY	IRRIGABILITY SURVEY SUPPLEMENTAL	IRRIGABILITY SURVEY FULL SERVICE	IRRIGABILITY SURVEY TOTAL
CLASS 1	67	40		40
CLASS 2	3,629	3,180	250	3,430
CLASS 3	625	420	190	610
CLASS 4				
SUBTOTAL	4,321	3,640	440	4,080
CLASS 5				
CLASS 6W	333			
CLASS 6	11,070			
R.O.W. 1/				
TOTALS	15,724			

IRRIGABLE AREA	PRODUCTIVE AREA	AREA NOT CLASSIFIED
4,080	3/ 3,880	

8. MUNICIPAL AND INDUSTRIAL LAND USE

	AREA SURVEYED (ACRES)	AREA SELECTED FOR SERVICE (ACRES)
CLASS "H"		

9. SUPPLEMENTAL PROCEDURES

LABORATORY		FIELD	
SALINITY	2,143	SALT LEACHING	
pH	2,143	SOIL AMENDMENT	
GYPSUM	32	PROFILE MODIFICATION	
PARTICLE SIZE	32	WATER HOLDING CAP.	
EXCH. SODIUM	32	WATER QUALITY STUDIES	X
CATION EX. CAP.	32	PUMP-IN TESTS	
BULK DENSITY		PUMP-OUT TESTS	X
SURFACE AREA		INFILTRATION	
AGG. STABILITY		PERMEABILITY	
EXCHANGE ACIDITY		FERTILITY PLOTS	
LIME REQUIREMENT		DEV. COST STUDIES	
EXCHANGE ALUMINUM		LYSIMETER	
FERTILITY		CORRELATION AREA	
Frag. Hyd. Cond.	145		

10. NUMBER OF BORINGS AND PITS

TYPE	MINIMUM PER SQ. MILE	AVERAGE PER SQ. MILE	TOTAL
SHALLOW (0-5')		9	559
DEEP (5-10')		1	41
TOTALS			
OPEN PIT OR DEEP HOLES>10'			

11. PRIOR SURVEYS OR CLASSIFICATION

AGENCY AND TYPE	YEAR	SCALE	COVERAGE
USDA Soil Survey	1920	1" = 5,280	All
USBR Reconn Land Class	1937	1" = 1,000	All
USDA SCS Farm Survey	1956		Partial
USBR Detail Land Class	1946	1" = 500'	Partial
USBR Detail Land Class	1957	1" = 400'	Partial

12. SPECIFICATIONS AND ECONOMIC INFORMATION

	PROJECT	CLIMATE ZONE	OTHER	
TYPE OF SPECS.				
	CLASS 1	CLASS 2	CLASS 3	CLASS 4
PAYMENT CAPACITY 2/ ☒ PER ACRE ☐ ACRE FOOT		18.00		
ACREAGE EQUIVALENTS				

13. CLASSIFICATION INFORMATION

TYPE OF APPRAISALS						
	X	LAND DEVELOPMENT	X	PRODUCTIVITY	X	LAND USE
	X	LAND DRAINABILITY	X	WATER REQ.		OTHER

CLASS 4 DESCRIPTION: None

CLASS 5 DESCRIPTION: None

14. IRRIGABLE AREA STUDY

BASIS FOR IRRIGABLE AREA		
	X	SYSTEM LAYOUT
		PERCENTAGE REDUCTION

15. FIELD REVIEWS

TYPE		DATES
REGIONAL	Arable	June 21-25, 1965
CHIEF ENGINEER	"	" "

16. SECRETARIAL CERTIFICATION

ITEM	INITIAL	SUPPLEMENTAL	RECERTIFICATION
DATE	April 8, 1971		
ARABLE ACREAGE	4,321 acres		
IRRIGABLE ACREAGE	4,080 acres		

17. FOOTNOTES

1/ Existing rights-of-way tabulated with class 6 land.

2/ Because of the small class 1 and class 3 total acreage the final payment capacity was determined for class 2 lands only.

3/ Represents 95 percent of the irrigable area.

CHAPTER I

INTRODUCTION, SUMMARY, AND CONCLUSIONS

Preface

Land classification is an essential part of the Bureau of Reclamation's project planning and development. It involves the determination, selection, and designation of lands suitable for profitable crop production under sustained irrigation practices.

This appendix is a report of the procedures and findings of the investigations in determining the arable and irrigable lands within the Jensen Unit of the Central Utah Project.

Authorization to make this classification and the supporting investigations is provided for in the Federal Reclamation Laws (Act of June 17, 1902, 32 Stat. 388) and subsequent acts amendatory thereof or supplementary thereto. The Appropriation Act of June 30, 1953 (Public Law 470, 82nd Congress), states and provides "that no part of this or any other appropriation shall be made available for the initiation of construction until the Secretary shall certify to Congress that an adequate soil survey and land classification has been made and that the lands to be irrigated are susceptible to the production of agricultural crops by means of irrigation." The detailed survey described in this appendix to the Definite Plan Report forms the basis for that certification which was accomplished April 8, 1971, and supersedes previous surveys and reports.

Type and Purpose of Investigations

The land classification survey discussed and presented in this report is detailed in scope. It involves the examination of land features in sufficient detail to provide the necessary information as to the extent and the degree of suitability of lands in the area for irrigation.

The specific purpose of the detailed land classification is to systematically appraise and delineate all similar lands of the area into categories or classes and subclasses according to their power to produce adaptable crops under an agricultural program based on sustained irrigation. In addition, the land classification provides data which is essential in solving the agronomic, economic, and engineering problems associated with Bureau project planning and development.

Land Characteristics

The soils of the Jensen Unit have developed under desert conditions. They are highly calcareous, high in inherent plant nutrients, have weakly developed soil profiles, and a wide range of soil textures. They were derived from both old and recent alluvial materials composed principally of eroded Mancos shale and other geologic formations of the Uinta Basin and Mountains.

The bulk of the Jensen Unit lands (approximately 86 percent) is found on the two distinct benches or terraces located adjacent to the Green River. The remaining 14 percent of the arable lands occurs on the narrow tracts of land adjacent to Brush and Little Brush Creeks and a few small tracts scattered along the low river flood plain formed by the Green River. The soils of the benches are derived from varied parent material of recent geologic origin. They are fine textured (predominantly clay loam and clay), deep, and are underlain at various depths (usually greater than 5 feet) with a cobble-gravel layer which in turn overlies the Mancos shale formation.

These terrace soils, being derived from alluvium, have been modified and reshaped by the Green River and have no distinct profile patterns or horizons. Areas of deep, fine-textured soils are often in close proximity to areas of coarse-textured soils or soils shallow over gravel and cobble.

Topography on the bench land is usually smooth with long, gentle slopes. Gradients vary from 1 to 3 percent. It becomes rough and broken near their lower boundaries and rough to gently rolling at their upper extensions. A view of typical bench lands in the Jensen Unit is shown on the following page.

The arable lands adjacent to Brush and Little Brush Creeks occur as narrow bodies of land and are gently rolling to smooth with moderate slopes (gradients up to 8 percent). The soil is usually deep and of medium texture (clay loam). There are some residual soils, however, with a predominantly clay profile. The topographic deficiencies of these lands are the most distinctive characteristic. The irrigated fields are usually small and irregularly shaped as a result of many small drainage channels dividing the narrow creek bottom. This results in short to moderate irrigation runs. Many of the arable lands are located on small, side-slope alluvial fans deposited at right angles to the major stream course.

The nonirrigated lands found scattered on the benches or terraces adjacent to the Green River are of two types: (1) small isolated areas with fine-textured soils developed from alluvium eroded from the surrounding shale hills and (2) areas with shallow soil over cobble-gravel layers. Both types of soils are gypsiferous.

View of alfalfa fields on typical bench lands in the Jensen Unit.

Soils of lands adjacent to Big Brush Creek above the Tyzack Dam site and along Little Brush Creek have been derived from the surrounding sandstone formations and exhibit characteristics such as soil color and textures that are similar to these formations. Below Tyzack Dam site the soils are derived mainly from the underlying shale formations modified by the alluvial material eroded from upstream formations. These soils are light yellowish-brown in color with medium to fine textures.

Drainage Characteristics

The bulk of the Jensen Unit lands are well drained. These adequately drained arable lands occupy the higher, more favorable, topographic positions within the area. Their subsurface materials are permeable and medium textured. No barrier is present to restrict ground water movement. The present water table is deep and is expected to remain at safe depths under project operations.

Approximately 700 acres of presently irrigated arable land have correctable drainage deficiencies. These lands occupy a low topographic position on the lower bench in the general vicinity of the town of Jensen. Because these lands lack gradient and there is an absence of outlet channels, drainage problems have developed. An additional 10 acres of full service land will also require project drainage. These drainage-deficient lands have fair permeability rates in the upper 8 to 10 feet of medium- to fine-textured materials and high permeability rates in the gravel layer overlying the shale barrier. It will be feasible to provide adequate subsurface drainage to these lands.

Land Classification

The classification of lands not previously classified, lying principally in the Gibson Gulch area, and the refinement of the 1957 classification of lands in the vicinity of Jensen and along Brush Creek were started in the fall of 1964 and completed during the spring of 1965. The arable lands were classed as 1, 2, and 3, while lands not capable of profitable crop production over a sustained period were delineated as nonarable class 6 lands if nonirrigated and class 6W nonarable if presently irrigated. Class 5D was also delineated during the initial survey, but after further analysis these lands were redesignated class 2 or class 6.

The Gibson Gulch area was later excluded from the unit and, therefore, is not included in this report.

Table I-1 is a summary of the gross acreage classified and the irrigable acreage included in the Jensen Unit. This table shows a total of

15,720 acres of land classified within the unit, of which 4,320 acres are arable and 4,080 acres are irrigable.

Table I-1
Summary of land classification
(Unit: acres)

Land class	Lands: Irrigated	Lands: Nonirrigated	Total
	Classified area		
Class 1	67		67
Class 2	3,354	275	3,629
Class 3	424	201	625
Total classes 1, 2, and 3	3,845	476	4,321
Class 6W	333		333
Class 6		11,070	11,070
Total	4,178	11,546	15,724
Rounded	4,170	11,550	15,720
	Irrigable area		
Class 1	40		40
Class 2	3,180	250	3,430
Class 3	420	190	610
Total classes 1, 2, and 3	3,640	440	4,080

Conclusions

Lands in the Jensen Unit are well suited to the production of adapted crops under an agricultural system based on sustained irrigation. Most of the lands have been fully or partially irrigated for some 75 years. During this period most of the salinity and alkali problem areas have been corrected by leaching, and the lands were leveled and laid out into workable farm units.

A drainage problem has developed in a few local areas, mostly on the lowest terrace and lands adjacent to the Green River. With project development and the installation of a drainage system, however, those lands that are susceptible to reclamation will be drained, reclaimed, and utilized as productive lands.

Table I-2 is a summary of the arable lands classified in the Jensen Unit.

Table I-2
Summary of arable area

Land class	Subclass	Gross area (Unit--acres)	Percent of arable area	Soil and topography characteristics	Crop adaptability and land suitability
Class 1		67	1	Smooth, gently sloping lands on river terraces or benches, sandy loam to friable clay loam underlain by cobble--gravel zone usually below 10-foot depth. Soils are well drained.	Suitable for the production of all adapted crops.
Class 2	2s	2,317	55	Smooth, gently sloping, usually located on the benches and river terraces. Clay loam to friable clay, profiles may contain lenses or layers of coarse-textured materials. Most subclass 2s lands are underlain by the gravel-cobble material at an average depth of 10 feet. Soils are underlain by shale at an average depth of 20 feet. Approximately 7 percent of the subclass 2s lands are moderately shallow over gravel-cobble layers. Surface soils are usually well drained but in some instances fine-textured subsoils may somewhat restrict soil permeability.	Suitable for the production of all adapted crops. Shallow soils with coarse textures may require more frequent irrigations.
	2t	314	6	Uneven to slightly uneven slopes usually greater than 4 percent. Located mostly on lands adjacent to Brush Creek. Soils are sandy loam to friable clay loam, well drained. Smooth, gently sloping lands have irregular size and shape.	Suitable for the production of all adapted crops. Some land development would improve production.
	2st	998	23	Slightly uneven, moderately sloping lands located on the higher river terraces and small alluvial fans from side canyons and washes along Brush Creek. Soil is a fine-textured clay loam with lenses of sandy or coarse material underlain at moderate or shallow depths by gravelly sandy loam or cobble (approximately 21 percent). Soils are well drained. Irrigation pattern, field size, and shape and length of irrigation run and gradient are the limiting topographic deficiency on most of these lands.	Suitable for the production of adapted crops. Special management practices may be required. Shallow soils may tend to be droughty and suited to the production of good rotation pastures.
Class 3	3s	50	1	Smooth, gently sloping lands representing a small percentage of the arable area usually on the river flood plain. Soils are predominantly clay. The low flood plain area usually has restricted drainage conditions.	Utilized as improved pasture, grasses, and clovers, but includes some small grains and alfalfa.
	3t	28	1	Slightly uneven, gentle to moderate slopes, located on benches and alluvial fans. Soils are medium-textured sandy loam to clay loam. Small, irregular field size and shape is the limiting factor, accompanied by short irrigation runs.	Small acreage suited to the production of adapted crops. Will require special management practices.
	3st	547	13	Most of these lands are slightly uneven, with gentle to moderate slopes located on benches and alluvial fans. Soil data indicate a predominantly stratified profile with surface texture ranging from loamy sand to clay. Approximately 10 percent of these lands is underlain at shallow or moderate depths by gravel-cobble layers. Coarse-textured soils account for approximately 1 percent of these lands. Gradients in excess of 3 percent are common as is irregular field size and shape.	Suitable for production of adapted crops. Shallow, steep soils will be droughty and require special irrigation practices. Steep gradients require better land management practices.
Total		4,321	100		

CHAPTER II

GENERAL DESCRIPTION

Location

The Jensen Unit is located in the east-central part of Uintah County of northeastern Utah. Jensen, from which the unit derives its name, is a small rural community on the west bank of the Green River. It is the only community within the boundaries of the classified area and is situated 12 miles southeast of the Uintah County seat at Vernal. U.S. Highway 40, an all-weather transcontinental route, passes through the community of Jensen and the southern part of the Jensen Unit lands. Highway 40 connects the community of Jensen and surrounding area with the large population and market centers of Denver, 325 miles to the east and Salt Lake City, 190 miles to the west. Dinosaur National Monument is located 6 miles to the north of Jensen on State Highway 149 and 3 miles outside the northern boundary of the Jensen Unit lands.

Physiography

The Jensen Unit lies in the eastern portion of the Uinta Basin, a broad structural depression. The northern boundary of the basin is formed by the high Uinta Mountains. These mountains rise gradually from the basin floor to elevations exceeding 13,000 feet above sea level. The southern boundary is formed by the Tavaputs Plateau. Physical features of the basin include mesas, benches, terraces, buttes, washes, and badlands interspersed with valleys and broad flats eroded from sedimentary deposits of sandstone and shale.

The area is drained by the Green River, a major tributary of the Colorado River, and by Brush Creek, a small permanent creek that is tributary to the Green River. The Green River has its headwaters in the high Wind River Mountains of western Wyoming. It flows southward some 150 miles to its confluence with the Colorado River. In passing through the Jensen Unit lands after flowing through Split Mountain Canyon, the river flows slowly northwest some 3 miles where it meanders sharply almost due south past its confluence with Brush Creek and on past the southern boundary of the Jensen Unit near its confluence with Ashley Creek.

Brush Creek has its headwaters in the lofty Uinta Mountains. Within the Jensen Unit it flows southeasterly in a shallow alluvial depression cut in the soft underlying shale formations. Between Brush and Ashley Creeks there is an upland area composed of eroded badlands, flat-topped mesas, washes, and small valleys or flats interspersed with arable lands.

The area immediately west of and adjacent to the Green River lies on two strath or river terraces and the low river flood plain.

Lands to be irrigated by the Jensen Unit are at an average elevation of about 4,800 feet and range in elevation from 4,730 to 5,460 feet.

Geology

Historical

The oldest exposed rock in the Uinta Basin area is quartzite sandstone and sandy shale of the Proterozoic Age of the Uinta Mountain group. The Lodore formation of the Cambrian Age overlies the Uinta Mountain group extending from Brush Creek eastward to the Green River.

The Uinta Mountains were first formed during the late Cretaceous time. Erosion during the moist Oligocene period reduced the mountains to a low relief. This was followed by renewed uplift in the late Pliocene or early Pleistocene period.

During this process of folding, uplift, and erosion in the Uinta Mountains, the overlying Upper Cretaceous and Tertiary formations were removed from the Jensen Unit area leaving soft shale and sandstone of the Mancos shale formation exposed. On the mesa and bench lands of the unit, a layer of water-worn cobbles and gravels, 10 to 50 feet thick, covers this Mancos shale. This gravel-cobble material was eroded from the Bishop conglomerate of the Miocene Age and consists of rounded to subangular tan, purple, or red-banded quartzite boulders interspersed with rock fragments from other formations exposed by earlier erosional processes.

The erosional processes include glaciers that formed in the Uinta Mountains and descended into the several stream valleys. Three ice advances, termed "Earliest, Maximum, and Latest," are recognized and are identified with corresponding outwash gravels and land forms present in the area. The two strath terraces described in the Jensen area were formed during the glaciation of the Uinta Mountains in Pleistocene time. The widespread, gently rolling, erosion surface that forms the tops of Jefferson Park, Pole Mountain, Lake Mountain, Dry Fork Mountain, Diamond Mountain, and the upland area between Ashley and Brush Creeks is a remnant of the Jensen erosional surface that has been isolated by subsequent erosion.

Younger erosional surfaces or strath terraces are some 150 to 230 feet lower than the surrounding remnants of the Jensen erosional surface (Sunshine Bench) and 100 to 125 feet above the present stream level. The upper terrace or Vernal surface is cut on the soft clay shale member of the Mancos shale formation and is covered with 5 to 10 feet of boulders and coarse gravels. The main Vernal surface probably had its origin in the latter planation of Ashley Creek during the interglacial stage that followed maximum glaciation in the Uinta Mountains.

Located some 50 feet below the Vernal terrace and about 55 feet above the present low water level of Ashley Creek is a younger erosional surface called the "Thornburgh Strath Level." It is cut in soft Mancos shale and has a mantle of 5 to 10 feet of red quartzite boulders and gravels. Below the Thornburgh surface is the present river flood plain. Most of the arable lands in the Jensen Unit are situated on the two strath terraces on the west bank of the Green River between its confluence with Brush and Ashley Creeks. These terrace surfaces have been altered through recent erosion so that much of the cobble veneer has been removed or occurs in spotty, isolated locations as gravel layers.

Soil derivation

Soils of the Jensen Unit are derived mainly from modified old alluvial material laid down by stream action. Throughout the area much of this old alluvial material has been removed, replaced, or redeposited as recent alluvium and subjected to the soil-forming processes. The parent material for these soils has been eroded from the Mancos shale and other rock formations of the Uinta Basin and Mountains.

Billings clay is the predominant soil series and type and occurs extensively on the upper terrace and along Brush Creek. The Billings soils contain very little organic matter. They vary in color from light yellowish-brown to pale brown and are characterized by fine subsoil textures that are usually compacted. Both the surface and subsoils contain crystals of gypsum. Soil depth usually exceeds 6 feet with the average depth to cobble approximately 20 feet. Surface drainage is favorable, but where fine, compacted subsoils occur, the movement of soil moisture is slightly retarded. Billings soils that have gravel and cobble layers which often occur in the subsoil with lenses of sandy material occur along the outer edge of the upper terrace.

Soil types found on the lower terrace or bench include the Naples and Green River series, with the Green River series found predominantly on the small river flood plain. These are soils derived from the more recent alluvial materials.

Naples soils are usually pale reddish-brown to a light reddish-brown on the surface. Where products of weathered shale occur in the subsoil, the color is lighter and the subsoil more compacted. The alluvial soils are generally deep, with a sandy loam to loam surface some 10 to 12 inches deep and underlain by clay loam or somewhat compacted clay. A localized area has a thin surface veneer of fine, small, water-worn gravel, and where the subsoils of the Naples series do not extend below 6 feet, they are usually underlain by beds of gravel and occasionally by Billings soil material. Surface drainage is adequate; but where soils are shallow or have poor topographic position, their internal drainage may be restricted and hence they are nonarable. Both the surface and subsurface soils are calcareous with a zone of lime accumulation effecting a color change in the subsoil.

The soils associated with the Green River series are usually found on the river flood plain with an occasional area located on the first terrace above the flood plain. The Green River soils are pale brown or light grayish-brown to dark brownish-gray, occasionally marked with darker streaks of organic material both on the surface and in the subsoil. Both the surface soil and subsoil are slightly to strongly calcareous. Soil textures vary from a sandy loam to clay on the surface. The subsoil is somewhat variable but generally consists of a compact clay. This soil is free of gravel but has a continuous layer of grayish-brown, coarse-textured sandy loam below 36 inches. Because of their location in low flood plain positions, these nonarable lands are subject to flooding from the Green River and the drainage conditions are usually poor.

A soil association and general location map is presented on the following page.

Climate

The Jensen Unit area has a semiarid climate. It is characterized by wide daily and annual variations both in temperature and precipitation. There are four well defined seasons. The summers are warm with an occasional hot spell. Winters are cold and sometimes severe with a light snowfall recorded. The prevailing winds are from a westerly direction. Climatological data are presented in Table II-1 for the stations at Vernal and Jensen.

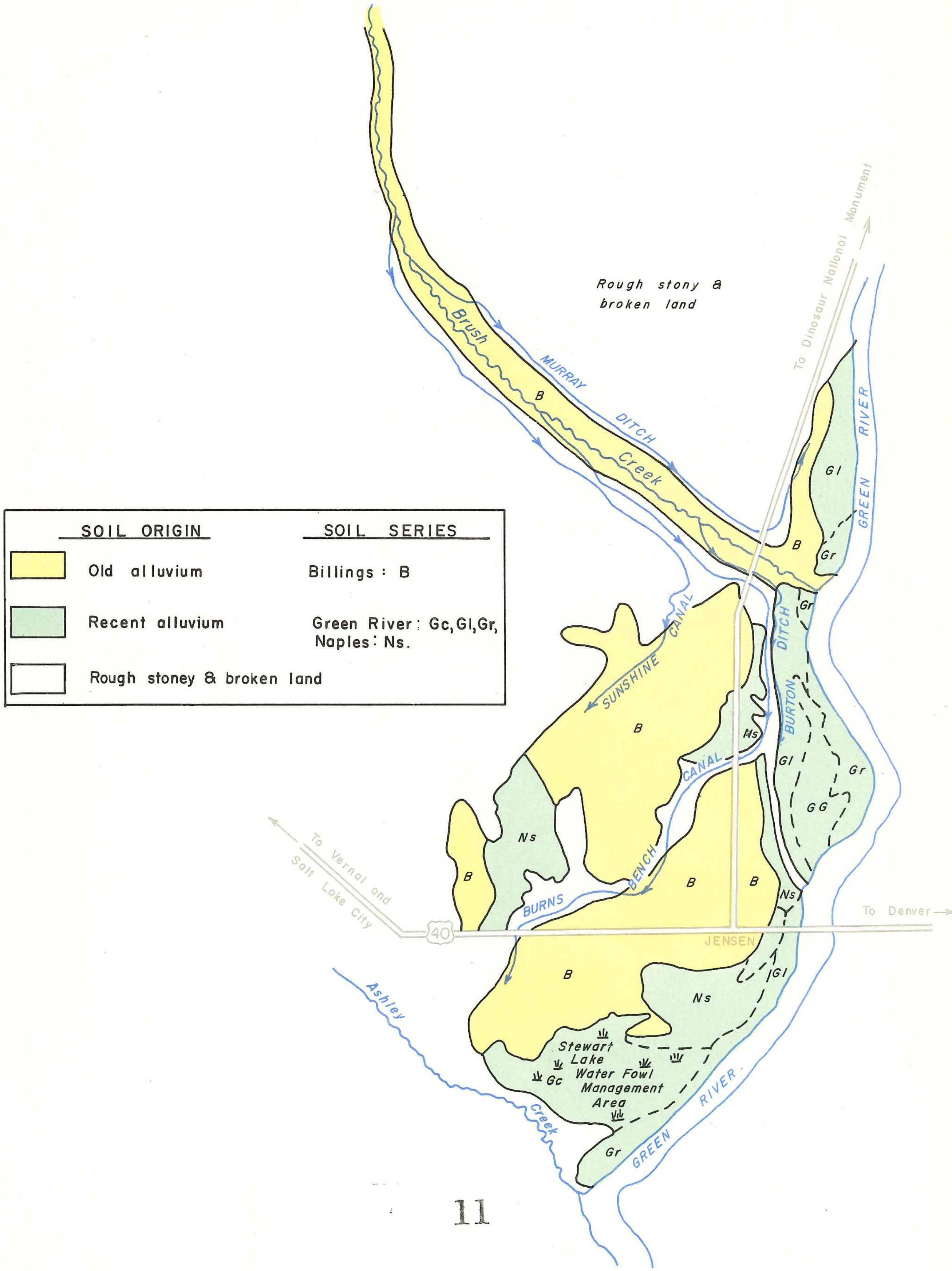
Table II-1
Climatic data--Jensen Unit

	Station	
	Jensen	Vernal
Elevation (feet)	4,720	5,280
Temperature (^{o} F.)		
Mean annual	45.7	44.6
Extremes		
High	106	103
Low	-36	-38
Precipitation (inches)		
Mean annual	7.67	7.97
Extremes		
High	12.55	14.78
Low	3.52	2.81
Frost-free period (days)	119	119
Average growing season		
Number of days	180	
From	April 14	
To	October 10	

JENSEN UNIT

LOCATION & SOIL ASSOCIATION MAP

REVISED SEPT. 1975



Effect on vegetation

The dominant native vegetative species vary throughout the area, but all are common to the semiarid regions of the western United States. Prominent species on arable lands include: shadscale, greasewood, four-wing salt brush, galleta grass, sagebrush, and rabbitbrush. Utah juniper grows on the rough, broken escarpment lands, and willows and cottonwood trees grow along the river and its tributaries.

Effect on agriculture

The small annual precipitation (7.67 inches) with only 60 percent (4.60 inches) recorded during the growing season precludes dry farming practices. Thus cultivation is limited to those crops grown under irrigation that are adapted to the prevailing climatic conditions.

Agricultural History

A Spanish expedition headed by Father Escalante crossed the Green River 4 miles above the present town of Jensen on September 17, 1776. Its purpose was to find a direct route from Sante Fe, N. Mex., to Monterey, Calif. This is the first recorded incident of white men being in the area. The expedition reported the area as, "a land dry and arid with a vegetation of cactus and desert plants."

In 1825, General William N. Ashley, along with Jim Bridger and Andrew Henry, made a fur trapping expedition into the area; hence the names Ashley Valley and Ashley Creek.

The Vernal area of Ashley Valley was settled in 1873. Several Mormon pioneers settled the Jensen area in the fall of 1877 and in the spring of 1878. They diverted water from Brush Creek for irrigation. At first small ditches were built to serve the most readily accessible agricultural lands adjacent to the stream.

The town of Jensen was named after Lars Jensen who settled in the area in 1879 and who, from 1881 to 1909, operated a ferry boat across the Green River.

Three of the four canals--Burton, Murray, and Burns Bench--as well as several small individual ditches have been diverting water from Brush Creek since 1878. The Sunshine Canal was constructed later. As more and more land was developed and brought under cultivation, late-season water shortages developed. These shortages resulted in litigation, and in 1896 the natural flows of Brush Creek were adjudicated by court decree.

Due to the isolation of the area, the first settlers were compelled to make their community self-supporting. The area, though still lacking rail transportation to outlying markets, now enjoys fast efficient motor freight transportation.

Irrigation practices and requirements

Small grains, alfalfa, and pasture have been the principal crops in the area, with alfalfa hay and pasture produced on 73 percent of the irrigated land. There are few immediate cash crops grown, with most crops marketed as livestock and animal products. A breakdown of farming operations practiced in the Jensen area is presented in Table II-2.

Table II-2
Jensen Unit farms

Farm type	Percent
Cattle	
Less than 25 head per unit	8
Over 25 head per unit	48
Sheep	8
Combination	28
General	
Number of livestock	8
Total	100

The average size farm in the area is approximately 130 acres of arable land supporting approximately 70 head of stock.

Most crops are irrigated by the furrow or corrugation method. On the smoother lands with longer irrigation runs border dikes are used. Wild flooding is practiced on the rolling, more uneven lands utilized principally as pasture.

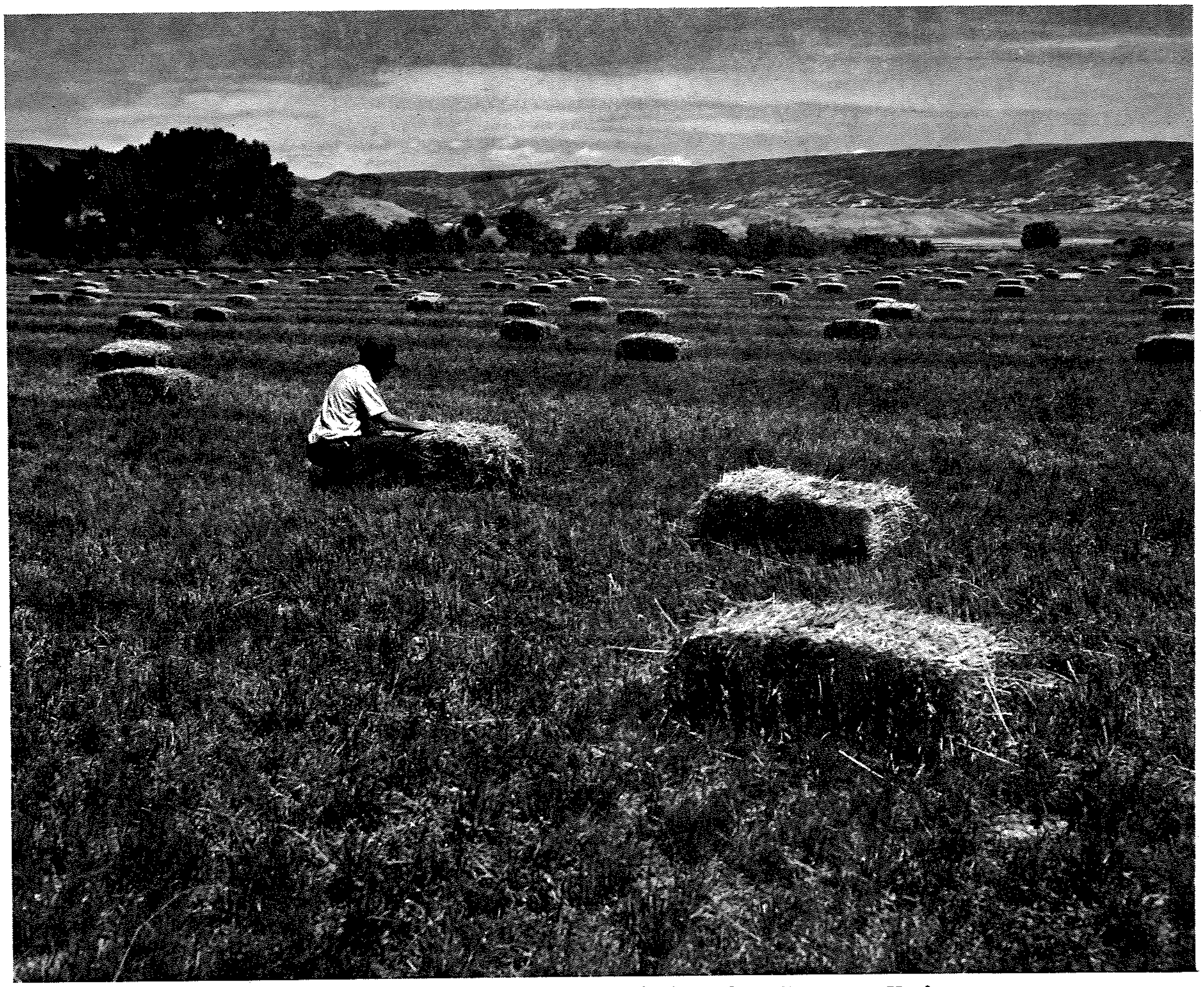
The crop yields per acre without and with the project are shown in Table II-3.

Table II-3
Anticipated crop yields

Crop	Unit	Yields per acre: Without project	Yields per acre: With project
Alfalfa	Ton	3.8	4
Barley	Bu.	70.0	70
Corn silage	Ton	13.0	15
Rotation pasture	AUM		5
Permanent pasture	AUM	6.0	9

The diversion requirement for the Jensen Unit as determined by consumptive use studies indicates a need of 3.7 acre-feet per acre at head of canal. Preproject diversions, based on a 33-year study period, show an average diversion at head of canal of 2.85 acre-feet per acre. Under project conditions 3.7 acre-feet per acre will be delivered at head of canal with a few tolerable shortages occurring during the study. This would equal approximately 3.15 acre-feet per acre at the farm headgate.

The photograph below shows alfalfa hay being harvested in the Jensen Unit area.



View of alfalfa hay being harvested in the Jensen Unit area.

CHAPTER III

LAND CLASSIFICATION SURVEYS

Previous Surveys

In 1937-38 a reconnaissance land classification was conducted to determine and delineate the arable lands. Presently irrigated lands were not designated as to land class but were delineated as cultivated or meadow. The nonirrigated lands were classified according to their payment capacity into two classes--class 1 and class 2. The Jensen Unit then consisted of 4,344 acres.

In 1946 the Jensen Unit was classified in detail to determine the acreage that should be included in the unit. A total of 7,207 acres was delineated into six classes: 1, 2, 3, 4, 5, and 6. This survey included all lands being irrigated from the existing canals.

At the meeting held April 10, 1956, at the Regional Office in Salt Lake City, Utah, it was determined that the 1946 classification, with minor changes, would be adequate for the 1958 report. During April 1957, additional soil samples were collected and analyzed, and the land classification was refined and brought up to date.

The 1958 report was delayed to allow time for additional investigations of alternative project plans which now form the basis for this report.

The Soil Conservation Service and other agencies have, in the past, conducted various soil and farm planning surveys on lands of the Jensen Unit.

Present Survey

The land classification survey discussed in this appendix is detailed in scope. The lands of the area have been examined in sufficient detail to determine their suitability for sustained irrigation and to provide information for other studies of the Jensen Unit. The appendix will be used as a basis for certification. These investigations included the 1964 detailed classification of lands lying adjacent to Brush and Little Brush Creeks and the refinement and transfer of the 1957 classification onto new base maps. Nonirrigated lands in the Gibson Gulch area, lying between Ashley Creek and Brush Creek, were classified in detail during 1964 but were later excluded from the project plan of development.

Table III-1 is a summary of the area classified within the present boundaries of the Jensen Unit, excluding the Gibson Gulch area lands.

Objectives and Methods

The objectives of this classification were to separate and delineate the arable from the nonarable lands of the Jensen Unit. The lands were classified according to their payment capacity under sustained irrigation.

Table III-1
Summary of area classified

Land class	Irrigated land	Nonirrigated land	Total
Class 1	67		67
Class 2s	2,226	91	2,317
Class 2t	256	58	314
Class 2st	872	126	998
Total class 2	3,354	275	3,629
Class 3s	50		50
Class 3t	23	5	28
Class 3st	351	196	547
Total class 3	424	201	625
Total classes 1, 2, 3	3,845	476	4,321
Class 6W	333		333
Class 6st		11,070	11,070
Total nonarable	333	11,070	11,403
Grand total	4,178	11,546	15,724

The important factors which influence the segregation and delineation of lands into different classes and subclasses are: (1) characteristics of the soil, subsoil, and substrata material; (2) topographic features; (3) drainage conditions; and (4) land development requirements. These factors are considered as they occur either singularly or in combinations as they affect the payment capacity of the land.

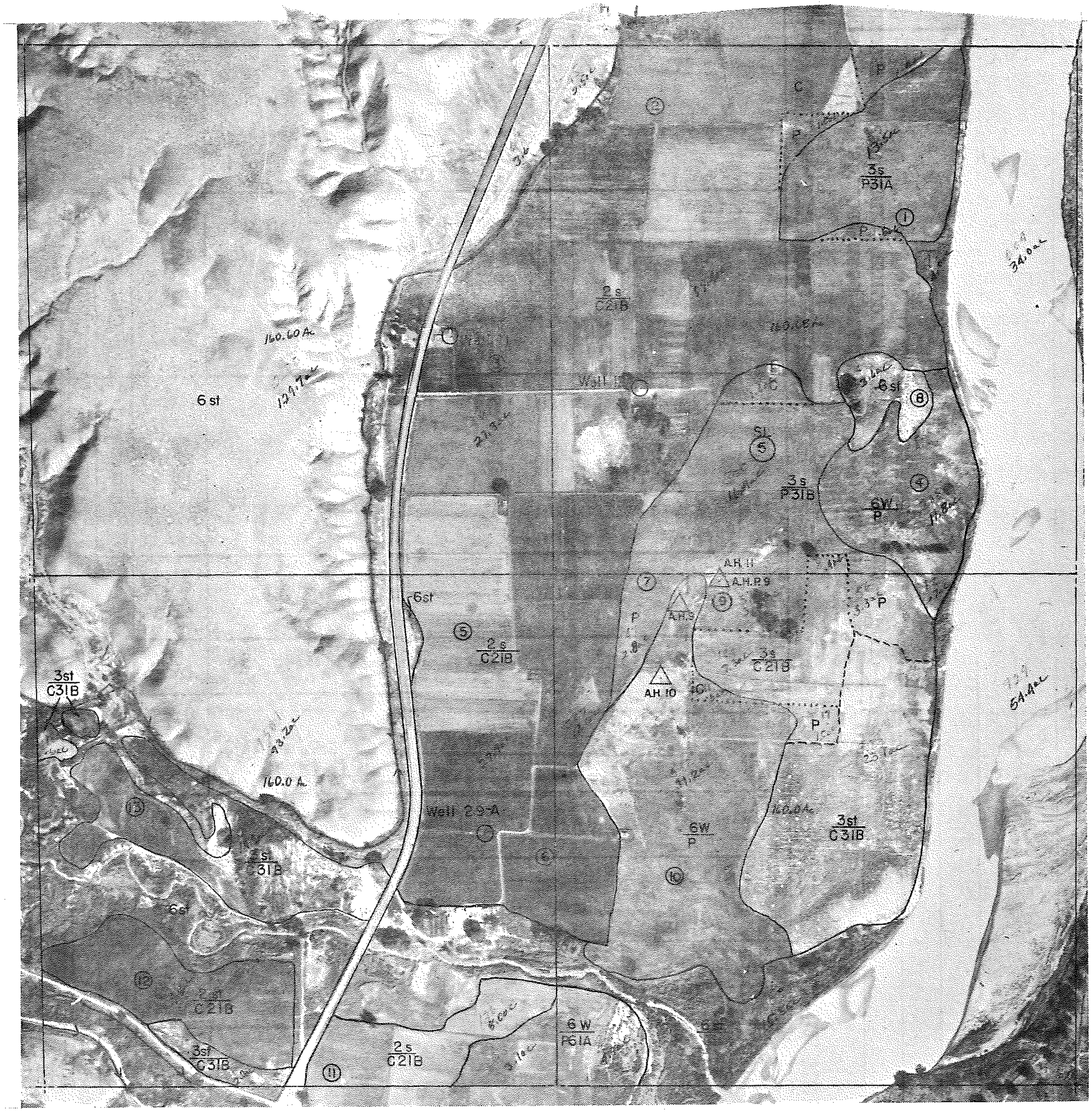
A sample field sheet from the Jensen Unit is presented on the following page.

Maps and Equipment

Aerial photographs with a scale of 1" = 400' were used as base maps. The arable lands were delineated as classes 1, 2, or 3. Class 6W lands are water right lands that failed to meet the minimum requirements for an arable class but which were being irrigated at the time of classification. Class 6 lands are nonirrigated.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DETAILED LAND CLASSIFICATION
PROJECT ___JENSEN UNIT___
CLASSIFIER ___C. WRIGHT___
DATE ___1964___

SEC. 4
T.5 S. R.23E. S.L.B.&M.
DRY-5 RR-119



SOIL PROFILE SYMBOLS

- Sands
- Loamy sands
- Sandy loams
- Loams & silt loams
- Clay loams
- Very permeable clays
- Permeable clays
- Slowly permeable clays
- Shale or raw soil from shale
- Creviced rock
- Gravel or cobble
- Solid rock

Profile represents 5 foot depth
"18" ___% total salts - "9.0" pH
++1/2 - reaction to HCl
"L" - free lime "7" profile number
"14" and "4"% avail. H_2O cap.
"10" ___% silt "8" ___% clay
"0.5" distributed hyd. conductivity in/hr.

1 — 3s / P21A / weeds / mottled below 36"

2 — 2s / C21B / alfalfa / 3% slope

3 — 2s / C21B / alfalfa / 1% slope

4 — 6W / P / salt grass

5 — 2s / C21B / alfalfa / 1% slope

6 — 2s / C21B / alfalfa / 1% slope

7 — 3s / P31B / alfalfa / 1% slope / water 48"

8 — 6st / B / greasewood

9 — 3s / P31B / grass & clover / water at 36"

10 — 6W / P / salt grass / water at 12" / mottled below 12"

11 — 2s / C21B / sunflower & grain

12 — 2st / C21B / alfalfa / 1% slope

13 — 3st / C31B / alfalfa

The classification data were recorded directly onto the photos by the classifier in the field. The photos were then checked, matched, checked again, and inked as permanent records. The acreages were computed by planimetering these inked sheets.

Detail of Coverage

To facilitate the classification and delineation of the separate subclasses of arable lands, an average of twenty-five 5-foot auger borings was made per section. The profile descriptions of these borings were logged in notebooks along with other pertinent information such as: land use, vegetative cover, percent slope, relief, depth-to-water tables where applicable, etc. These were transferred to the photographs for a permanent record.

Also in the earlier classification studies of the unit, a heavy duty, hydraulic, earth-boring machine was used for deep profile studies and drainage investigations. A total of 41 deep holes was dug, 31 with the earth-boring machine and an additional 10 that were dug with hand augers.

Soil samples were collected from the 5-foot profile and deep hole borings and analyzed at the Central Utah Projects Office laboratory. The procedures followed for these laboratory tests are those outlined in the Bureau of Reclamation Manual, Volume V, Part 2. In addition, 32 samples were analyzed in the Regional Laboratory in Salt Lake City, Utah. These tests consisted of the conductivity of saturation extract, anion-cation relationship, exchange capacity, exchangeable sodium, gypsum content, and particle-size analysis. The methods of analysis used by the Regional Laboratory to characterize soils and waters are generally those included in Reclamation Instructions, Part 517, Laboratory Procedures or United States Department of Agriculture, Agriculture Handbook 60.

Table III-2 is a summary of the laboratory tests of the Jensen Unit.

Table III-2
Summary of laboratory tests

Test	Number of samples tested		
	1946	1964	Total
Salinity--EC$\times 10^3$		32	32
Percent salt	556	1,587	2,143
pH paste	556	1,587	2,143
pH 1:5		1,587	1,587
Particle-size analysis		32	32
Gypsum		32	32
Exchangeable sodium		32	32
Lime	556	1,587	2,143

Specifications

The land classification specifications developed for the Jensen Unit were developed in the Central Utah Projects Office with assistance from Regional personnel. These specifications are based on a correlation of the physical land features of soil, topography, and drainage with land development costs, production costs, and anticipated crop production under irrigated farming with a full water supply.

In general the specifications conform with those outlined in Volume V of the Bureau of Reclamation Manual, except for minor adjustments required in the specifications to more properly typify the local, physical, and economic conditions such as additional information regarding land development costs.

The land development costs were established in cooperation with the Economics Branch. Actual contact and consultation with farmers in the area were made and used as a basis for preparing farm budgets. These farm budgets were used in establishing the payment capacity for the various classes.

The payment capacity per acre is shown below.

	Payment capacity
Class 1	1/$22.00
Class 2	18.00
Class 3	1/12.00

1/ Assumed payment capacities as no farm budgets were prepared for classes 1 and 3.

The adopted maximum land development cost necessary to irrigate 1 acre of either class 1, 2s, or 3s land, based upon the "with" project conditions, is as follows.

Clearing	$15.00
Leveling	45.00
Structures	25.00
Total	85.00

The maximum development costs for class 2t and 3t lands are determined by capitalizing at 6 percent the decrease in payment capacity from class 1 and adding this amount to the total development cost for class 1, 2s, and 3s land. These computations are shown in Table III-3.

Table III-3
Permissible development costs

	Land class		
	1	2	3
Payment capacity	1/ $22	$18	1/ $12
Difference from class 1		4	10
Difference capitalized at 6 percent		66	166
Maximum development costs for classes 1, 2s, and 3s	85	85	85
Maximum permissible development costs	85	150	250

1/ Assumed payment capacities as no farm budgets were prepared for classes 1 and 3.

The specifications used for the detailed classification of the Jensen Unit are presented in Table III-4.

Table III-4
Specifications for detailed land classification

Land characteristics	Class 1 arable	Class 2 arable	Class 3 arable	Class 6W nonarable	Class 6 nonarable
Soils (s)					
Texture (0-5')	Medium sandy loam to friable clay loam	Loamy fine sand to very permeable clay	Loamy sand to permeable clay	Irrigated lands possessing water rights which have insufficient payment capacity to justify their inclusion in an arable class.	Nonirrigated lands which do not meet the minimum requirements for an arable class.
Depth					
To sand, gravel, or cobble					
Water washed	36 inches	24 inches	12 inches		
With soil matrix	30 inches	24 inches	18 inches		
To creviced sandstone	48 inches	36 inches	24 inches		
To drainage barrier	7 feet	7 feet	7 feet		
Salinity (ECe) @ equilibrium with irrigation water	4 micromhos	8 micromhos	8 micromhos		
Exchangeable sodium @ equilibrium with irrigation water	Less than 10 percent	Less than 15 percent	Less than 15 percent		
Topography (t)					
Slope					
Smooth, in one plane	Up to 4 percent	Up to 8 percent	Up to 12 percent		
Undulating	Up to 3 percent	Up to 6 percent	Up to 10 percent		
Surface	Tracts larger than 8 acres in size with irrigation runs greater than 500'. Leveled by moving less than 150 cubic yards per acre.1/	Tracts larger than 5 acres in size with runs exceeding 300'. Leveled by moving less than 360 cubic yards per acre.1/	Tracts larger than 3 acres in size with runs exceeding 200'. Leveled by moving less than 700 cubic yards per acre.1/		
Cover (brush and rock)	Cleared at costs of less than $15 per acre.	Cleared at costs of less than $80 per acre.	Cleared at costs of less than $180 per acre.		
Drainage (d)2/	No farm drainage	No farm drainage	No farm drainage		
Maximum development costs	$85	$150	$250		

Basic land development costs per acre (classes 1, 2s, 3s)	
Clearing (rock, brush)	$15
Leveling	45
Farm structures	25
Total	85

1/ At 30 cents per cubic yard.
2/ Subsurface drainage will be a project cost.

CHAPTER IV

RESULTS OF CLASSIFICATION

Classes and Subclasses

During the 1964-65 investigations of the Jensen Unit, five classes of land were delineated and tabulated. Of the 15,724 acres covered in this survey, 4,321 acres or 27 percent are arable and 11,403 acres or 73 percent are nonarable. The arable lands include 3,845 acres (89 percent) that are presently irrigated and 476 acres (11 percent) that are nonirrigated full service lands. Table IV-1 shows a summary and acreage percentage breakdown of the various land classes and subclasses in the Jensen Unit.

Table IV-1
Summary of classification

Subclass	Total area	Percent of total unit	Percent of arable	Percent of class
Arable area				
Class 1	67		1	100
Class 2				
2s	2,317	15	55	65
2t	314	2	7	8
2st	998	6	23	27
Total class 2	3,629	23	85	100
Class 3				
3s	50	1	1	8
3t	28			4
3st	547	3	13	88
Total class 3	625	4	14	100
Total arable	4,321	27	100	
Nonarable area				
Class 6W	333	2		
Class 6st	11,070	71		
Total nonarable	11,403	73		
Total Jensen Unit	15,724	100		

Class 1 land

Lands of this class in the Jensen Unit are highly suited for irrigation farming. They have smooth, gentle slopes and deep, friable, medium-textured soils that permit deep root and water penetration. These lands are free from excessive accumulations of soluble salts and have no sodic problems. Because of the favorable topographic and soil characteristics of these lands, no drainage problems are expected with project development.

Location and Extent

There are 67 acres of class 1 land, which is 1 percent of the total arable area. These lands are located for the most part on land presently irrigated near the town of Jensen on Burns Bench and on Little Brush Creek. They are found in discontinuous tracts but of adequate field size to qualify for class 1.

Topography

The class 1 lands are located on the gently sloping bench lands usually with gradients of from 0.5 to 2 percent. They usually have an eastern or southern exposure. Since these lands are presently irrigated, they will require no additional land development. Soil erosion on most lands in the Jensen Unit is held to a minimum and will not become a problem with project development.

Typical Profile

These soils are stratified due to stream action which has worked and reworked the soil material. They are deep, with the subsoil often extending to beyond 25 feet in depth where a layer of cobble and gravel overlies the Mancos shale formation.

Class 1 soils have good hydraulic conductivity (fragmented samples), the rates varying from 0.28 to 0.85 inch per hour. The water-holding capacity is good, usually comprising over 6 inches of available moisture per 4-foot profile. The soils are calcareous throughout the profile with little or no pronounced zone of lime accumulation.

No rock or cobble interfere with cultivation. The main variation from the typical profile is in the soil texture of both the surface and subsurface soils. Textures range between sandy loam and friable clay loam, including some soils with a high silt content.

A typical class 1 profile description and soil analysis are presented in Tables IV-2 and IV-3.

Suitability for Irrigation

Class 1 lands of the Jensen Unit are the most suitable for irrigation agriculture. The soils are characteristically medium textured, permeable, and low in soluble salt and alkali. These soils are capable of producing high yields of adapted crops, as evidenced by the nearly 90 years of crop production under irrigation.

The topography of class 1 lands is smooth and gently sloping. Their low gradient and long slopes in one direction are conducive to maintaining an efficient irrigation system with low labor costs. The internal

TABLE IV-2

TYPICAL SOIL PROFILE

PROJECT Central Utah AREA Jensen CLASS OR SUBCLASS 1

(in)	Log	EC x 10^3	Exch. Na. Meq./100gm		Soil profile description (Color, texture, structure, consistence, and variations, etc.)
0-12	1	0.87	0.36		10YR 5/3 brown sandy loam to loam, weak, fine crumb structure. Weakly coherent when dry and friable when moist. Slightly sticky and plastic when wet. Many roots and pore spaces. Calcareous soil with no zone of lime accumulation.
12-26	2	3.07	.39		10YR 5/4 yellowish brown, sandy loam, single grain. Loose when dry. Loose moist, and nonsticky and nonplastic when wet. Many roots, slightly calcareous.
26-60	3 4 5	3.04	.53		10YR 5/2 grayish brown sandy loam, single grain, loose dry; very friable when moist, nonsticky and nonplastic when wet. Few roots, low organic matter content, good drainability.

REMARKS: Parent material: recent alluvium deposited by the Green River. Slope 1 to 2 percent with a north exposure. Irrigated land use: alfalfa, small grain, and corn. Variations from typical include color and texture changes within the profile.

Table IV-3
Typical profile soil analysis
Regional Laboratory

Project: Central Utah, Jensen Unit

Description of Sample Location: Section 29, T. 5 S., R. 23 E.
Alfalfa field, fair stand on class 1 soil, slope 1 percent to the north, no rock

SAMPLE						
Lab. No.	805	806	807			
Field No.	SL-2A	SL-2B	SL-2C			
Depth, inches	0-12	12-26	26-60			
Texture	loam	sdy-lm	sdy-lm			
SOIL						
Saturation percentage	26.3	23.4	29.9			
pH, saturated paste	7.9	8.0	8.1			
pH, 1:5 dilution	8.4	8.6	8.8			
Insoluble carbonates	med	high	high			
Gypsum m.e./100 gm.	none	none	none			
% salt, Bureau of Soils Cup						
SATURATION EXTRACT						
Conductivity, EC x 10^3 @ 25° C.	.87	3.07	3.04			
pH	8.5	8.5	8.1			
Total dissolved solids ppm	822	3,340	3,030			
Boron ppm	.17	.86	.96			
Carbonate m.e./liter	none	none	none			
Bicarbonate m.e./liter	6.16	1.70	4.10			
Chloride m.e./liter	.42	2.40	2.30			
Sulfate (calculated) m.e./liter	4.98	44.50	38.50			
Calcium m.e./liter	6.48	23.60	15.00			
Magnesium m.e./liter	3.24	15.60	15.60			
Potassium m.e./liter	.22	.30	.20			
Sodium m.e./liter	1.62	9.10	14.10			
SAR	.7	2.1	3.6			
CATION EXCHANGE RELATIONS						
Total sodium m.e./100 gm	.40	.60	.95			
Soluble sodium m.e./100 gm	.04	.21	.42			
Exchangeable sodium m.e./100 gm	.36	.39	.53			
Cation exchange capacity m.e./100 gm	9.25	6.25	7.63			
Exchangeable sodium of cation exchange capacity %	3.9	6.2	6.9			
MECHANICAL ANALYSIS						
Particles .05 mm Sand %	68.6	72.0	65.0			
Particles .05 .005 mm Silt %	14.0	14.8	20.6			
Particles .005 .002 mm Silt %	.8	1.8	1.4			
Particles .002 mm Clay %	16.6	11.4	13.0			
Classification	sandy loam	sandy loam	sandy loam			

drainage on the lands is excellent and the surface drainage is good. With unit development and a supplemental water supply provided, crop yields are expected to be increased and a more efficient rotation program made possible.

Class 2 lands

The class 2 lands of the Jensen Unit are only slightly less suited for sustained irrigation farming than lands delineated as class 1. The primary difference is in the soil textures, with class 2 soils somewhat finer (clays and fine clay loams). Other deficiencies also occur, such as coarse textures (sand and loamy sand), shallow depth over gravel and cobble, or minor topographic deficiencies occurring separately (subclass 2t) or in combination with a soil deficiency (subclass 2st).

The class 2 lands in the Jensen Unit totaled 3,629 acres and represent 85 percent of the total arable area. The subclasses are usually found in large continuous blocks throughout the area. Class 2 lands adjacent to Brush Creek are in small scattered tracts interspersed with class 3 or rough class 6 lands.

The topographic characteristics of class 2 land vary considerably. Subclass 2s land, topographically, is similar to class 1 land by having smooth to gentle slopes of 0.5 to 3 percent. Subclass 2t lands have slightly undulating to uneven surfaces with slopes of from 1 to 7 percent trending in more than one direction. These lands require some leveling, but generally they are of irregular size and shape and fully developed.

A more detailed description of the various subclasses of class 2 follows.

Subclass 2s

Location and extent.--Most of the lands in the Jensen Unit area were designated as subclass 2s. There were 2,317 acres, which is 55 percent of the total arable area. These lands are distributed uniformly throughout the unit. The largest continuous tracts are found on the benches adjacent to the Green River in the vicinity of Jensen. There are also scattered tracts of subclass 2s lands adjacent to Brush and Little Brush Creeks.

Typical profile.--A soil profile description and soil analysis typical of the lands delineated as subclass 2s are presented in Tables IV-4 and IV-5. The soils of this subclass are usually fine textured. Variations from the typical profile include coarse-textured soils or soils that are moderately shallow over cobble and gravels. Most of the soil profiles are stratified and have weakly developed soil horizons. The soils of presently irrigated lands are free from accumulations of soluble salts. The fertility level of these soils is moderately high as evidenced by the present yields on irrigated land.

TABLE IV-4

TYPICAL SOIL PROFILE

PROJECT Central Utah AREA Jensen CLASS OR SUBCLASS 2s

(in)	Log	EC x 10^3	Exch. Na. Meq./100gm		Soil profile description (Color, texture, structure, consistence, and variations, etc.)
0-12	Si	0.49	0.35		10YR 5/3, brown, silty clay soil with a weak fine subangular structure in the plow zone. Soil consistency is hard when dry, firm moist and sticky and plastic when wet. Surface contains many roots and pores. Slightly calcareous. Free from stones.
12-36	Si	.39	.37		10YR 6/4, light yellowish brown silty clay loam. Weak, medium subangular blocky structure, hard when dry, very firm when moist and sticky and plastic when wet. Few roots and pores. Calcareous soil with no zone of lime accumulation.
36-60		.39	.35		10YR 6/4, light yellowish brown clay loam. Structureless, hard when dry, very firm when moist. Sticky and plastic when wet. Calcareous. Few roots and pores. Roots penetrate beyond the 60-inch depth.

REMARKS: Alluvial material derived from shale hills. Restricted permeability in the subsoil. Variations occur in soil color and texture. Irrigated land use includes alfalfa, small grains, and corn.

Table IV-5
Typical profile soil analysis
Regional Laboratory

Project: Central Utah, Jensen Unit

Description of Sample Location: Section 8, T. 5 S., R. 23 E.
Smooth 1 percent slope, no surface stones. Good stand of alfalfa on subclass 2s land.

SAMPLE							
Lab. No.		809	810	811			
Field No.		SL-4A	SL-4B	SL-4C			
Depth, inches		0-12	12-36	36-60			
Texture		clay	clay	clay			
SOIL							
Saturation percentage		49.6	45.2	43.4			
pH, saturated paste		7.9	7.8	7.9			
pH, 1:5 dilution		8.6	8.6	8.6			
Insoluble carbonates		high	high	high			
Gypsum	m.e./100 gm.	none	none	none			
% salt, Bureau of Soils Cup							
SATURATION EXTRACT							
Conductivity, EC x 10^3 @ 25° C.		.49	.39	.39			
pH		8.4	8.6	8.5			
Total dissolved solids	ppm	460	318	316			
Boron	ppm	.10	.14	.13			
Carbonate	m.e./liter	none	none	none			
Bicarbonate	m.e./liter	4.12	2.64	2.20			
Chloride	m.e./liter	.32	.06	.02			
Sulfate (calculated)	m.e./liter	2.36	2.04	2.52			
Calcium	m.e./liter	4.24	2.96	2.88			
Magnesium	m.e./liter	1.72	1.16	1.20			
Potassium	m.e./liter	.16	.06	.06			
Sodium	m.e./liter	.68	.56	.60			
SAR		.4	.4	.4			
CATION EXCHANGE RELATIONS							
Total sodium	m.e./100 gm	.38	.40	.38			
Soluble sodium	m.e./100 gm	.03	.03	.03			
Exchangeable sodium	m.e./100 gm	.35	.37	.35			
Cation exchange capacity	m.e./100 gm	20.56	19.56	18.19			
Exchangeable sodium of cation exchange capacity	%	1.7	1.9	1.9			
MECHANICAL ANALYSIS							
Particles .05 mm	Sand %	15.0	14.2	21.2			
Particles .05 .005 mm	Silt %	37.6	41.6	37.0			
Particles .005 .002 mm	Silt %	5.6	5.6	3.8			
Particles .002 mm	Clay %	41.8	38.6	38.0			
Classification		silty clay	silty cl-lm	clay loam			

Because most of these lands are located on the higher terraces and because of the presence of a gravel-cobble layer in their substrata, these lands have favorable physical characteristics. Their productivity will remain at a moderately high level under project conditions.

Topography.--The topographic features of this subclass are similar to those described for class 1. The land areas are smooth with gradients varying from 0.5 to 3 percent with most slopes on a south or east exposure.

Irrigation methods include wild flooding and border dikes, but the corrugation method predominates.

Suitability for irrigation.--Lands of this subclass, representing a large total acreage, have moderate suitability for irrigation. They have smooth, gentle slopes and adequate drainage but are slightly lower than class 1 in productive capacity because of fine-textured soils with a restricted permeability or limited soil depth to gravel and cobble. With supplemental project water supplies and with good management and crop rotations, these lands are capable of producing sustained high yields of climatically adapted crops.

Subclass 2t

Lands designated as 2t are usually found as small, scattered tracts located along Brush and Little Brush Creeks. A few of these small tracts are located in the presently irrigated lands adjacent to the Green River. The 2t land comprised only 7 percent of the arable area and total 314 acres.

Typical profile.--This subclass has class 1 soil (Table IV-2), but the topography is class 2. Most soil profiles have medium textures and are low in soluble salts when irrigated or the salts contained in the nonirrigated lands are susceptible to leaching.

Topography.--Topographic deficiencies vary somewhat and include gradients of 3 to 6 percent, complex slopes, medium irrigation runs, irregular size and shape of fields, and occasionally an undulating or uneven surface requiring leveling.

Suitability for irrigation.--Subclass 2t lands are moderately well suited to irrigation farming. They have yield potentials and crop adaptation ranges comparable to class 1 lands but are limited in their value for irrigation agriculture because of topographic factors as described above.

Subclass 2st

The 2st lands of the Jensen Unit are scattered throughout the area. Irrigated lands of this subclass are located adjacent to Brush and Little

Brush Creeks and near the edges of the terraces and bench lands adjacent to the Green River.

There are 998 acres of 2st lands which represent 23 percent of the total arable area.

Typical profile.--A soil profile typical of land classified as 2st is presented in Table IV-4. The soils of this subclass are similar to subclass 2s lands already discussed. They have textures finer or coarser than class 1 lands and are occasionally shallow to gravel, cobble, or shale. The soil deficiency is in combination with a slight topographic deficiency.

Most irrigated lands in the unit do not have excessive amounts of soluble salts, but where the salt content increases on the new land areas and the partially irrigated lands, leaching is possible.

Topography.--The topographic features of these lands vary considerably. They have moderate slopes (3 to 6 percent) and long to moderate length of irrigation runs coupled with complex slopes. The undeveloped lands have a smooth to slightly uneven surface which will require some smoothing or leveling.

The method of irrigation practiced on the presently irrigated lands includes furrow, corrugations, or wild flooding on the more rolling lands.

Suitability for irrigation.--Lands of this subclass are moderately well suited for irrigation. They have slight deficiencies in both soil and topography which limit production and increase labor costs. With proper management and through project development they are capable of producing sustained high yields.

Erosion from irrigation will not be a serious problem on most of these lands. Only on the steep slopes must caution be exercised to prevent excessive erosion.

Class 3 lands

The class 3 lands of the Jensen Unit are less suited for irrigation and the production of adapted crops than those designated as class 2. They are marginal for irrigation development because of excessive deficiencies in soil and/or topography. The soil deficiencies consist of clay texture for the full 5-foot profile, shallow soils over gravel and cobble, or moderate concentrations of soluble salt in the soil. Some class 3 soils on the new land areas contain excessive amounts of gypsum in crystalline form. Though these lands involve greater risks in farming than the better class lands, they will with proper management have an adequate repayment capacity.

The class 3 lands of the Jensen Unit are intermingled with but generally located on the outer margins of the class 2 lands. They are scattered throughout the area in small blocks or tracts. There were 625 acres delineated, representing 14 percent of the total arable area, with 201 acres or 32 percent of the lands presently irrigated.

Approximately 10 percent of the total class 2, 3, and 6W lands in the Jensen Unit is moderately shallow to shallow over cobble, gravel, or rock fragments. These lands, most of which are in class 3, are scattered throughout the unit but are found predominantly on the terraces adjacent to the Green River. Small tracts of shallow lands are also scattered along Brush Creek.

A profile description and soil analysis are presented in Tables IV-6 and IV-7 which are considered typical of the class 3 shallow lands found adjacent to the Green River. Shallow phase soils found adjacent to Brush Creek usually have finer surface textures and have lenses of small, flat rock fragments at various depths throughout their profile. Topographic deficiencies usually found associated with these lands include gradients in excess of 3 percent and small, irregularly shaped fields. The topography of most class 3 lands, however, is very similar to lands delineated as class 2. They either have long, smooth, gentle slopes with gradients of 1 to 3 percent, or they have short irrigation runs with slopes increasing to 8 percent. Small, irregularly shaped fields are the limiting factors for subclass 3st land, which represents the bulk of class 3 lands in the Jensen Unit. Land surfaces that are undulating or rolling will require some leveling to improve irrigation efficiency.

Subclass 3s

The lands delineated in this subclass represent 8 percent of the total class 3 lands but only 1 percent of the total arable lands in the Jensen Unit. These lands are all presently irrigated and are located in two separate blocks totaling some 50 acres on the Green River flood plain.

The soils of this subclass are predominantly clay throughout their profile, as shown in Table IV-8. Most profiles are calcareous but have no well defined zone of lime accumulation, and the subsoils are slowly permeable. Soluble salt concentrations may be high but are not usually excessive and are susceptible to leaching with a full water supply and proper irrigation practices. These soils are of recent alluvial origin and have little horizon development. Until recently, before construction of Flaming Gorge Dam, the lands were subject to yearly flooding and sedimentation. This repeated flooding has developed a granular surface if moist and a cracked surface that curls when dry. The compacted subsoils contribute to the slow permeability of these soils. Variations from the typical class 3 profile (Table IV-8) consist mainly of coarser or finer soil textures and different soil depths. Soil analyses of typical class 3 samples are shown in Table IV-9.

TABLE IV-6

TYPICAL SOIL PROFILE

PROJECT Central Utah AREA Jensen CLASS OR SUBCLASS Shallow soil phase 3s or st

(in)	Log	EC x 10^3	Exch. Na. Meq./100gm		Soil profile description (Color, texture, structure, consistence, and variations, etc.)
0-14		2.87	0.29		10YR 5/3, brown sandy loam to loam, weak, fine crumb structure to a structureless single-grain soil particle arrangement. Consistency is loose, nonsticky and nonplastic when wet. There are many roots and pore spaces. Surface soils are calcareous with no zone of lime accumulation. Permeability of surface soil is rapid, moisture retention fair.
14-22					10YR 6/4, light yellowish brown to 6/3 pale brown gravelly sandy loam. Structureless, nonsticky and nonplastic. Soil is calcareous with some coating of gravel and cobble fragments. Permeability is fast and moisture retention usually poor or fair depending on soil matrix composition.
22+					Gravel cobble layer. Soil matrix consists of loamy sand and sandy loam material. Mixes with gravel and cobble. Gravel consists of 60 percent or more of soil volume.

REMARKS: Parent material: recent alluvium, slope 1-2 percent with a southeasterly exposure at site. Present land use is improved pasture with alfalfa, clover grass mix in fair to good condition. Profile variations from the described site include depth to gravel and cobble, surface texture changes and subsoil matrix composition.

Table IV-7
Typical profile soil analysis
Regional Laboratory

Project: Central Utah, Jensen Unit

Description of Sample Location: Section 21, T. 5 S., R. 23 E.

Subclass 3st pasture, fair stand of grass and clover.

SAMPLE							
Lab. No.		808					
Field No.		SL-3A					
Depth, inches		0-14					
Texture		sdy-lm					
SOIL							
Saturation percentage		24.3					
pH, saturated paste		8.0					
pH, 1:5 dilution		8.4					
Insoluble carbonates		medium					
Gypsum	m.e./100 gm.	.05					
% salt, Bureau of Soils Cup							
SATURATION EXTRACT							
Conductivity, EC x 10^3 @ 25° C.		2.87					
pH		8.4					
Total dissolved solids	ppm	3,190					
Boron	ppm	.06					
Carbonate	m.e./liter	none					
Bicarbonate	m.e./liter	4.60					
Chloride	m.e./liter	1.20					
Sulfate (calculated)	m.e./liter	40.30					
Calcium	m.e./liter	26.60					
Magnesium	m.e./liter	14.00					
Potassium	m.e./liter	.90					
Sodium	m.e./liter	4.60					
SAR		1.0					
CATION EXCHANGE RELATIONS							
Total sodium	m.e./100 gm	.40					
Soluble sodium	m.e./100 gm	.11					
Exchangeable sodium	m.e./100 gm	.29					
Cation exchange capacity	m.e./100 gm	8.94					
Exchangeable sodium of							
cation exchange capacity	%	3.2					
MECHANICAL ANALYSIS							
Particles .05 mm	Sand %	60.6					
Particles .05 .005 mm	Silt %	24.4					
Particles .005 .002 mm	Silt %	2.2					
Particles .002 mm	Clay %	12.8					
Classification		sandy loam					

TABLE IV-8

TYPICAL SOIL PROFILE

PROJECT Central Utah AREA Jensen CLASS OR SUBCLASS 3s

(in)	Log	$EC \times 10^3$	Exch. Na. Meq./100gm		Soil profile description (Color, texture, structure, consistence, and variations, etc.)
0-12		1.66	0.60		10YR 4/1, dark gray. Clay surface soil with weak moderate subangular blocky structure. Hard when dry, firm when moist, sticky and plastic when wet. Abundant roots, few pores. Calcareous. Organic content good. Permeability restricted.
12-36		.84	.51		10YR 5/2, grayish brown. Structureless clay. Hard when dry, firm when moist, sticky and plastic when wet. Few roots and pores. Calcareous soil. Restricted permeability.
36-60		.90	.46		10YR 6/2, light brownish gray. Structureless heavy clay loam to light clay. Slightly hard when dry. Friable when moist. Slightly sticky and plastic when wet. Slowly permeable. Calcareous soil with no zone of lime accumulation.

REMARKS: Low river flood plain nearly flat. 0 to 1 percent slopes with an easterly exposure. Irrigated land use: Improved pasture grasses and clovers. Organic soil on the surface with organic matter stratifications throughout the profile. Fine textures vary from silty clay to clay.

Table IV-9
Typical profile soil analysis
Regional Laboratory

Project: Central Utah, Jensen Unit

Description of Sample Location: Section 4, T. 5 S., R. 23 E.
Smooth 0 to 1 percent slope, no rock. Improved pasture, grasses and clover, good stand on subclass 3s land.

SAMPLE						
Lab. No.	812	813	814			
Field No.	SL-5A	SL-5B	SL-5C			
Depth, inches	0-12	12-36	36-60			
Texture	clay	clay	clay			
SOIL						
Saturation percentage	79.1	59.1	46.4			
pH, saturated paste	7.8	7.9	7.9			
pH, 1:5 dilution	8.2	8.5	8.5			
Insoluble carbonates	high	high	medium			
Gypsum m.e./100 gm.	.74	.04	none			
% salt, Bureau of Soils Cup						
SATURATION EXTRACT						
Conductivity, EC x 10^3 @ 25° C.	1.66	.84	.90			
pH	8.5	8.4	8.4			
Total dissolved solids ppm	1,540	670	746			
Boron ppm	.01	.01	.08			
Carbonate m.e./liter	none	none	none			
Bicarbonate m.e./liter	3.60	1.82	1.46			
Chloride m.e./liter	.15	.14	.06			
Sulfate (calculated) m.e./liter	19.65	8.38	9.30			
Calcium m.e./liter	11.60	5.76	6.32			
Magnesium m.e./liter	8.10	3.00	2.80			
Potassium m.e./liter	.15	.06	.10			
Sodium m.e./liter	3.55	1.52	1.60			
SAR	1.1	.7	.7			
CATION EXCHANGE RELATIONS						
Total sodium m.e./100 gm	.88	.60	.53			
Soluble sodium m.e./100 gm	.28	.09	.07			
Exchangeable sodium m.e./100 gm	.60	.51	.46			
Cation exchange capacity m.e./100 gm	28.28	26.25	15.25			
Exchangeable sodium of cation exchange capacity %	2.1	1.9	3.0			
MECHANICAL ANALYSIS						
Particles .05 mm Sand %	11.2	15.0	29.4			
Particles .05 .005 mm Silt %	21.4	20.8	38.6			
Particles .005 .002 mm Silt %	6.2	6.4	1.8			
Particles .002 mm Clay %	61.2	57.8	30.2			
Classification	clay	clay	clay loam			

Subclass 3s lands have a favorable topography but moderate to serious soil deficiencies which limit production and thus lower their irrigation desirability.

Subclass 3t

Lands delineated as subclass 3t, such as subclass 3s, are minor in extent, representing only 4 percent of the total class 3 area and less than 1 percent of the arable lands. A total of 28 acres of 3t land was delineated in the Jensen Unit classification.

Lands of this subclass have class 1 profiles (Table IV-2); but due to their position and size, these lands have been downgraded to class 3. The most common limiting factors are irregular size and shape of field. Surface relief varies between smooth to uneven, the latter requiring land leveling to improve irrigation efficiency.

The subclass 3t lands have distinctly limited suitability for irrigation because of more severe topographic deficiencies than those of subclass 2t lands. Because of the more extreme topographic deficiencies, these lands have higher development and operational costs than the better class lands but have similar cropping patterns and yields. The small, irregular tracts, however, require extra labor and management to obtain yields comparable to subclass 2t lands.

Subclass 3st

The 3st lands of the Jensen Unit are scattered throughout the area, mostly in small tracts. In all, there were 547 acres tabulated, representing 88 percent of the total class 3 lands and 13 percent of the total arable area.

Typical profile.--A typical soil profile for subclass 3st lands is presented in Table IV-8. Variations from this profile include soils that are shallow over gravel and cobble, as shown in Table IV-6. Textures of the surface soils vary from loam and sandy loam to clay loam and clay. The soluble salts are low on the presently irrigated lands and moderately high on the nonirrigated and partially irrigated areas. These salts, however, can be leached with proper irrigation methods. Similar well drained and properly irrigated lands are relatively free from soluble salts.

Topography.--Subclass 3st lands are usually located at the outer margins of the arable lands and form the boundary between other arable lands and nonarable areas. The topography of these lands is determined by their position, which is usually on ridge tops and at the outer margins of the benches and mesas. Here the soils are shallower and the topography steepens into the rough, eroded escarpments of class 6 land.

The topographic deficiency consits of undulating to rolling relief with complex slopes and irregular irrigation patterns. Gradients vary from 2 to 8 percent with changing slopes and irrigation runs trending in more than one direction.

These limiting topographic features coupled with a soil deficiency resulted in these lands being designated subclass 3st.

Suitability for irrigation.--These lands are slightly less suited for irrigation than subclass 3s lands and constitute the lowest class of arable land in the Jensen Unit. They are, however, capable of paying operation, maintenance, and replacement costs and some construction costs. The yields on subclass 3st lands are moderately high and are expected to be improved under project conditions with the efficient use of supplemental water and proper soil management practices.

Their suitability for irrigation is evident from the 75-year history of successful irrigation farming.

Class 6 lands

Class 6 lands are those that fail to meet the minimum requirements for arable land in the Jensen Unit. These land areas are considered permenently nonarable due to one or more deficiencies in soil, topography, or drainage characteristics and are not included as project lands.

There were 11,070 acres tabulated as class 6 lands. This total includes the rough, broken lands of the Jensen Unit. Much of this acreage includes lands within a section that was too rough to classify but was included in the total so as to balance each section to 640 acres during the planimetering and tabulation of arable lands within that section.

Included in the class 6 lands is a large area of marsh land known locally as Stewart Lake. This area has been developed as a waterfowl management area. These lands along with other low lands adjacent to the Green River which at times are subjected to inundation were classified as class 6 nonarable.

Soils

Since most of the delineated class 6 land are found on the rough, broken, and rolling land areas of the unit, their soils are usually shallow over shale and sandstone formations that make up their parent materials. The class 6 lands scattered throughout the arable lands (usually class 6W) of the unit have a soil profile similar to the profile of the arable lands with which they are closely associated. On most of these lands the soil deficiency alone is not sufficient to downgrade the area into a nonarable land class, but it is usually accompanied by either a severe topographic or drainage deficiency or both.

Topography

Class 6 lands have a varied topography, including steep, eroded hillsides or flat, gullied bottom lands. They are usually steep, rough, rolling, or gullied lands that would require excessive development costs.

Class 6W lands

Class 6W lands include presently irrigated lands that fail to meet the minimum requirements for arable land. These lands are scattered throughout the irrigated areas of the Jensen Unit. The largest continuous tracts are found on the lowest terrace or bench and on the river flood plain.

These lands usually have both a soil and drainage deficiency. In most instances the drainage deficiency is compounded because of their low-lying position, 8 to 10 feet above the water surface of the river.

There are 333 acres of class 6W lands in the Jensen Unit which represent only 2 percent of the total area classified and some 8 percent of the presently irrigated lands.

Typical Profile

Most of these lands are derived from recent alluvium deposited and reworked by the Green River. The profiles are fairly uniform and are similar to adjacent arable lands. They have deep, medium- to fine-textured soils, with occasional coarse-textured soils or soils that are shallow over gravel. Because of their drainage restriction these soils usually are high in soluble salts, resulting in a low productive capacity. Most 6W lands on the river bottoms are utilized as pasture.

The soil profile for 6W lands located on the benches above the river flood plain consists of a shallow soil over gravel-cobble layers, being somewhat shallower than the class 3s and 3st soil profile shown in Table IV-6. These soils have medium surface textures but are often high in soluble salts, as is indicated by the data presented in Table IV-10.

Lands lying close to the Green River are subject to flooding during the high spring runoff. These 6W lands are wet throughout the year, with a ground water depth varying from 0 to 35 inches. Drainage and flood control measures are not feasible, hence they are nonarable.

Suitability for Irrigation

Lands classed as 6W are presently being utilized for the production of pasture and in some instances for limited production of adapted crops. They do not, however, have sufficient repayment capacity for inclusion in an arable land class.

Salinity and Alkali

General discussion

Salinity and alkali problems are almost nonexistent on irrigated arable lands in the Jensen Unit. A high soluble salt content is often found on the nonirrigated and 6W lands.

Table IV-10 is a summary of the laboratory data from a cross section of the total of 1,014 samples collected and analyzed at the Central Utah Projects Office Laboratory in Provo, Utah, and in the Regional Soils Laboratory in Salt Lake City, Utah.

Table IV-10
Summary of 1964 laboratory data

	No. of samples	Percent of soluble salts High	Low	Average	pH paste High	Low	Mode
Bench lands							
Irrigated							
Class 1	6	0.10	0.03	0.06	8.1	7.6	8.0
Class 2	254	.37	.02	.08	8.7	7.1	8.0
Class 3	34	.21	.03	.10	8.3	7.6	8.0
Class 5D(2)1/	26	2.28	.10	.63	8.6	7.7	8.0
Class 6W	31	1.27	.07	.36	8.4	7.7	7.8
Nonirrigated							
Class 2 (idle)	76	1.30	.04	.39	8.8	7.3	8.2
Class 3	22	1.29	.04	.56	8.5	7.7	7.9
Class 6	55	2.50	.02	.40	9.0	7.6	8.0
Brush Creek area							
Irrigated							
Class 2	298	.46	.03	.12	8.3	6.8	7.9
Class 3	81	.40	.02	.08	8.3	7.0	7.9
Class 6W	7	.95	.44	.65	8.1	7.4	
Nonirrigated							
Class 2	47	1.80	.03	.33	8.9	7.2	7.9
Class 3	52	1.30	.04	.46	9.1	7.6	8.3
Class 6	25	1.09	.06	.33	8.8	7.7	7.7
Total samples	1,014						

1/ Class 2 lands requiring project drainage and leaching.

In 1958, 16 samples were collected from five sites on newly developed lands under the Sunshine Canal. These samples, along with 16 samples gathered in 1968, were sent to the Regional Soils Laboratory in Salt Lake City, Utah, for additional analysis. The results, other than those previously presented with typical soil profiles, are shown in Table IV-11.

Table IV-11
Typical profile soil analysis
Regional Laboratory

Project: Jensen Unit

Description of Sample Location: Section 18, T. 5 S., R. 23 E. Samples J-560 to J-562 were taken from subclass 2s lands newly cultivated and planted to alfalfa. Well 35 located in sec. 20, T. 5 S., R. 23 E., Subclass 2s, alfalfa.

SAMPLE					
Lab. No.	J-558	J-559	J-560	J-561	J-562
Field No.	Well 35	Well 35	17	17	17
Depth, inches	0-60	60-120	0-12	12-36	36-60
Texture			clay	clay	clay
SOIL					
Saturation percentage	42.7	54.6	43.7	43.5	58.4
pH, saturated paste	7.9	7.9	7.9	8.0	8.4
pH, 1:5 dilution	8.3	8.3	8.4	8.1	8.4
Insoluble carbonates	High	High	High	High	medium
Gypsum m.e./100 gm.	1.59	None	.53	8.45	12.64
% salt, Bureau of Soils Cup	.10	.17	.23	.25	.69
SATURATION EXTRACT					
Conductivity, EC x 10^3 @ 25° C.	1.625	2.486	4.518	4.449	12.757
pH	7.7	7.6	7.8	7.7	7.9
Total dissolved solids ppm	1.425	2.296	4.230	4.350	12.466
Boron ppm	.78	.45	1.07	1.05	1.92
Carbonate m.e./liter	None	None	None	None	None
Bicarbonate m.e./liter	4.45	2.10	4.95	3.00	2.76
Chloride m.e./liter	1.15	1.33	.75	.45	None
Sulfate (calculated) m.e./liter	14.35	27.93	53.85	58.15	171.12
Calcium m.e./liter	9.85	15.61	23.85	27.15	22.08
Magnesium m.e./liter	6.40	7.14	5.25	7.35	23.00
Potassium m.e./liter	.40	.14	.75	.15	.46
Sodium m.e./liter	3.30	8.47	29.70	25.90	128.34
SAR	1.2	2.5	7.8	6.2	27
CATION EXCHANGE RELATIONS					
Total sodium m.e./100 gm	.60	1.08	2.80	2.53	11.60
Soluble sodium m.e./100 gm	.14	.46	1.30	1.13	7.50
Exchangeable sodium m.e./100 gm	.46	.62	1.50	1.40	4.10
Cation exchange capacity m.e./100 gm	15.13	18.75	16.25	16.81	16.44
Exchangeable sodium of cation exchange capacity %	3.0	3.3	9.2	8.3	24.9
MECHANICAL ANALYSIS					1/
Particles .05 mm Sand %	19.2	10.2	15.0	14.2	9.0
Particles .05 .005 mm Silt %	54.4	49.8	53.4	54.8	55.8
Particles .005 .002 mm Silt %	4.0	6.4	6.2	14.0	5.2
Particles .002 mm Clay %	22.4	33.6	25.4	17.0	30.0
Classification	SiL	SiCl	SiL	SiL	SiCL

1/ Difficulty due to flocculation.

Table IV-11 (continued)
Typical profile soil analysis
Regional Laboratory

Project: Jensen Unit

Description of Sample Location: Section 18, T. 5 S., R. 23 E.
Sample location: subclass 2st idle lands. Rolling land between washes.

SAMPLE							
Lab. No.		J-563	J-564	J-565	J-566	J-567	J-568
Field No.		18	18	18	19	19	19
Depth, inches		0-12	12-36	36-60	0-12	12-36	36-60
Texture		Cl	L	L	L	L	L
SOIL							
Saturation percentage		42.6	46.4	54.1	42.5	47.2	45.8
pH, saturated paste		7.9	8.0	8.5	7.9	8.0	7.7
pH, 1:5 dilution		8.1	8.0	8.6	8.5	8.7	7.8
Insoluble carbonates		High	High	High	High	High	High
Gypsum	m.e./100 gm.	9.06	14.36	11.90	None	None	14.53
% salt, Bureau of Soils Cup		.25	.35	.75	.07	.09	.20
SATURATION EXTRACT							
Conductivity, EC x 10^3 @ 25° C.		4.689	7.610	15.773	.766	.661	2.892
pH		7.8	7.7	8.1	7.9	7.9	7.7
Total dissolved solids	ppm	4,425	6,942	14,280	632	496	2,934
Boron	ppm	.99	7.88	9.60	.56	.38	.75
Carbonate	m.e./liter	None	None	None	None	None	None
Bicarbonate	m.e./liter	3.90	2.86	3.36	5.32	3.46	1.89
Chloride	m.e./liter	None	18.20	15.12	.06	.16	None
Sulfate (calculated)	m.e./liter	57.75	80.86	206.72	3.72	3.82	39.87
Calcium	m.e./liter	25.80	29.64	22.96	5.64	4.36	31.86
Magnesium	m.e./liter	3.15	22.10	69.44	2.44	1.84	6.21
Potassium	m.e./liter	.15	.26	.56	.28	.04	.18
Sodium	m.e./liter	32.55	49.92	142.24	.74	1.20	3.69
SAR		8.5	9.8	21	.4	.7	.8
CATION EXCHANGE RELATIONS							
Total sodium	m.e./100 gm	3.28	4.13	11.60	.53	.68	.83
Soluble sodium	m.e./100 gm	1.39	2.32	7.70	.03	.06	.17
Exchangeable sodium	m.e./100 gm	1.89	1.81	3.90	.50	.62	.66
Cation exchange capacity	m.e./100 gm	18.25	15.13	17.69	16.44	19.81	18.88
Exchangeable sodium of cation exchange capacity	%	10.4	12.0	22.0	3.0	3.1	3.5
MECHANICAL ANALYSIS			1/	1/			
Particles .05 mm Sand	%	16.0	8.4	16.2	16.4	10.8	16.8
Particles .05 .005 mm Silt	%	53.4	51.6	51.6	52.0	57.2	53.8
Particles .005 .002 mm Silt	%	5.2	4.4	8.2	7.2	3.6	6.2
Particles .002 mm Clay	%	25.4	35.6	24.0	24.4	28.4	23.2
Classification		SiL	SiCl	SiL	SiL	SiCl	SiL

1/ Difficulty due to flocculation.

Table IV-11 (continued)
Typical profile soil analysis
Regional Laboratory

Project: Central Utah, Jensen Unit

Description of Sample Location: Section 19, T. 5 S., R. 23 E.
Subclass 2s, good stand of alfalfa.

SAMPLE							
Lab. No.	802	803	804				
Field No.	SL-1A	SL-1B	SL-1C				
Depth, inches	0-10	10-36	36-60				
Texture	clay	clay	clay				
SOIL							
Saturation percentage	46.8	37.1	38.3				
pH, saturated paste	7.8	8.0	7.9				
pH, 1:5 dilution	8.4	8.6	8.7				
Insoluble carbonates	High	medium	medium				
Gypsum m.e./100 gm.	None	None	None				
% salt, Bureau of Soils Cup							
SATURATION EXTRACT							
Conductivity, EC x 10^3 @ 25° C.	.96	1.08	1.10				
pH	8.5	8.3	8.2				
Total dissolved solids ppm	896	896	880				
Boron ppm	.72	.30	.28				
Carbonate m.e./liter	None	None	None				
Bicarbonate m.e./liter	5.64	2.80	2.20				
Chloride m.e./liter	.36	1.52	.44				
Sulfate (calculated) m.e./liter	6.56	10.04	11.04				
Calcium m.e./liter	5.36	5.28	4.56				
Magnesium m.e./liter	3.04	3.52	3.28				
Potassium m.e./liter	.20	.12	.08				
Sodium m.e./liter	3.96	4.44	5.76				
SAR	1.9	2.1	2.9				
CATION EXCHANGE RELATIONS							
Total sodium m.e./100 gm	.83	.72	.95				
Soluble sodium m.e./100 gm	.19	.16	.22				
Exchangeable sodium m.e./100 gm	.64	.57	.73				
Cation exchange capacity m.e./100 gm	18.88	13.06	14.50				
Exchangeable sodium of							
cation exchange capacity %	3.4	4.4	5.0				
MECHANICAL ANALYSIS							
Particles .05 mm Sand %	20.4	38.4	34.2				
Particles .05 .005 mm Silt %	40.6	31.6	32.2				
Particles .005 .002 mm Silt %	3.2	2.6	2.6				
Particles .002 mm Clay %	35.8	27.4	31.0				
Classification	clay loam	loam to cl lm	clay loam				

Table IV-11 (continued)
Typical profile soil analysis
Regional Laboratory

Project: Central Utah, Jensen Unit

Description of Sample Location: Section 13, T. 4 S., R. 22 E.
Subclass 2t, fair stand of alfalfa. Rolling land with short irrigation runs.

SAMPLE						
Lab. No.	815	816	817			
Field No.	SL-6A	SL-6B	SL-6C			
Depth, inches	0-12	12-24	24-60			
Texture	clay	clay	h.cl.lm.			
SOIL						
Saturation percentage	48.8	52.2	47.7			
pH, saturated paste	7.8	7.8	7.8			
pH, 1:5 dilution	8.4	8.5	8.5			
Insoluble carbonates	medium	low	low			
Gypsum m.e./100 gm.	none	none	none			
% salt, Bureau of Soils Cup						
SATURATION EXTRACT						
Conductivity, EC x 10^3 @ 25° C.	.54	.44	.43			
pH	8.7	8.6	8.6			
Total dissolved solids ppm	484	356	346			
Boron ppm	.01	none	.13			
Carbonate m.e./liter	none	none	none			
Bicarbonate m.e./liter	4.70	2.78	2.16			
Chloride m.e./liter	.14	.12	.08			
Sulfate (calculated) m.e./liter	2.02	2.54	2.78			
Calcium m.e./liter	4.40	3.28	3.12			
Magnesium m.e./liter	1.68	1.28	1.16			
Potassium m.e./liter	.34	.12	.12			
Sodium m.e./liter	.44	.56	.62			
SAR	.3	.4	.4			
CATION EXCHANGE RELATIONS						
Total sodium m.e./100 gm	.33	.35	.35			
Soluble sodium m.e./100 gm	.02	.03	.03			
Exchangeable sodium m.e./100 gm	.31	.32	.32			
Cation exchange capacity m.e./100 gm	19.88	23.13	20.63			
Exchangeable sodium of cation exchange capacity %	1.6	1.4	1.6			
MECHANICAL ANALYSIS						
Particles .05 mm Sand %	24.0	21.2	25.2			
Particles .05 .005 mm Silt %	36.6	34.4	35.8			
Particles .005 .002 mm Silt %	2.4	3.4	2.4			
Particles .002 mm Clay %	27.0	41.0	36.6			
Classification	clay loam	clay	clay loam			

Specific problems

As indicated by the laboratory results in Table IV-10, some locally irrigated areas (5D lands) have developed a salinity problem where inadequate drainage conditions exist. Where this problem can be corrected by project drainage, these lands were determined to be arable (class 2). The 5D lands not subject to reclamation were redesignated as class 6W land.

A small acreage of nonirrigated arable lands in the Jensen Unit has excessive salt and occasional moderately high pH. The long history of irrigation of similar soils in the area shows that leaching of the saline soils is feasible. Additional tests also verify this.

Some localized areas of irrigated land also contain moderate to high amounts of salt. These cultivated areas are only partially irrigated and are allowed to become idle whenever a dry year occurs or they are allowed to become dry during the late irrigation season when water is in short supply. This practice allows the salts to accumulate near the surface during certain seasons or parts of an irrigation season. This condition can be corrected with proper irrigation practices and an adequate water supply throughout the irrigation season.

Quality of Water

Source

Some water for irrigation of Jensen Unit lands will be diverted from Brush Creek, a small mountain stream whose headwaters originate high on the south slope of the Uinta Mountains. Its source of water is from snowmelt and mountain springs. Spring runoff and winter flows will be stored in Tyzack Reservoir. Water will also be pumped from the Green River through the Burns Pumping Plant to the lands in the vicinity of Jensen.

Suitability for irrigation

Natural Flows

The water stored in Tyzack Reservoir or pumped from the Green River (Table IV-17) is of excellent quality for irrigation of lands in the Jensen Unit. Water analysis data from the five sampling sites on Big Brush and Brush Creeks are presented in Tables IV-12, -13, -14, -15, and -16. At Stauffer Chemical Company's diversion 4 miles above Tyzack Reservoir on Big Brush Creek, the highest electrical conductivity reading for flows during the irrigation season was 380 micromhos per centimeter with a sodium adsorption ratio of 0.10. The data collected during the nonirrigation season show slightly higher values. This is expected due to the low streamflows and higher concentrations that occur during the winter months.

TABLE IV-12

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Big Brush Creek at Stauffer Chemical Company

Lab. No.	Field No.	Sampling Date	EC x 10^6 @ 25° C.	pH	Total dis- solved salts ppm	Boron ppm.		Sodium Adsorp- tion Ratio	Satu- ration index	Gage height or esti- mated flow	Equivalents per million or milliequivalents per liter							
											Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
		9-1-67	243	7.9	133			0.1		E-20								
		7-28-67	231	7.7	127			.1		E-15								
		6-30-67	117	7.5	85			.1		E-50								
		5-27-67	76	7.5	79			.03	-1.3	E-125	0.60	0.22	0.02	0.02	None	0.66	0.03	0.17
		4-28-67	231	8.1	142			None	+.2	E-15	1.70	.88	.06	.02	None	2.25	.04	.37
		4-5-67	312	8.2	177			.1	+.6	E-8	2.22	1.20	.11	.01	None	3.21	.05	.28
		1-1-67	312	8.2	183			.1	+.4	E-8	2.12	1.00	.09	.02	None	2.41	.09	.73
		10-3-66	180	8.4	93			.1	+.1	E-12	.86	1.10	.09	.02	0.04	1.88	.03	.44
		10-27-66	300	8.3	167			.1	+.6	E-12	2.10	1.24	.07	.01	.04	2.97	.08	.33
		9-2-66	272	7.9	144			.1	+.1	E-10	1.80	1.03	.07	.02	None	2.63	.04	.35
		7-28-66	342	7.9	207			.1	+.2	E-6	2.37	.97	.12	.03	None	2.80	.05	.64
		6-30-66	295	7.8	175			.1	+.1	E-8	2.14	.80	.10	.02	None	2.79	.03	.24
		5-26-66	99	7.3	66			.1	-1.3	E-30	.70	.34	.04	.02	None	.88	.01	.21
		4-28-66	112	7.8	87			.1		E-25	1.38		.06	.03	None	1.29	.06	.12
		3-23-66	524	8.2	360			.1		E-7	5.47		.24	.03	None	3.07	.01	2.66
		1-26-66	438	8.0	271			.1		E-10	4.43		.22	.03	None	2.57	.07	2.04
		10-5-65	370	8.5	228			.1		E-10	3.88		.20	.06	.16	2.03	.07	1.88
		8-30-65	380	8.2	233			.1		GH 0.07	3.93		.17	.30	None	2.66	.11	1.36
		7-23-65	291	8.5	170			.1	+.6	GH .16	1.98	.97	.12	.02	.15	1.99	.05	.90
		6-25-65	110	8.2	76			.1	-.4	GH 1.58	.76	.34	.08	.02	None	.75	None	.46
		5-28-65	171	7.8	121			.1	-.5	GH .98	1.18	.42	.10	.02	None	1.24	.03	.45
		4-29-65	412	8.5	255			.1	+.8	GH .11	2.53	1.71	.19	.02	.21	2.44	.07	1.73
						Equivalent Weights					20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-13

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Big Brush Creek above Vernal

Lab. No	Field No.	Sampling Date	$EC \times 10^6$ @ 25° C	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorp-tion Ratio	Satu-ration index	Gage height or esti-mated flow	Equivalents per million or milliequivalents per liter: Cations Ca	Mg	Na	K	Anions CO_3	HCO_3	Cl	SO_4
		2-3-59	341	8.3	204	None							0.12					
		4-13-59	376	8.3	211	0.01		0.1	+0.7		2.88	1.66	.16	0.03	0.21	2.95	0.07	0.90
		5-8-59	186	8.1	115	None												
		6-3-59	119	8.1	87	.01		.1	-.5		.79	.42	.08	.02		.89	.03	.39
		7-8-59	216	7.7	123	None		.1	-.4		1.43	.77	.09	.02	None	1.75	None	.56
		7-30-59	307	7.7	188	.10		.1	-.2		2.01	1.08	.12	.02		2.51	.04	.68
		9-1-59	394	7.9	243	None												
		9-28-59	396	7.8	255	.10		.1	+.2		2.58	1.45	.14	.03		3.03	.08	1.09
		10-29-59	452	7.9	276	None		.1	+.4		3.02	1.56	.13	.03	.18	3.03	.06	1.47
		1-28-60	444	8.3	254	None		.1	+.8		2.92	1.69	.13	.03	.28	3.38	.06	1.04
		4-14-60	264	8.5	159	None		.1	+.5		1.64	.98	.09	.02	.08	1.87	.02	.66
		4-1-64	555	8.4	377	None		.2	+1.0		3.82	2.20	.30	.03	.35	3.04	.14	2.82
		4-28-64	597	8.1	421	None		.2	+.7		4.06	2.34	.31	.02	None	3.69	.12	2.92
		5-12-64	480	8.3	322			.2	+.7		3.20	1.84	.27	.02	.18	2.73	.08	2.34
		5-27-64	152	8.0	85			.1	-.4		1.26	.21	.11	.01	None	.89	.01	.69
		6-25-64	194	8.4	144			.1	+.1		1.39	.56	.10	.02	.08	1.10	.01	.88
		7-8-64	318	8.6	186			.1	+.8		2.33	.98	.16	.01	.33	1.86	.03	1.26
		8-5-64	410	8.2	248			.2	+.6		2.89	1.31	.22	.02	None	2.85	.08	1.51
		8-26-64	431	8.6	275			.2	+.9		2.85	1.67	.24	.03	.19	2.21	.10	2.29
		9-30-64	417	8.5	271			.1	+.8		2.76	1.67	.19	.02	.27	2.38	.08	1.91
		10-28-64	417	8.6	268			.1	+1.0	E-10	2.75	1.68	.22	.02	.35	2.60	.12	1.60
		2-4-65	426	8.5	304			.2	+.6	E-10	2.03	2.15	.32	.04	.18	1.75	.09	2.52
		4-29-65	426	8.4	280			.2	+.5	E-15	2.68	1.72	.23	.03	.23	1.15	.04	3.24
		5-28-65	171	8.0	123			.1	-.3	E-75	1.23	.43	.10	.02	None	1.23	.02	.53
		6-29-65	148	8.2	98			.1	-.2	E-100	1.04	.37	.11	.02	None	1.01	.08	.45
		7-23-65	337	8.1	208			.1	+.3	E-15	2.43	.89	.14	.02	None	2.23	.03	1.23
		8-30-65	380	8.5	238			.1		E-15	4.01		.20	.04	.20	2.48	.12	1.45
		10-5-65	406	8.5	259			.2		E-10	4.08		.22	.06	.16	2.38	.08	1.74
		10-27-65	398	8.6	235			.1		E-10	4.06		.20	.02	.23	2.52	.02	1.51
		1-26-66	500	8.3	313			.1		E-10	5.19		.23	.03	.13	3.15	.10	2.07
		3-23-66	526	8.0	364			.1		E-7	5.71		.23	.03	None	3.02	.20	2.75
		4-5-67	738	8.0	563			.2	+.6	GH 0.30	5.30	2.89	.49	.06	None	2.95	.16	5.63
		4-28-67	593	7.9	433			.2	+.4	GH .50	4.40	2.08	.31	.06	None	2.52	.09	4.86
		5-27-67	151	7.5	122			.03	-.9	GH 1.90	1.21	.50	.03	.03	None	.89	.02	.86
		6-30-67	224	7.7	156			.1	-.4	E-150	1.73	.49	.10	.02	None	1.21	.02	1.11
		7-28-67								E-15								
		9-1-67								E-24								
								Equivalent Weights			20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-14

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Brush Creek at Sunshine Canal

Lab. No	Field No.	Sampling Date	ECx10^6 @ 25° C	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorp-tion Ratio	Satu-ration index		Equivalents per million or milliequivalents per liter: Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
	10	8-2-68	425	8.0	282			0.2	+0.3		2.90	1.48	0.30	0.03	None	2.51	0.07	2.13
	9	7-1-68	285	8.1	174			.1	+.1		1.92	1.12	.21	.03	None	1.79	.05	1.44
	8	6-4-68	214	7.9	171			.1	-.1		1.92	.52	.15	.02	None	1.60	.02	.99
	7	11-13-67	679	8.2	500			.3	+.8		4.60	2.61	.66	.06	None	3.48	.16	4.29
	6	8-28-67	453	7.9	305			.2	+.3		3.24	1.73	.30	.04	None	2.71	.06	2.54
	5	7-31-67	449	8.4	309			.2	+.8		3.21	1.58	.36	.04	0.16	2.20	.10	2.73
	4	7-3-67	339	7.7	233			.2	-.1		2.47	.97	.23	.02	None	1.84	.02	1.83
	3	5-26-67	258	7.7	191			.2	-.3		2.15	.66	.19	.03	None	1.49	.06	1.48
	2	4-26-67	551	8.1	413			.3	+.6		3.94	2.13	.52	.06	None	2.86	.08	3.71
	1	4-3-67	828	8.0	612			.4	+.7		5.44	3.20	.85	.06	None	3.45	.20	5.90
								Equivalent Weights			20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-15

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Brush Creek above Burns Bench Canal

Lab. No.	Field No.	Sampling Date	ECx10^6 @ 25° C.	pH	Total dis-solved salts p.p.m.	Boron p.p.m.		Sodium Adsorp-tion Ratio	Satu-ration index		Equivalents per million or milliequivalents per liter: Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl.	SO_4
523	53	3-23-66	834	8.0	643			0.6			8.46		1.15	0.06	None	3.20	0.12	6.35
	52	1-25-66	775	8.1	553			.6			7.32		1.08	.05	None	2.61	.20	5.64
	51	10-28-65	618	8.3	429			.4			5.95		.72	.04	0.06	2.34	.10	4.21
	50	9-29-65	578	8.4	398			.4			5.59		.60	.10	.19	2.50	.13	3.47
	49	8-31-65	587	8.4	428			.5			5.85		.80	.05	.11	2.24	.14	4.21
	48	7-22-65	337	8.1	208			.1	+0.6		4.88	1.62	.60	.06	.13	2.33	.08	4.63
	47	6-23-65	213	8.5	132			.2	+.3		1.50	.51	.20	.02	.13	1.08	None	1.02
	46	5-25-65	244	8.1	168			.2			1.83	.42	.23	.02	None	1.46	.03	1.01
	45	4-29-65	683	8.4	498			.5	+.7		3.17	3.17	.95	.06	.07	1.94	.14	5.20
	44	2-14-65	885	8.3	672			.7	+.6		4.16	3.81	1.48	.07	.22	1.50	.22	7.58
	43	10-28-64	758	8.2	548			.5	+.9		5.03	2.95	.91	.06	None	3.96	.14	4.85
	42	10-7-64	550	8.5	387			.3	+.9		3.38	2.12	.55	.04	.24	2.55	.16	3.14
	41	9-2-64	582	8.5	397			.3	+1.0		3.70	2.20	.55	.05	.35	2.44	.10	3.61
	40	7-29-64	493	8.5	334			.3	+.9		3.29	1.62	.42	.04	.17	2.27	.10	2.83
	39	7-1-64	442	8.6	287			.3	+.9		3.12	1.24	.51	.03	.19	1.86	.05	2.80
	38	6-9-64	351	7.7	250			.2			2.63	.83	.25	.03	None	2.09	.04	1.61
	37	5-26-64	272	8.3	163			.6	+.3		2.14	.46	.72	.02	.07	1.39	.02	1.86
								Equivalent Weights			20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-15 (Continued)

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Brush Creek above Burns Bench Canal

Lab No	Field No	Sampling Date	$EC \times 10^6$ @ 25° C	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorption Ratio	Saturation index		Equivalents per million or milliequivalents per liter							
											Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
	36	5-12-64	734	8.0	503			0.4	+0.6		4.68	2.74	0.84	0.06	None	3.31	0.14	4.87
	35	4-27-64	751	8.2	540			.4	+.8		4.66	3.07	.85	.05	None	3.43	.12	5.08
	34	3-30-64	837	8.2	618			.5	+.8		4.86	3.59	1.07	.04	None	3.33	.22	6.00
	33	1-30-62	737	7.9	558			.4	+.4		4.27	3.18	.68	.04	None	2.78	.18	5.21
	32	10-31-61	1783	7.4	1588	0.20		.7	+.5		16.32	3.83	2.25	.12	None	3.53	.26	18.73
	31	10-2-61	842	7.5	628	.07		.4	+.3		5.95	2.73	.78	.06	None	3.65	.18	5.69
	30A	9-5-61	718	7.6	538	.20		.5	+.1		4.20	3.06	.89	.07	None	3.05	.16	5.01
	30	8-3-61	523	7.9	353			.3	+.3		3.16	1.83	.49	.04	None	2.47	.07	2.98
	29	6-29-61	515	7.6	349			.3			3.58	1.51	.48	.05	None	2.59	.08	2.95
	28	6-1-61	373	8.1	236			.3	+.2		2.35	.95	.33	.04	None	1.81	.05	1.81
	27	4-26-61	703	7.6	493	.07		.4	+.2		4.42	2.58	.84	.04	None	3.51	.15	4.22
	25	2-8-61	725	8.2	613			.6	+.3		3.93	3.43	1.27	.05	None	1.26	.18	7.24
	24	12-21-60	719	8.0	499			.4	+.7		4.76	2.82	.80	.04	0.19	3.46	.18	4.59
	23	11-22-60	788	7.9	554			.5	+.6		4.90	3.11	.93	.04	.13	3.72	.20	4.93
	22	10-21-60	611	8.2	394			.3	+.8		4.28	1.96	.57	.04	.08	3.36	.12	3.29
	21	9-14-60	590	8.3	399			.4	+.6		3.21	2.39	.70	.05	.22	2.11	.13	3.89
	20	8-2-60	390	8.2	263			.8	+.4		2.48	1.05	.31	.04	.24	1.88	.05	1.71
	19	7-1-60	483	8.3	343			.3	+.6		2.96	1.70	.53	.04	.28	2.18	.09	2.68
	18	6-2-60	333	7.8	205			.2			2.27	.89	.28	.03	None	2.12	.04	1.31
	16	5-3-60	555	8.6	387			.4	+1.1		3.56	2.00	.66	.03	.25	2.68	.10	3.22
	17	4-12-60	473	8.2	319			.2	+.7		3.23	1.52	.35	.05	None	3.05	.08	2.05
	15	1-27-60	678	8.6	472			.6	+1.2		3.51	2.94	1.00	.03	.25	2.96	.20	4.07
	14	10-29-59	687	7.8	473			.4	+.4		4.29	2.46	.72	.04	.41	3.16	.12	3.82
	13	9-29-59	645	7.9	460													
	12	9-2-59	630	8.2	439			.3	+.5		4.22	2.07	.54	.06	.17	2.96	.10	3.66
	11	7-30-59	529	7.8	363	.15		.3	+.6		3.35	1.83	.52	.04		2.76	.10	2.88
	10	7-7-59	570	8.3	396			.4	+.3		3.75	2.03	.68	.05	.23	2.61	.10	3.55
	9	6-3-59	279	7.9	187			.3	+.3		1.80	.76	.33	.03		1.58		1.34
	8	5-8-59	404	7.7	266			.3	+.2		2.74	1.14	.42	.04		2.15	.02	2.17
	7	4-13-59	608	8.3	414	.08		.6	+.6		2.90	2.67	.98	.06	.24	2.09	.16	4.12
	6	2-3-59	688	8.1	498			.5	+.5		3.54	3.13	.94	.04	.24	2.09	.12	5.20
	5	10-29-58	585	8.4	414	.22		.5	+.8		3.07	2.45	.77	.04	.09	2.49	.11	3.58
	4	9-2-58	564	8.3	381	.07		.4	+.7		3.33	2.06	.58	.04	.25	2.47	.02	3.27
	3	7-1-58	517	8.4	348	.15		.5	+.7		2.99	1.78	.76	.04	.21	2.12	.04	3.12
	2	5-28-58	262	7.9	167	.08		.2	-.1		1.93	.47	.17	.03		1.56	.01	1.03
619	1	4-17-58	839	7.4	660	.12		.7			4.48	3.08	1.38	.10	.31	3.24	.18	5.71
Equivalent Weights											20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-16

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Brush Creek at Burton Canal

Lab. No.	Field No.	Sampling Date	ECx10^6 @ 25° C.	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorp-tion Ratio	Satu-ration index		Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
											Equivalents per million or milliequivalents per liter							
											Cations				Anions			
	12	8-2-68	453	8.3	304			0.3	+0.7		3.10	1.58	0.41	0.03	0.33	2.37	0.05	2.73
	11	7-1-68	311	8.0	195			.2	+.1		2.08	1.06	.30	.03	None	1.83	.02	1.62
	10	6-4-68	237	8.0	173			.2	-.1		1.78	.60	.18	.02	None	1.44	.01	1.13
	9	5-7-68	541	8.1	367			.3	+.6		3.60	2.06	.52	.04	None	2.81	.09	3.32
	8	2-2-68	803	8.0	625			.3	+.8		5.79	3.28	.71	.05	None	3.81	.16	5.86
	7	11-3-67	726	8.3	545			.5	+.9		4.54	2.92	.89	.06	.19	3.03	.16	5.03
	6	8-28-67	482	8.3	327			.3	+.7		3.40	1.68	.40	.04	.09	2.65	.12	2.66
	5	7-31-67	537	7.6	375			.3	+.1		3.75	1.75	.54	.04	None	2.67	.12	3.29
	4	7-3-67	383	7.6	262			.3	-.2		2.82	1.11	.35	.03	None	1.97	.04	2.30
	3	5-26-67	281	7.9	239			.2			2.32	.78	.21	.05	None	1.64	.05	1.67
	2	4-26-67	617	8.4	453			.4	+.9		4.11	2.39	.72	.07	.21	2.71	.10	4.27
	1	4-3-67	866	7.9	686			.5	+.7		6.09	3.43	1.05	.07	None	3.55	.24	6.85
Equivalent Weights											20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

The sampling site on Big Brush Creek north of Vernal (Table IV-13) was utilized to indicate the quality of flows into Tyzack Reservoir. The values obtained here indicate water of excellent quality. The average electrical conductivity was 336 micromhos per centimeter and the SAR was 0.14 for water in Big Brush Creek during the irrigation season. Values were found to be higher during the nonirrigation season. Tables IV-14, -15, and -16 indicate the quality of water at the major diversion points downstream from Tyzack Reservoir.

Irrigation water will be pumped directly from the Green River and utilized on the bulk of Jensen Unit lands. The quality of Green River water during the irrigation season (Table IV-17) indicates that it would have no detrimental effects on project lands or crops adaptable to the area.

The average electrical conductivity value for the irrigation season was 473 micromhos per centimeter as compared with 674 micromhos per centimeter during the remainder of the year. This is somewhat higher than what is expected in Tyzack Reservoir on Big Brush Creek.

Return flows

Major diversions from Brush Creek occur some 11 miles downstream from Tyzack Dam. The intervening lands are irrigated by many small diversions with some return flows accruing to the stream. It is expected that with the slight increase in irrigation under project conditions the quality of the mixed flows in the reach of Brush Creek above the last diversion would be entirely suitable for irrigation of the Jensen Unit lands. The return flows accruing from irrigation of the small tracts of land along this reach are not expected to change the quality of Brush Creek water significantly, as indicated by present conditions in Tables IV-14, -15, and -16.

Based on a farm irrigation efficiency of 56 percent for the unit lands, the water supply will be increased by a weighted average of 44 percent above normal irrigation requirements to allow for surface, lateral, and deep percolation losses. With an average electrical conductivity of approximately 450 micromhos per centimeter for the irrigation water, about 6 percent of the water entering the soil is required for leaching purposes and for maintaining the electrical conductivity of the soil solution at the bottom of the root zone at 8 millimhos per centimeter, a safe level for the type of crops to be grown in the area. Of the 44 percent increase in the water supply to take care of losses, about 14 percent is allowed for deep percolation, which more than offsets the leaching requirement.

Below the last major diversion at Burton Ditch, Brush Creek is made up almost entirely from return flows during the irrigation season. Data gathered from a sample site near Jensen and presented in Table IV-18 show

TABLE IV-17

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Green River near Jensen

Lab. No	Field No.	Sampling Date	ECx10^6 @25°C	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorption Ratio	Saturation index	Gage height or estimated flow	Equivalents per million or milliequivalents per liter							
											Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
		3-23-66	605	8.1	428			1.4		GH 4.70	4.43		2.12	0.10	None	2.49	0.52	3.64
		1-25-66	690	8.5	466			1.6			5.02		2.52	.08	0.31	3.04	.83	3.44
		10-28-65	589	8.8	368			1.7		GH 3.20	3.89		2.39	.07	.40	1.68	.87	3.40
		9-29-65	688	8.4	436			2.6		GH 4.90	4.64		3.46	.18	.38	2.54	.85	4.51
		8-31-65	526	8.7	330			2.2		GH 2.82	2.84		2.57	.07	.39	1.10	.89	3.10
		7-22-65	391	8.4	236			1.2	+0.4	GH 4.25	1.69	0.97	1.38	.04	None	1.87	.43	1.78
		6-23-65	205	8.3	135			.5		High water	1.17	.51	.48	.02	0.01	1.33	.11	.73
		5-25-65	233	8.7	160			.7	+.5	High water	1.38	.37	.62	.03	.26	1.21	.12	.81
		4-28-65	507	8.6	343			1.2	+.8	GH 6.10	2.17	1.41	1.62	.07	.31	1.93	.35	2.68
		2-5-65	670	8.7	449			1.6	+.9	GH 4.70	2.27	2.16	2.35	.07	.33	2.05	.60	3.87
		10-28-64	692	8.7	489			1.5	+1.1	GH 2.96	3.22	1.88	2.45	.07	.11	2.94	.64	3.93
		10-7-64	705	8.7	497			1.5	+1.1	GH 2.75	3.29	2.00	2.50	.08	.42	2.57	.74	4.14
		9-2-64	708	8.6	458			1.6	+1.0	GH 2.63	3.24	1.91	2.53	.08	.36	2.69	.68	4.03
		7-29-64	661	7.7	440			1.4	+.1	GH 3.80	3.07	1.91	2.27	.08	None	2.94	.63	3.27
		7-1-64	307	8.2	161			.8	+.1	GH 6.50	1.58	.58	.82	.02	None	1.62	.18	1.20
		6-9-64	288	7.6	182			.5	-.3	High water	1.85	.58	.53	.04	None	1.96	.13	.91
		5-26-64	245	8.6	146			.6	+.4	High water	1.37	.52	.61	.02	0.08	1.40	.13	.91
		5-12-64	492	8.5	324			1.1	+.7		2.34	1.24	1.51	.06	.33	2.07	.44	2.31
		4-27-64	503	8.2	342			1.3	+.4	GH 4.72	2.36	1.22	1.70	.07	none	2.36	.34	2.65
		3-30-64	639	8.5	418			1.6	+.7	GH 2.08	2.51	1.84	2.37	.08	0.36	2.69	1.02	2.73
		2-5-64	658	8.5	418			1.5	+.9	GH 2.00	2.93	1.72	2.28	.08	.26	2.99	.90	2.86
		7-19-62	469	7.7	303	0.15		1.0			2.24	1.44	1.36	.04	None	2.64	.34	2.12
		6-29-62	353	7.7	209			.6	-.1		2.10	.84	.68	.04	None	2.46	.19	1.01
		5-15-62	256	8.0	161			.6			1.38	.64	.56	.03	None	1.78	.11	.72
		5-1-62	330	8.0	217	.28		.7	+.1		1.66	1.07	.79	.04	None	2.13	.16	1.27
		4-17-62	580	7.9	396			1.2	+.3		3.00	1.49	1.80	.08	None	3.01	.42	2.94
		10-31-61	582	8.3	389			1.4	+.6	GH 2.83	2.68	1.44	2.03	.06	0.24	2.27	.56	3.10
		10-2-61	598	7.5	377			1.0	+.1	GH 3.90	3.41	1.40	1.57	.07	None	3.63	.41	2.37
		9-5-61	876	7.6	607	.05		2.2	+.1		3.36	2.37	3.72	.12	0.24	2.98	1.11	5.24
		8-3-61	749	7.9	490			1.5	+.4		3.75	1.66	2.49	.11	None	2.97	.80	4.24
		6-29-61	331	8.0	198			.9			1.50	.71	.95	.03	None	1.90	.29	1.01
		6-1-61	282	7.8	185			.5	-.1		1.90	.60	.51	.03	None	1.92	.16	.96
		4-26-61	560	7.8	376			1.3	+.1		2.50	1.44	1.76	.06	None	2.75	.43	2.58
		2-8-61	632	8.3	419			2.0	+.3		1.77	1.92	2.75	.07	0.14	1.70	.98	3.69
		12-21-60	846	8.3	556			2.4	+.6		2.45	2.55	3.76	.08	.21	2.78	.99	4.86
		11-22-60	728	8.2	474			1.0	+.6		3.05	2.15	1.57	.05	.21	2.89	.68	3.04
Equivalent Weights											20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-17 (Continued)

QUALITY OF WATER

NATURAL FLOW

Sampling Site Location Green River near Jensen

Lab No	Field No	Sampling Date	EC x 10^6 @ 25° C	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorp-tion Ratio	Satu-ration index	Gage height or esti-mated flow	Equivalents per million or milliequivalents per liter							
											Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
		10-21-60	761	7.8	487			1.9	+.2		2.88	2.09	3.05	0.07	None	3.21	0.89	3.99
		9-14-60	670	8.0	418			1.9	+.2		2.34	1.71	2.73	.06	.12	2.46	.90	3.36
		8-2-60	552	7.8	347			1.6			2.10	1.52	2.15	.07	None	2.59	.67	2.58
		7-1-60	387	8.0	252			1.0	+1.0		1.72	1.00	1.22	.05	None	1.98	.33	1.68
		6-2-60	253	8.0	153			.7	-.2		1.25	.55	.65	.03	None	1.46	.14	.88
		5-3-60	483	8.2	315			1.2	+.3		1.96	1.35	1.60	.05	None	2.27	.42	2.27
Equivalent Weights											20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-18

QUALITY OF WATER

RETURN FLOW

Sampling Site Location Brush Creek near Jensen

Lab. No.	Field No.	Sampling Date	EC x 10^6 @ 25° C.	pH	Total dis-solved salts p.p.m	Boron p.p.m.		Sodium Adsorp-tion Ratio	Satu-ration index	Gage height or esti-mated flow	Equivalents per million or milliequivalents per liter							
											Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl.	SO_4
		3-23-66	1010	8.0	777			0.9		E-5	9.49		1.98	0.07	None	3.44	0.24	7.86
		1-25-66	687	8.2	530			.6		E-10	7.12		1.08	.05	None	2.27	.18	5.80
		10-28-65	756	8.3	545			.7		E-7	7.02		1.40	.06	0.11	2.54	.19	5.75
		9-29-65	694	8.4	487			.7		E-10	6.39		1.18	.11	.16	2.77	.15	4.60
		8-31-65	2340	8.0	2220			3.6		E-1	20.06		11.48	.18	None	3.24	.89	27.59
		7-22-65	2400	8.3	2240			3.7	+0.9	E-1	9.77	8.81	11.40	.32	.11	1.94	.77	27.48
		6-23-65	224	8.9	154			.3	+.7	E-75	1.52	.47	.32	.02	.37	.79	.01	1.16
		5-25-65	285	8.2	207			.3	+.2	E-70	1.98	.56	.38	.02	None	1.57	.04	1.33
		4-28-65	911	8.3	676			1.0	+.7	E-5	4.36	3.77	2.03	.07	.10	2.28	.20	7.65
		2-4-65	866	8.4	676			.7	+.6	E-10	3.94	3.98	1.47	.06	.46	1.17	.20	7.62
		10-28-64	3560	8.2	3310			5.3	+1.2	E-0.5	12.46	15.10	19.80	.24	None	4.39	1.09	42.12
		10-7-64	3280	8.1	3080			5.0	+1.1	Trace	12.28	13.34	17.96	.14	None	4.35	.97	38.40
		9-2-64	2480	8.4	2130			4.0	+1.0	Trace	8.80	9.71	12.16	.16	.31	2.27	.68	27.65
		7-29-64	1650	8.2	1380			2.4	+1.0	Trace	8.00	5.97	6.40	.17	None	3.32	.39	17.83
		7-1-64	1560	8.4	1250			2.7	+.9	Trace	6.19	5.65	6.64	.13	.14	2.00	.43	16.04
		6-9-64	448	7.7	315			.5		E-12	2.88	1.10	.75	.04	None	2.05	.07	2.65
Equivalent Weights											20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

TABLE IV-18 (Continued)

QUALITY OF WATER

RETURN FLOW

Sampling Site Location Brush Creek near Jensen

Lab No	Field No	Sampling Date	ECx10[6] @ 25°C	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorption Ratio	Saturation index	Gage height or estimated flow	Equivalents per million or milliequivalents per liter: Cations Ca	Mg	Na	K	Anions CO_3	HCO_3	Cl	SO_4
		5-26-64	320	8.5	190			.1	+.6	E-50	2.31	.67	.09	.01	.09	1.41	.03	1.55
		5-12-64	4200	7.9	1938			5.4	+1.2	E-0.5	16.32	17.02	22.00	.26	None	7.47	1.14	46.99
		4-28-64	3880	7.9	3552			5.1	+1.3	E- .5	15.79	15.89	20.20	.17	None	7.50	1.16	43.39
		3-30-64	1250	8.2	992			1.7	+.8	E-2	5.36	5.12	3.86	.06	None	3.21	.34	10.85
		1-27-60	735	8.2	515			.5	+.9		4.58	2.81	1.00	.03	.31	3.91	.18	4.02
		10-29-59	2493	8.3	2056	0.37		5.0										
		9-29-59	727	8.2	534	.25		.7	+.7		4.58	2.07	1.22	.08	.16	2.65	.10	5.04
		9-1-59	1285	8.2	1014	.20		2.3	+.7		4.64	4.31	.48	.09		2.79	.29	10.76
		7-30-59	3286	7.9	3000													
		7-7-59	3676	8.1	3306	.50		5.8	+1.3		13.16	13.42	21.15	.19	None	7.20	1.31	39.41
		6-3-59	3498	7.9	3108													
		5-8-59	3201	7.8	2824	.42		4.9	+.9		11.50	12.24	17.01	.16	None	6.59	1.05	33.27
		4-13-59	3456	8.2	3100	.50		5.9	+1.0		10.15	13.32	20.25	.16	.24	3.45	1.23	38.96
		2-3-59	825	8.0	609	None		1.0	+.3		3.54	3.55	1.91	.04	.32	1.98	.26	6.98
		10-29-58	2221	8.3	1934	.33		2.3	+1.0		7.05	8.62	6.48	.14	.32	3.04	.70	18.23
		9-2-58	3396	8.1	3050	.77		5.3	+1.0		10.46	13.01	18.13	.18	.40	4.08	1.06	36.24
		7-1-58	3670	8.0	3226	.77		2.0	+.9		9.86	12.50	6.54	.16	.48	3.90	1.42	23.36
		5-28-58	334	8.4	199	.43		.4	+.5		2.15	.62	.49	.03	None	1.77	.11	.41
		4-17-58	1084	8.0	810	.07		1.3	+.6		5.08	4.03	2.87	.13	None	2.87	.32	8.92
		2-10-58	535	7.9	491	.02		.8	+.5		4.25	2.55	1.39	.05	None	3.62	.17	4.45
		10-31-57	927	8.2	699	.03		1.2	+.8		4.47	3.13	2.33	.05	.39	3.08	.22	6.29
		10-7-57	2475	7.8	2124	.08		3.4	+1.0		10.68	9.08	10.75	.16	.37	6.55	.79	22.92
		8-14-57	1156	8.3	900	.08		1.8	+1.0		5.67	3.25	3.86	.09	.06	3.57	.34	8.88
		7-19-57	3963	8.0	3646	0.32		5.8	+1.3		14.41	14.18	22.00	0.19	None	8.44	1.57	40.77
		6-12-57	315	8.8	191			.5	+.7		1.65	.61	.49	.03	None	1.43	.03	1.32
		5-20-57	1200	8.3	874	.04		2.3	+.9		5.06	3.18	4.60	.13	None	2.97	.38	9.62
		4-11-57	1174	8.2	856													
		3-11-57	754	8.1	554	.07		.8	+.7		4.44	2.68	1.44	.05	None	3.52	.16	4.93
		2-5-57	730	8.3	524	.07		.6	+.8		3.98	2.94	1.07	.04	0.12	3.17	.19	4.55
		10-18-56	4114	7.9	3750	.38		6.3	+.8		13.83	14.64	23.75	.19	1.17	3.16	1.61	46.43
		9-18-56	2310	7.8	1920	.30		4.6	+.5		6.47	7.09	12.04	.13	.96	4.12	.84	19.81
		8-7-56	3323	8.1	3044	.42		4.2	+1.2		11.79	12.14	14.68	.15	.09	5.41	1.20	32.06
		7-10-56	3708	7.9	3348	.27		5.3	+1.1		13.71	13.42	19.40	.17	.16	7.53	1.47	37.54
		5-25-56	350	8.2	263	None		.5	+.4		2.53	.59	.42	.04	.07	1.79	.02	1.70
		3-14-56	977	8.0	739	.01			+.8		6.87	2.87	1.39	.08	.40	3.79	.25	6.77
		9-26-55	1140	8.4	865	.17			+1.1		5.88	3.89	2.88	.18	.66	3.33	.35	8.49
								Equivalent Weights			20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

the historical quality of this return flow water in Brush Creek before it empties into the Green River. The average electrical conductivity value for the nonirrigation season is 1,322 micromhos per centimeter and the average SAR value of 1.72. During the irrigation season the average electrical conductivity increases to 2,091 micromhos per centimeter and the SAR value increases to 2.54. At the present time this water is not being used for irrigation of Jensen Unit lands nor will it be used under project conditions.

Drainage water from the Jensen Unit was sampled and the results presented in Table IV-19 on the following page. The site is from an open drain northwest of Jensen. The average electrical conductivity for nonirrigation season flow was 2,010 micromhos per centimeter and the SAR value was 2.63. The irrigation season flows from this drain had an electrical conductivity of 2,075 micromhos and an SAR value of 2.84 which is only slightly higher than that of the nonirrigation season. At the present time this drainage water is mixed with canal water for irrigation of about 40 acres of classes 1 and 2 land with no visible adverse effects to soil or crops.

Effect on downstream users

The consumptive use of water by the Jensen Unit of the Central Utah Project will deplete waters of the Colorado River system by 15,000 acre-feet per year. Approximately 22,600 acre-feet of diversions will take place--4,600 acre-feet for irrigation and 18,000 acre-feet for municipal and industrial purposes. A total of 440 acres of new land will receive a full irrigation supply, while 3,640 acres of presently irrigated lands will receive supplemental water. It is anticipated that the effect of stream depletion together with salt pickup from the new lands will increase concentrations of total dissolved solids at Imperial Dam. In the Jensen Unit area, it was assumed that a balance had been reached in the salt inflow and outflow to presently irrigated lands, and therefore no pickup of salts from these lands was assumed. These soils are, for the most part, well drained and have a gravelly substrata and therefore are unlikely to pick up additional salts.

It was assumed that about 2 tons of salt per acre of newly irrigated land would be the amount of salt pickup from the project. This would amount to 880 tons per year or an increase of about 0.1 p.p.m. at Imperial Dam. The depletion of water by the project would increase salinity at Imperial Dam by about 1.5 p.p.m. and the total effect of salt pickup and stream depletion would amount to 1.6 p.p.m. Of the 1.6 p.p.m., 0.4 p.p.m., or 25 percent, would be attributable to irrigation.

TABLE IV-19

QUALITY OF WATER

RETURN FLOW

Sampling Site Location Drain near Jensen

Lab. No.	Field No.	Sampling Date	$EC \times 10^6$ @ 25° C.	pH	Total dis-solved salts ppm	Boron ppm		Sodium Adsorption Ratio	Saturation index	Gage height or estimated flow	Equivalents per million or milliequivalents per liter							
											Cations				Anions			
											Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
		3-23-66	580	7.4	413			0.7		E-1/5	4.85		1.15	0.02	None	1.42	0.17	4.48
		1-25-66	2900	7.7	2960			4.1		Trace	26.34		14.90	.22	None	4.25	1.68	35.38
		10-28-65	2600	7.9	2370			3.3		E-25	22.06		10.80	.22	None	4.33	1.48	27.27
		9-25-65	2300	8.2	2060			3.3		E-0.75	17.56		9.80	.23	None	1.80	1.23	24.56
		8-31-65	2330	8.2	2180			3.2		E- .50	20.48		10.32	.17	None	2.79	1.39	26.79
		7-22-65	2440	8.1	2280			3.2	+1.0	E- .25	10.96	9.90	10.36	.17	None	3.44	1.47	26.48
		6-23-65	2450	8.3	2280			3.5	+.9	E- .20	12.15	7.78	11.04	.08	0.13	1.63	1.36	27.93
		5-25-65	2000	8.1	1830			3.0	+.7	E- .50	8.18	8.67	8.56	.17	None	2.12	1.19	22.27
		4-28-65	2590	8.4	2390			3.6	+.8	Trickle	9.04	11.75	11.52	.18	.17	1.29	1.53	29.50
		10-28-64	2560	8.1	2292			3.1	+1.1	E- .30	12.35	9.72	10.28	.23	None	4.63	1.32	26.63
		10-7-64	1600	8.4	1290			2.2	+1.3	E- .25	7.52	6.36	5.76	.31	.61	3.82	.99	14.53
		9-2-64	2310	8.2	2060			2.9	+1.0	E-Tr.	11.18	9.40	9.40	.16	None	3.24	1.11	25.79
		7-29-64	1780	8.5	1520			2.8	+.9	E- .25	7.12	6.64	6.96	.12	.13	1.57	.80	18.34
		7-1-64	2090	8.3	1800			2.9	+.8	E- .50	8.44	8.12	8.48	.15	.21	1.83	.98	22.17
		6-24-64	414	8.5	282			.2	+.7	E- .75	3.14	1.03	.24	.01	.27	1.33	.12	2.70
Equivalent Weights											20.0	12.2	23.0	39.1	30.0	61.0	35.5	48.0

INTERIOR - - RECLAMATION SLC UTAH

CHAPTER V

DETERMINATION OF IRRIGABLE AREA

Review of Classification

During the field work and at its completion, representatives of the Land Resources Branches of the Regional and Chief Engineer's Offices reviewed the land classification. By their suggestions and recommendations they assisted in the presentation of the data in this report.

The Economics Branch of the Office of Utah Activities assisted in the formulation of the specifications used for development costs. At the completion of the land classification, the economists reviewed and utilized the data in determining the project repayment and agricultural benefits.

Land classification data were used by the hydrologist to assist in the determination of diversion requirements and the selection of lands to be included in the project. The Drainage Branch reviewed and utilized land classification data for determining drainage requirements and assisted in disposing of drainage-deficient areas.

Summary of Project Plan

The Jensen Unit plan of development calls for construction of project features to meet irrigation, municipal and industrial, fish and wildlife conservation, and flood control needs of the area. These features include Tyzack Dam, Reservoir, Pumping Plant, and Aqueduct, Burns Pumping Plant and discharge lines, Stewart Lake Lateral, and recreation facilities.

Tyzack Dam will be located on Big Brush Creek approximately 3.5 miles downstream from State Highway 44, and about 10 miles northeast of Vernal. Tyzack Dam will be an earth-filled structure some 145 feet high with a crest length of 1,640 feet. Tyzack Reservoir will have a total capacity of 26,000 acre-feet, an active capacity of 24,000 acre-feet, and an inactive capacity of 2,000 acre-feet. The project will develop about 22,600 acre-feet of water for irrigation and municipal and industrial purposes.

The Burns Pumping Plant will be located on the Green River near the mouth of Brush Creek. The pump will have a total design capacity of 97.4 second-feet and will have separate discharge lines to the Burns Bench, Burton, Murray, and Sunshine Canals. It will have an average annual discharge of 9,700 acre-feet. The water will be delivered during the irrigation season.

Tyzack Pumping Plant will pump storage water from Tyzack Reservoir through the Tyzack Aqueduct to the existing Steinaker Reservoir and to Ashley Creek for distribution by local water users. The pump and aqueduct will have a design capacity of 46 second-feet, and the aqueduct will consist of 3.1 miles of discharge line and 9 miles of pressure pipeline. The Jensen Unit water supply will average 18,000 acre-feet annually for municipal and industrial purposes and 4,600 acre-feet per year for irrigation.

The project plan also includes provisions for recreation, fish and wildlife conservation, and flood control.

Determination of Irrigable Area

In determining the lands to be included in the project, a total of 15,720 acres was delineated and classified. The survey conducted in 1964 included full and supplemental service lands. The classified area is summarized in Table V-1, with totals rounded to the nearest 10 acres.

This survey indicated there are 4,170 acres of presently irrigated land in the Jensen Unit. The arable lands include 3,840 acres of supplemental service lands and 480 acres of full service lands for a total of 4,320 acres. Nonarable lands in the Jensen Unit include 330 acres of class 6W land and 11,070 acres of class 6 land (including existing rights-of-way) for a total of 11,400 acres.

After determining the available water supply, it was decided that only those arable lands below Tyzack Reservoir adjacent to Big Brush Creek, Brush Creek, and the Green River would be included in the irrigable area. Thus the lands excluded from unit development comprise the full and supplemental service lands of Little Brush Creek and the arable lands to be inundated by Tyzack Reservoir. No allowance for future rights-of-way was made as there is little likelihood that the present system of canals and roads will be extended with project development.

Table V-2 shows the reduction from arable to irrigable area.

Table V-2
Reduction from arable to irrigable area
(Unit--acres)

	Supplemental service				Full service			Total unit
	Classes				Classes			
	1	2	3	Total	2	3	Total	
Arable	67	3,354	424	3,845	275	201	476	4,321
Irrigable	38	3,179	421	3,638	255	190	445	4,083
Rounded	40	3,180	420	3,640	250	190	440	4,080

Table V-1
Summary of classified area
(Unit--acres)

Canal	Irrigated land class: Class 1	Class 2	Class 3	Total classes 1, 2, and 3	Class 6W	Total irri-gated	Nonirrigated land class: Class 2	Class 3	Total classes 2 and 3	Class 6st	Total nonirri-gated	Total arable	Total nonarable	Total classi-fied
Little Brush Creek	29	138	1	168		168	17		17	1,218	1,235	185	1,218	1,403
Brush Creek[1/]		541	88	629		629	48	85	133	6,411	6,544	762	6,411	7,173
Murray		203	90	293	44	337	30	4	34	739	773	327	783	1,110
Burton		143	64	207	220	427				304	304	207	524	731
Sunshine		977	73	1,050	1	1,051	143	110	253	1,168	1,421	1,303	1,169	2,472
Burns Bench	38	1,352	108	1,498	68	1,566	37	2	39	1,230	1,269	1,537	1,298	2,835
Total	67	3,354	424	3,845	333	4,178	275	201	476	11,070	11,546	4,321	11,403	15,724
Rounded	70	3,350	420	3,840	330	4,170	280	200	480	11,070	11,550	4,320	11,400	15,720

1/ Includes Big Brush Creek lands.

Table V-3 summarizes the irrigable acreage in the Jensen Unit by canals.

Table V-3
Summary of irrigable area by canal
(Unit--acres)

Canal	Supplemental service Classes 1	2	3	Total 1,2,3	Full service Classes 2	3	Total 2,3	Total irrigable
Brush Creek1/		504	86	590	45	74	119	709
Murray		203	90	293	30	4	34	327
Burton		143	64	207				207
Sunshine		977	73	1,050	143	110	253	1,303
Burns Bench	38	1,352	108	1,498	37	2	39	1,537
Total	38	3,179	421	3,638	255	190	445	4,083
Rounded	40	3,180	420	3,640	250	190	440	4,080

1/ Includes Big Brush Creek lands downstream from Tyzack Reservoir.

As shown in the above tables, 4,080 acres were determined to be irrigable out of a total of 4,320 acres of arable land. Of the irrigable total, the following is a breakdown by land classes and percentages: class 1, 40 acres (1 percent); class 2, 3,430 acres (84 percent); and class 3, 610 acres (15 percent).

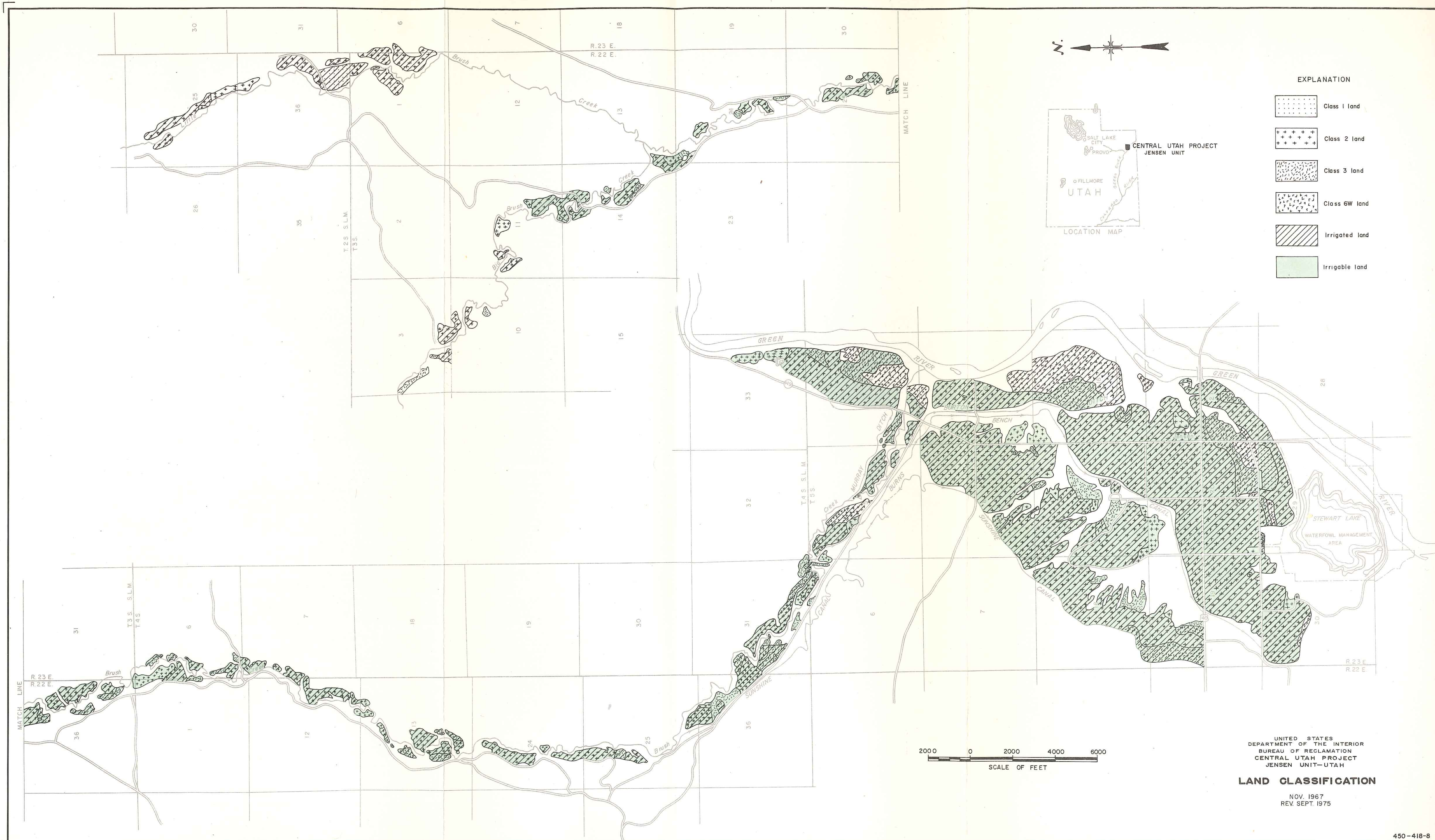
The productive acreage is approximately 95 percent of the irrigable acreage or 3,880 acres.

Map No. 450-418-8 shows the arable and irrigable lands in the Jensen Unit. The irrigable lands are shown in green color.

Supporting Data

The following supporting data for this appendix are on file at the Office of Utah Activities.

1. Aerial photographs of the Jensen Unit lands containing the land classification data.
2. Log and soil descriptions of all auger holes and soil borings.
3. Soil chemical analysis data.
4. Hydraulic conductivity of fragmented samples and particle size distribution data.
5. Climatic data.
6. Acreage tabulations and appropriate data.


EXPLANATION
Class I land
Class 2 land
Class 3 land
Class 6W land
Irrigated land
Irrigable land
CENTRAL UTAH PROJECT
JENSEN UNIT
SALT LAKE CITY
PROVO
FILLMORE
UTAH
LOCATION MAP
R.23 E.
R.22 E.
T.2S. S.L.M.
T.3S.
T.3S. S.L.M.
T.4S.
T.4S. S.L.M.
T.5S.
MATCH LINE
Brush Creek
Little Brush Creek
Big Brush Creek
GREEN RIVER
BURTON BENCH DITCH
MURRAY DITCH
BURNS CANAL
SUNSHINE CANAL
STEWART LAKE
WATERFOWL MANAGEMENT AREA
2000 0 2000 4000 6000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT—UTAH
LAND CLASSIFICATION
NOV. 1967
REV. SEPT. 1975
450-418-8

DRAINAGE

CHAPTER I

INTRODUCTION

Purpose of Appendix

The purpose of this appendix is to present the data, interpretations, and conclusions supporting the drainage and land classification appraisals of the Jensen Unit lands. The appendix provides and supports the drainage cost estimate which is included as a part of the overall construction costs of the unit as reported in the project cost estimate of the Jensen Unit Definite Plan Report.

Location and Extent of Project Lands

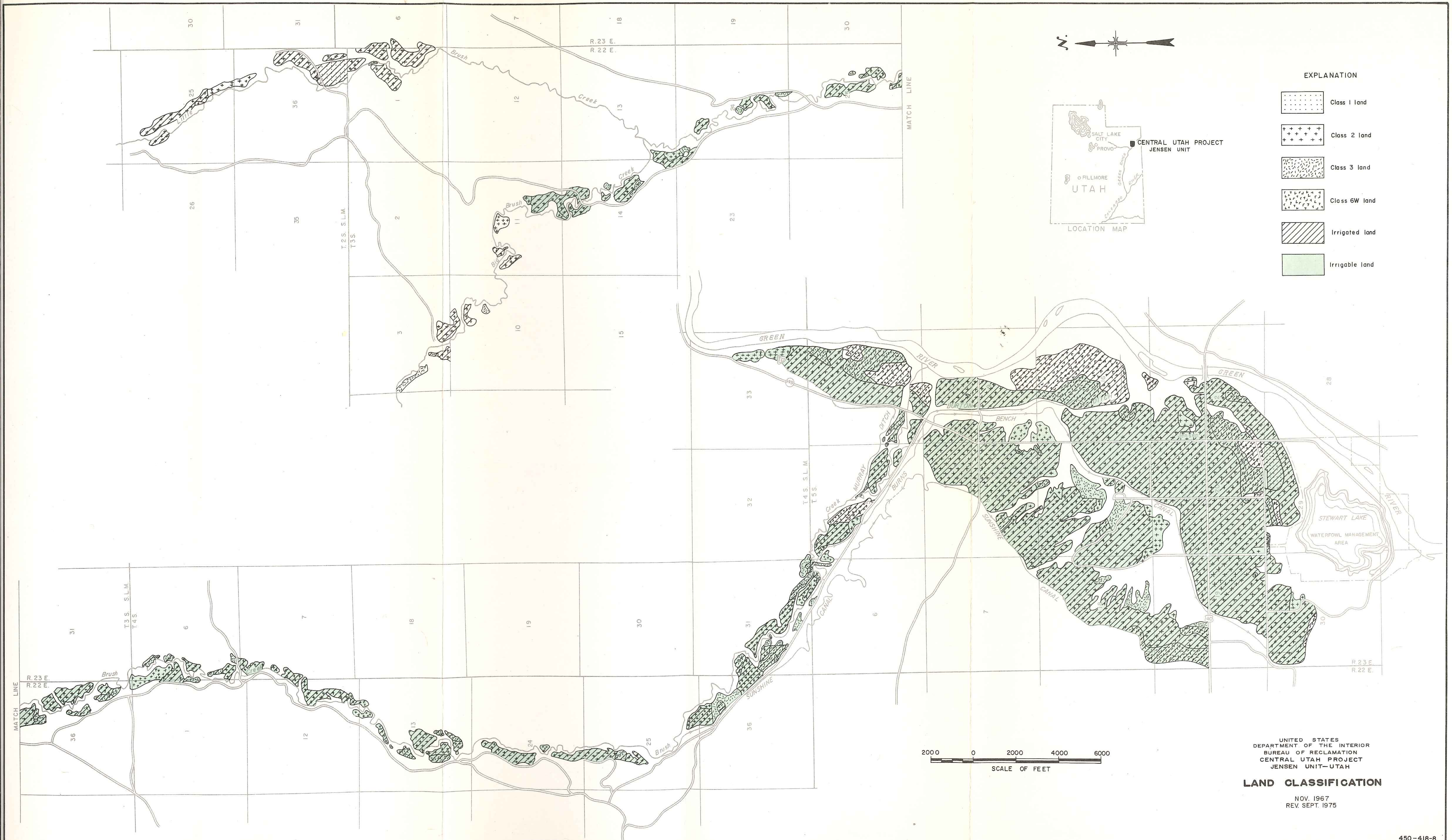
The Jensen Unit is located near the eastern border of Utah in Uintah County. Except for numerous small tracts of land located within the rather narrow Brush Creek flood plain, the Jensen Unit lands are located west of and adjacent to the Green River. The land area is bounded on the south by Stewart Lake Waterfowl Management Area and the Green River, on the west and the immediate north by low shale hills, and on the east by the Green River. U.S. Highway 40 passes through the central part of the unit. This highway connects Salt Lake City, Utah, lying 191 miles to the west, with Denver, Colo., on the east. (See frontispiece map.)

The community of Jensen, which is located along the eastern border near the central part of the unit, is the only settlement located within the unit lands boundary. Vernal, which is located 14 miles west of the lands area, is the largest community of the Uinta Basin.

This unit is composed of approximately 3,640 acres of presently irrigated lands and 440 acres of new lands. These lands are shown on Land Classification Map No. 450-418-8.

Agricultural History

The town of Jensen was named after Lars Jensen, who settled in the area in 1879 and from 1881 to 1909 operated a ferry boat service across the Green River. Several Mormon colonists arrived in the fall of 1877; and in the spring of 1878, they diverted water from Brush Creek for irrigation in the area for the first time. Small ditches were first built to serve the readily accessible agricultural lands adjacent to the stream. Three canal companies, namely, the Burton Ditch, Murray Ditch, and Burns Bench Canal, as well as individual ditches, were in operation in 1896. It was at this time that litigation resulting from late-season water


EXPLANATION
Class I land
Class 2 land
Class 3 land
Class 6W land
Irrigated land
Irrigable land
SALT LAKE CITY
PROVO
FILLMORE
UTAH
CENTRAL UTAH PROJECT
JENSEN UNIT
LOCATION MAP
R. 23 E.
R. 22 E.
T. 2 S. S.L.M.
T. 3 S.
T. 4 S. S.L.M.
T. 5 S.
MATCH LINE
Brush Creek
Little Brush Creek
GREEN RIVER
BURTON BENCH
MURRAY DITCH
BURNS
SUNSHINE CANAL
STEWART LAKE
WATERFOWL MANAGEMENT AREA
2000 0 2000 4000 6000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
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CENTRAL UTAH PROJECT
JENSEN UNIT—UTAH
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450-418-8

shortages and rights to the use of the stream's natural flow brought about an adjudication of Brush Creek water rights by court decree. The summer flow waters were thereby distributed equally among the users of the stream according to the number of acres each had in production at the time.

At the present time four major canals divert water from Brush Creek to serve lands of the Jensen Unit. They include the Sunshine Canal, Burns Bench Canal, Burton Ditch, and Murray Ditch. In addition, several small canals and ditches serve scattered tracts of land located within the narrow flood plains created by Big and Little Brush Creeks. In 1962 a pumping plant was installed to pump Green River water into the Burns Bench Canal. This pump has a capacity of about 16 cubic feet per second with an 85-foot elevation differential between the Green River and the Burns Bench Canal.

Due to the absence of railroad facilities and the poor condition of highways and roads, the first settlers were compelled to make their community self-supporting. Small grains, alfalfa, and pasture have been the principal crops of the area. There were few cash crops, with livestock and animal products being the source of cash income.

This situation has not changed greatly up to the present time; there are very few cash crops grown, and the principal source of income is from a livestock economy. The predominant crops grown in the Jensen Unit and their approximate percent distribution as compared to the total irrigated acreage are as follows.

Crop	Percent
Alfalfa	51
Small grains	16
Pasture	29
Corn silage	4

Precipitation in the Jensen Unit area is not sufficient for dry land farming; consequently, all of these crops must be irrigated.

The Jensen Unit area is rather arid, with wide daily and annual variation in temperature. The following is a summary of the climatological data through December 1965.

Summary of average climatological data

Station	Jensen
Elevation (feet)	4,720
Precipitation record (years)	33
Average annual precipitation (inches)	7.67
Average annual growing period	
Total frost-free days (above 32° F.)	119
Season (above 28° F.)	
From	April 14
To	October 10
Total days	180

Summary of Drainage Conditions

Approximately 85 percent of the Jensen Unit lands has adequate natural drainage capacity. Included in these adequately drained lands are approximately 2,940 acres of supplemental service lands and 430 acres of full service lands. These lands are located on the Sunshine Bench and along the higher and steeper portion of the Burns Bench. They have good natural drainage capacity for the following reasons: (1) they occupy the higher, more favorable topographic positions and good gradient situations (2) the subsurface materials of these lands are medium textured with adequate permeability rates, and (3) there are no shallow barrier depths to restrict ground water movement. Due to these favorable drainage characteristics, the present water table is deep and is expected to remain at safe depths under project operation.

The remaining 15 percent of the irrigable lands, composed of approximately 700 acres of supplemental service land and only 10 acres of full service land, is either drainage deficient at the present time or will become drainage deficient under project operation. These lands are drainage deficient for the following reasons: (1) they occupy low topographic positions on the southern portion of the Burns Bench in the general vicinity of the town of Jensen, (2) these lands are subject to the encroachment of surface and subsurface water from the higher lands, (3) they have relatively flat ground surface and barrier surface slopes, and (4) there are no well developed channels to provide outlet.

These drainage-deficient tracts do, however, have fair permeability rates in the upper 5 to 10 feet of fine-textured materials and high permeability rates in the gravel layer between the fine-textured materials and the shale barrier. This makes the drainage deficiency feasible to correct by artificial subsurface drainage facilities.

Jensen Unit Project Plan

The Jensen Unit would develop about 22,600 acre-feet of water for irrigation and municipal and industrial purposes. A supplemental water supply would be provided for about 3,640 acres of presently irrigated land and a full supply for about 440 acres of new land. About 18,000 acre-feet of water would be provided for municipal and industrial uses, and the balance of 4,600 acre-feet would be used for irrigation.

The major features of the project would be the Tyzack Dam, Reservoir, Pumping Plant, and Aqueduct and Burns Pumping Plant. The Burns Pumping Plant, located on Green River near the mouth of Brush Creek, would have a design capacity of 97.4 second-feet. Approximately 9,700 acre-feet of water would be pumped annually from the Green River. About 4,600 acre-feet of this amount would be used for irrigation in the Jensen area and the balance, or about 5,100 acre-feet, would be exchanged for a comparable amount of Big Brush Creek water that would be used for municipal and industrial purposes. Discharge lines would extend from the Burns Pumping Plant to each of the four major existing canals in the Jensen area.

Storage would be obtained in the Tyzack Reservoir to be constructed on Big Brush Creek about 3 miles below the stream's junction with Utah Highway 44. The reservoir would have a total capacity of 26,000 acre-feet, of which 24,000 acre-feet would be active. It would store early spring runoff and surplus flows of Big Brush Creek for subsequent irrigation and municipal and industrial uses. Storage water would be used, when available, for the irrigation of the Jensen Unit lands. The storage supplies, when insufficient, would be supplemented by irrigation water pumped from Green River by the Burns Pumping Plant. The 46-second-foot design capacity Tyzack Pumping Plant would pump approximately 18,000 acre-feet of water from the Tyzack Reservoir under maximum operating head of about 584 feet over the divide to the west. The pumped water would flow in the 12.1-mile-long Tyzack Aqueduct to Steinaker Reservoir of the Vernal Unit and to Ashley Creek. There it would be exchanged with Ashley Springs water and used for municipal and industrial purposes.

Existing canals and laterals would be used for the distribution of the project irrigation water. Some project drainage will be required on drainage-deficient land. Recreation facilities and fishery benefits would be provided at Tyzack Reservoir. The Jensen Unit area is within the boundaries of both the Uintah Water Conservancy District and the Central Utah Water Conservancy District.

Drainage Plan

The drainage distress lands of the Jensen Unit are contiguous and are located entirely on the Burns Bench. These drainage-deficient lands and the lands that are expected to become drainage deficient under project operation are encompassed by tracts A and B as shown on Map No. 450-418-49.

Under the drainage plan, project drainage would maintain the level of productivity commensurate with the repayment capacity as determined for the unit plan. No farm drainage will be required.

The use of two different types of project drainage systems was investigated for the Jensen Unit. The first system was a conventional subsurface drainage plan consisting of a network of 1.4 miles of open outlet drains and 4.7 miles of closed lateral drains with a design depth of 10 feet. This drain system would have a total construction cost of $774,000 which includes 25 percent contingencies and 50 percent engineering and overhead.

The alternate drainage system investigated consisted of a series of shallow wells from which ground water would be pumped to accomplish the required drainage. A detailed study of this type drainage system, however, showed it to be infeasible for the Jensen Unit.

The conventional drainage system has therefore been adopted as the official drainage plan for the Jensen Unit.

The Regional Director was advised of this recommendation in a letter from the Project Manager dated April 30, 1969. The Project Manager received a letter of concurrence from the Regional Director dated May 7, 1969. The Uintah Water Conservancy District was notified of the adoption of the conventional drainage plan for the Jensen Unit in a letter addressed to Mr. L. Y. Siddoway, Manager, and dated May 29, 1969.

CHAPTER II

INVESTIGATIONS

Investigational Program

The investigational program for the Jensen Unit was initiated in the spring of 1957, with parts of it being continued. This investigation has included the collection of that data required to determine the necessary drainage facilities for sustaining high production on project lands. This program included the following detailed studies.

1. Water table investigations
2. Topographic investigations
3. Subsurface investigations
4. Land classification
5. Permeability studies
6. Determination of drainage requirements--conventional drainage method
    a. Maximum water table
    b. Specific yield
    c. Deep percolation
    d. Permeability and depth-to-barrier
    e. Irrigation schedule and interval
    f. Drain layout
7. Determination of drainage requirements--pumping method (alternate drainage plan)

Water table investigations

In May of 1957 a program was started to gather the necessary information on existing water table conditions, fluctuations, and annual trends to ascertain the possible effects of the project water supply on the drainage conditions of project lands. During May and June of 1957, 41 water table observation holes were installed. Thirty-one of these observation holes were installed with an 18-inch power auger. The remaining 10 observation holes were drilled with 4-inch hand augers at locations that were in most cases inaccessible to power equipment.

In June and July of 1965, nine additional water table observation holes were installed by hand auger. Also, during November of 1965, six of the 41 water table observation holes initially installed were deepened with a 4-inch power auger.

The depths of these water table observation holes varied from about 5 feet to about 33 feet. This range in depth is due to variations in depths to the underlying deposit of coarse gravel and cobble.

During July and August of 1965, a total of eight holes was drilled with a rotary drill through the upper layer of fine alluvium and the underlying layer of sand, gravel, and cobble to the shale barrier. Each of these holes was cased with 2 1/2-inch-diameter, thick-walled, plastic tubing (hand perforated). Depths of these holes ranged from 15 to 28 feet. These holes, all located in the drainage distress area, were initially utilized as short duration pumping test sites to determine the permeability rates of the sand, gravel, and cobble materials. After these tests were completed, the holes were retained for use as water table observation holes.

The locations of all water table observation holes and other subsurface exploration sites are plotted on the subsurface exploration Map No. 450-418-49, included in this appendix, and also on the land classification photos held in the Office of Utah Activities.

All water table observation holes except the rotary drill holes were cased with 3-inch perforated downspout, and a concrete collar was cast in place around the top of each casing. When possible, the casings were placed the full depth of the augered hole.

Water table readings were generally taken at weekly intervals during the irrigation season and at monthly intervals in the nonirrigation season. The only information available on water table fluctuations in the Jensen area was obtained from these wells.

A summary of the number of water table observation holes and other subsurface explorations is included under the subsurface investigation section.

The information obtained from the observation holes has been used to prepare a minimum depth-to-water table map, ground water hydrographs, and multiple profiles, all of which are included in this appendix.

Topographic investigations

During the definite plan report investigations detailed topographic maps of the drainage-deficient land in the Jensen area were not available from the Geological Survey or any other source on a scale larger than 2,000 feet per inch at a contour interval of 20 feet. Because of the small area under investigation and the varying topography, a large scale was required to clarify the drainage problem. To accomplish this, a ground survey crew from the Central Utah Projects Office surveyed profiles that provided data for a 400-foot per inch reconnaissance topographic map. This map has been used to establish elevations of the ground surface and water table exploration holes used in multiple profiles and to lay out the proposed drainage system for cost estimate purposes. These maps are on file at the Office of Utah Activities.

During the spring of 1973, a detailed topographic survey was made by the Duchesne Field Office of the drainage-deficient lands. The resulting topographic map with a scale of 400 feet per inch and a 2-foot contour interval is now available for use in making a detailed layout of the proposed drainage system.

Subsurface investigations

During the drainage investigational program, a total of 80 subsurface exploration holes was drilled. These holes consisted of the following types of explorations.

Water table observation holes	50
Rotary drill holes	8
Auger hole permeability test sites	22
Total	80

This exploration program resulted in one exploration hole for each 50 acres of project land. Many of the auger hole permeability test sites were located near existing observation wells or rotary drill hole sites.

In order to gather adequate information on the characteristics of the subsurface materials in the project area, materials logs were obtained from the 50 water table observation holes that were established, eight rotary drill holes that penetrated to the shale barrier, and 22 auger holes that were drilled for use as permeability test sites. The logs were made by hand texturing the materials as they were being drawn from the hole. These logs served to locate sand and gravel layers, the shale barrier surface, and other materials that may have an influence on the various drainage characteristics. In addition, samples were taken from representative holes for laboratory analysis. Laboratory analysis helped substantiate the textures of the materials that were made by hand in the field.

The plan in choosing the subsurface exploration sites was to locate the holes up and downslope along profile lines, generally at a 1/2-mile spacing, with auger holes between and also at a 1/2-mile spacing. The additional auger and rotary drill holes added in 1965 provided more detailed information on the drainage problem area.

The location of all subsurface exploration sites has been plotted on the large-scale, 1" = 400' land classification photos to preserve their location accurately for future reference. These locations are shown on Map No. 450-418-49 in this appendix.

Permeability studies

Permeability data have been collected during the drainage investigations by using both the auger hole (bailout) permeability step test and the short duration pumping permeability test in the previously mentioned rotary drill holes. Because of a 2-layer subsurface profile in the Jensen area, it was necessary to use both test methods.

The pump tests were conducted to determine the average permeability of the sand and gravel materials in the lower layer which could not be tested by the auger hole method. In the upper soil layer of fine-textured alluvium, the auger hole permeability step tests were used to determine the average permeability.

In the permeability studies there were 22-auger-hole (bailout) permeability tests and eight pumping permeability tests run in the rotary drill holes during the Jensen Unit investigations. All of the rotary drill hole tests were located on the drainage-deficient lands of the Burns Bench and 18 of the auger hole permeability tests were located within this area. The four remaining auger hole test sites were located on the present Green River flood plain north of the community of Jensen.

Land classification data

The drainage engineers were aided in the investigation of drainage problem areas by land classification data. The specific land class data used in the drainage investigation are soil and subsoil type, soil parent material and characteristics, topographic features, subsurface conditions that would affect the drainability of land, such as shallow depths to gravel and shale, size, shape, and location of irrigable land tracts, and land development requirements. The land classification data are on file at the Office of Utah Activities.

Determination of drainage requirements--conventional drainage method

The conventional subsurface drainage requirements for the drainage-deficient lands in the Jensen area were determined by using Bureau of Reclamation techniques. The drain-spacing requirement was determined using the Bureau drain-spacing method. Discussion of the assumptions that were made and the variables considered in the application of these formulas follow.

Maximum Water Table

Records on the allowable maximum water table depth that will permit sustained high productivity were not available in the Jensen area. Therefore, the accepted depth of 4 feet has been adopted.

Specific Yield

The specific yield value used in the drain-spacing computation was estimated to be 10 percent.

Deep Percolation

The amount of deep percolation to be removed by the drains was estimated at 10 percent of the farm application. This estimate was based on the predominantly clay and clay loam soils found in the upper 4 feet of the soil profile. The predominant soil texture in the upper 4 feet of soil profile was determined by totaling the depth of different textures in the auger holes, rotary drill holes, and land classification soil logs in the drainage-deficient land below Burns Bench Canal.

Permeability and Depth-to-Barrier

As previously stated, the permeability rates of the upper fine-textured materials were determined by the auger hole step permeability test. Due to the sand and gravel materials that underlie much of the Jensen Unit area at a shallow depth, many of these permeability tests could, however, only be conducted for one step.

To determine the permeability rates of the underlying sand, gravel, and cobble material, a pumping test of 4-hour duration was run at the rotary drill hole sites. The average permeability and approximate storage coefficients for these materials were determined from straight-line solutions of the pump test data.

For reasons that will be subsequently discussed under the "Subsurface Characteristics" section of Chapter III, the average permeability rate of the upper fine-textured material (see Table 1, page 24) was used in the drain-spacing requirements for tract B, and the average permeability rate of the underlying sand, gravel, and cobble material (see Table 2, page 24) was used to determine the drain-spacing requirements of tract A.

Depths to the underlying shale barrier were established by the rotary drill holes that penetrated the sand, gravel, and cobble material.

Supporting data for the auger hole step permeability tests and the shallow well pumping tests are on file in the Office of Utah Activities.

Irrigation Schedule and Interval

Irrigation schedules and irrigation interval for the Jensen area were not available under conditions of a full and controlled water supply. Therefore, data developed for the adjacent Vernal Unit, which is considered to have a full supply, were adopted for use in the Jensen Unit. This was considered appropriate because of the similarity of the two areas in climate, location, and type of crops produced. This irrigation schedule specifies six irrigation applications with a 21-day irrigation interval.

Drain Layout

After the drain-spacing requirements for each drainage-deficient land tract were determined, using the previously discussed criteria, a drain layout was made of the entire system. This layout includes the proposed project open and closed drainage system and is on file in the Office of Utah Activities.

Determination of drainage requirements--
pumping method (alternate drainage plan)

Early in the drainage investigation for the Jensen Unit, it became evident that as a result of high transmissivity rates of the cobble and gravel material it might be feasible to accomplish the required drainage by pumping from wells.

A reconnaissance study was therefore made based on theoretical solutions and then available values for transmissivity, storage coefficient, etc. This study consisted of the theoretical design of a pump drainage system for which a cost estimate was made. This cost estimate indicated that the equivalent cost of the pump drainage system would be competitive with the conventional system of open and closed drains.

Therefore, in the original draft of the Drainage Appendix which was submitted to Denver for review on June 28, 1968, it was concluded that due to the indicated economic feasibility of the pumped drainage plan further investigation was justified. In a letter from the Chief Engineer's Office summarizing their review of the original draft of the Land Drainage Appendix dated August 27, 1968, it was suggested that any further investigations required to determine the feasibility of the proposed pump drainage plan be completed before a final drainage plan was selected.

To further study the potential of the pump drainage plan, two prototype wells with a diameter of 12 inches were installed within the drainage-deficient tracts. In addition, seven water table observation holes were installed that penetrated the cobble and gravel material. These holes along with other holes in the area were used to monitor the drawdown of the water table as the wells were pumped.

During the well drilling operation, it was found that the materials of the gravel and cobble aquifer were not as homogeneous as indicated by the previously available data. An exploratory hole was drilled near the site selected for one of the test wells. The materials encountered in this hole were not at all suitable for a well, being almost entirely fine sand with lenses of medium gravel. Another site was then selected for a test well about 1/4 mile away. Again a test hole was drilled and again the material encountered was predominantly fine sand with lenses of medium gravel. Since this material was also considered unsuitable for a test well, still another site was selected. A test hole at the third site encountered gravel and cobble except for a thin layer of coarse sand. The materials here were considered suitable for one of the 12-inch wells. At the second test well site, fine-textured materials extended to such a depth that only a shallow aquifer of cobble and gravel remained above the shale barrier.

From this experience it was concluded that it would be impossible to predict what the materials were in other parts of the drainage-deficient area and that numerous geological boundaries existed in the aquifer materials.

The two wells were each pumped for about 1 month. During this month the wells were pumped at various rates with corresponding local and regional water table drawdown being monitored.

The conclusion as to the existence of numerous geological boundaries in the form of areas of lower transmissivity rates was substantiated by abrupt changes in the drawdown rate of the wells during the pumping test. The data obtained from the pumping test are therefore considered to be applicable to only that area in the immediate vicinity of the test wells.

Despite this, another design of the pumped drainage system was made. To do this it was necessary to assume that materials in other parts of the drainage-deficient area would be the same as those at the sites of the two test wells. This would be a rather optimistic assumption. The cost estimate of this pumped drainage plan cannot, therefore, be considered entirely reliable. To develop a reliable cost estimate more subsurface investigations would be required. Further investigations are not considered justified.

CHAPTER III

DRAINAGE CHARACTERISTICS

Geology

The Jensen Unit lands are located within two different geological settings. The greater portion of the lands is located on two river terraces and on the higher levels of the river flood plain along the west side of the Green River not far below where it emerges from the south flank of the Uinta Mountains. About 19 percent of the lands is located on the flood plain of Brush Creek in the narrow, deep canyon above its confluence with the Green River.

In this locality the Green River has cut through the Mancos shale formation of marine origin and Cretaceous age. This formation consists largely of soft shale in this area and, as its marine origin would indicate, also contains considerable salt, with sulfate being the predominant anion.

The two river terraces are the remnants of former flood plains of the Green River which were excavated in Mancos shale and refilled with alluvium during Pleistocene times by alternate cycles of erosion and deposition. The alluvium consists of a layer of sand and gravel lying on the Mancos shale capped by fine-grained alluvium. The sand and gravels are generally well washed and sorted and free of clay and silt. The gravels are rounded to subangular and consist of hard, durable materials.

Portions of the recent and present flood plains of the Green River are occupied by unit lands. Here the materials are recently deposited and reworked river alluviums and are underlain also by the Mancos shale formation.

To be consistent with local usage, these terraces will be hereafter referred to as Sunshine Bench, the upper one, and Burns Bench, which is the lower one.

The lands on the Brush Creek flood plain lie within the confines of a narrow, deep canyon with a moderately thick deposit of alluvium along the 15-mile reach occupied by the unit lands.

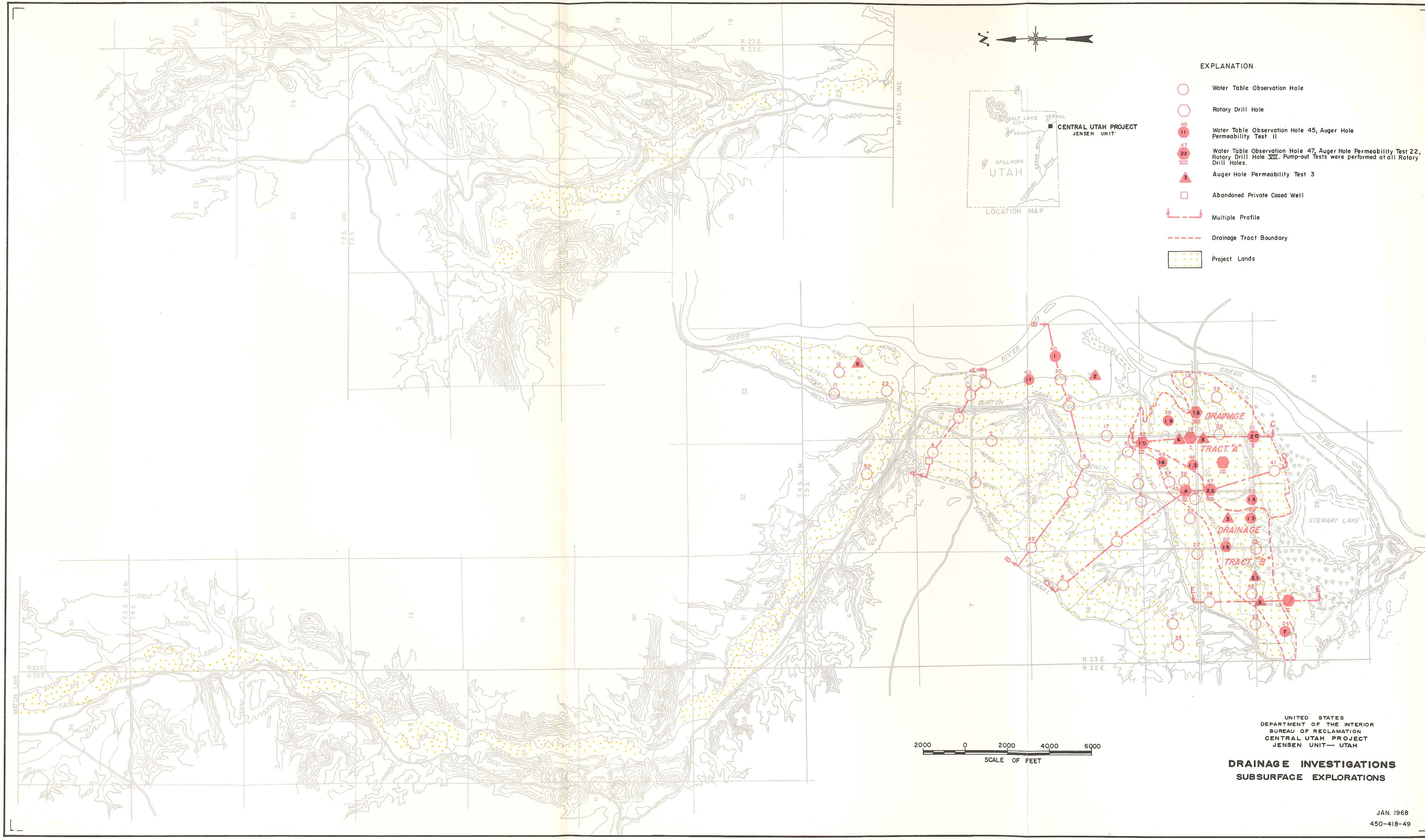
With the exception of about 4 1/2 miles of this 15-mile reach, all of the unit lands contained in Brush Creek Canyon are underlain by the shale member of the Mancos shale formation. The lower end of this 4 1/2-mile reach begins about 4 miles above the confluence of the Brush Creek channel and the Green River and occurs where Brush Creek has cut through the Split Mountain anticline. The lower part of this 4 1/2-mile reach is cut into and underlain by the Frontier sandstone member of the Mancos formation, and the upper part is cut into and underlain by the Morrison formation.

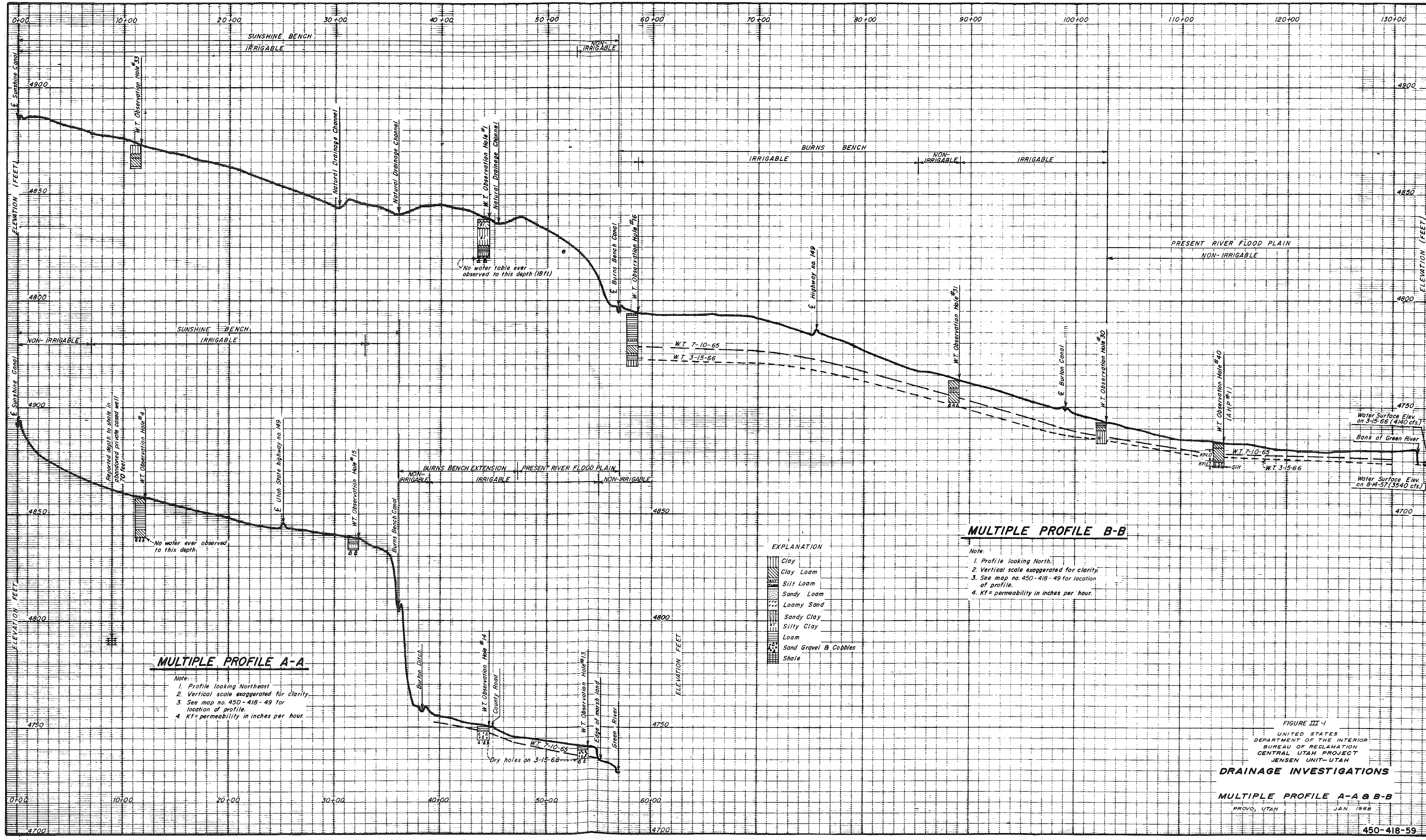
Topography

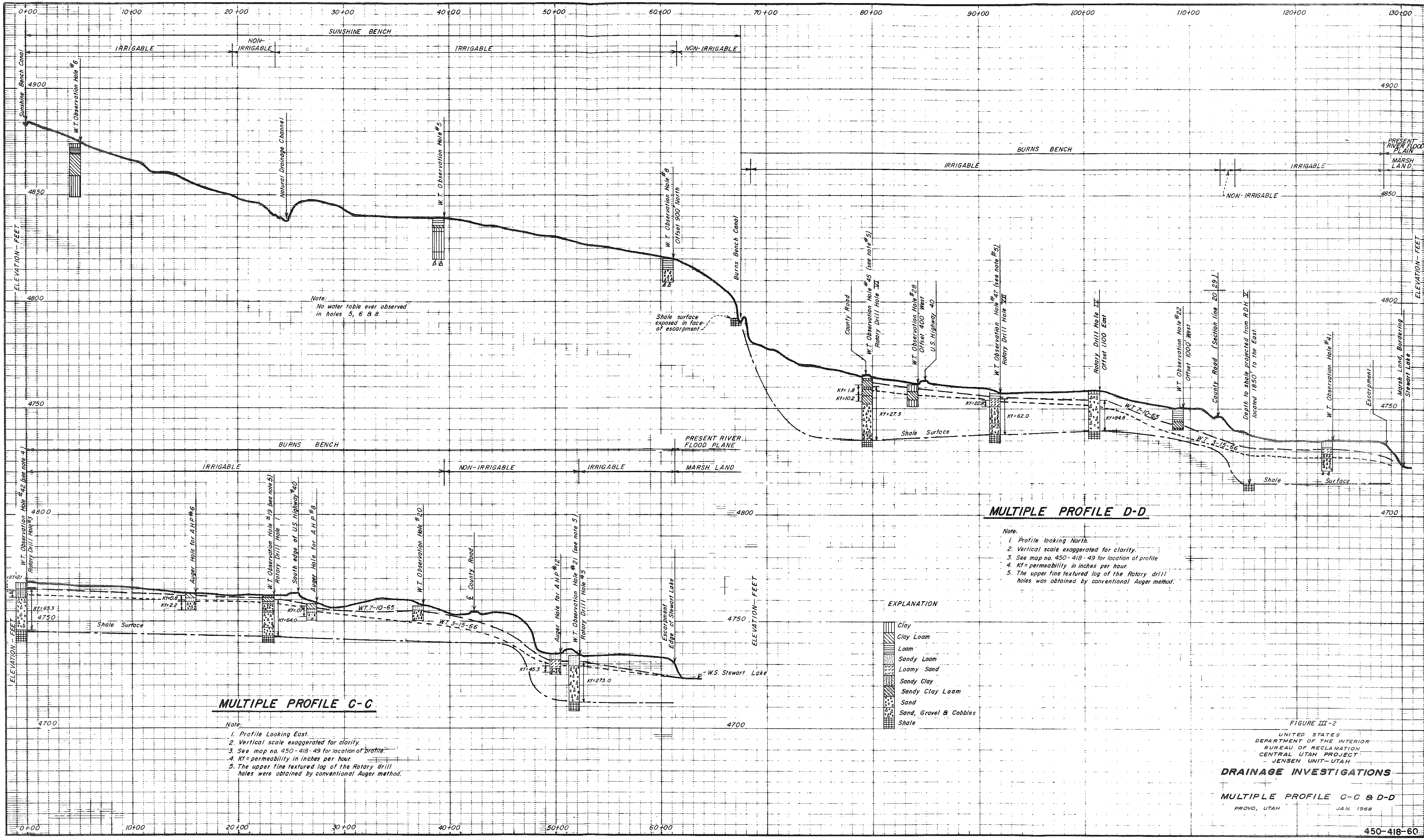
The main body of the Jensen land area is about 4 1/2 miles long and varies in width from less than three-fourths of a mile at the extreme northern end to 2 1/2 miles near the southern end (refer to Map No. 450-418-49). Lands of the unit range from 4,725 to 4,900 feet in elevation. As was previously mentioned under "Geology," the Jensen Unit lands are located mainly on two wide river terraces known as Sunshine Bench and Burns Bench and the present Green River flood plain. Many small tracts of land are scattered along a 15-mile reach of the present Brush Creek flood plain.

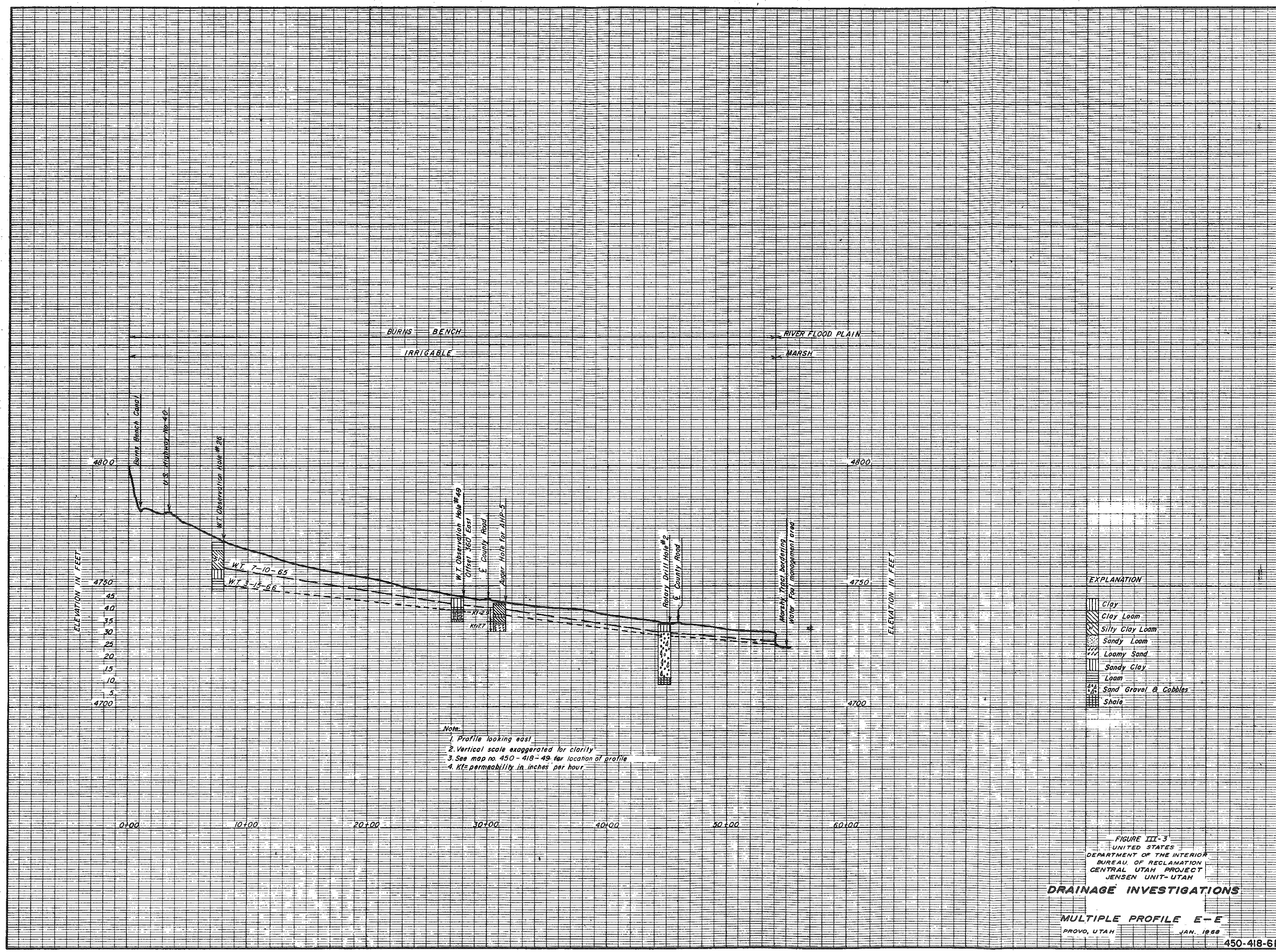
The highest and oldest bench of the Jensen Unit is the Sunshine Bench. The northern part of this bench is relatively smooth, with gradients ranging from 60 to 100 feet per mile to the southeast. In the southern part of the Sunshine Bench, the ground surface is broken with washes extending from the bench escarpment into the bench area. This condition can be noted on Multiple Profiles B-B and D-D and the subsurface exploration map. These wash formations are beneficial in that they provide drainage relief to the adjoining lands. The general slope of the southern part of the Sunshine Bench is to the southeast and ranges from about 60 to 80 feet per mile. In general, the topography of Sunshine Bench is favorable to drainage.

Situated immediately east of and adjacent to Sunshine Bench is the lower bench known as Burns Bench. The escarpment between the two benches ranges in height from 40 to 80 feet, as noted on Multiple Profiles B-B and A-A, respectively. The northern end of Burns Bench is much the same topographically as the northern end of Sunshine Bench. This fact is illustrated by Multiple Profile A-A. It has a relatively smooth topography, with gradients to the southeast of about 60 to 100 feet per mile. There are no natural drainage channels of any appreciable size in the northern part of the Burns Bench. The southern part of Burns Bench is rather undulating in places, with the rather flat general slope to the southeast ranging from 15 to 30 feet per mile. Multiple Profiles C-C, D-D, and E-E show typical slopes and topographic conditions. Surface drainage of this part of the bench is by shallow, natural depressions that convey the water to the present Green River flood plain that lies between the bench and the river. With the slope of these natural channels being relatively flat and the general slope of the adjacent land surface being relatively flat, water tables in the topographic lows of this part of the bench are consequently high during most of the year.


EXPLANATION
Water Table Observation Hole
Rotary Drill Hole
Water Table Observation Hole 45, Auger Hole Permeability Test 11
Water Table Observation Hole 47, Auger Hole Permeability Test 22, Rotary Drill Hole VII. Pump-out Tests were performed at all Rotary Drill Holes.
Auger Hole Permeability Test 3
Abandoned Private Cased Well
Multiple Profile
Drainage Tract Boundary
Project Lands
CENTRAL UTAH PROJECT
JENSEN UNIT
SALT LAKE CITY
VERNAL
PROVO
FILLMORE
UTAH
LOCATION MAP
MATCH LINE
GREEN RIVER
BURTON CANAL
DRAINAGE TRACT "A"
DRAINAGE TRACT "B"
STEWART LAKE
R. 23 E.
R. 22 E.
2000 0 2000 4000 6000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT— UTAH
DRAINAGE INVESTIGATIONS
SUBSURFACE EXPLORATIONS
JAN. 1968
450-418-49


MULTIPLE PROFILE A-A
Note:
1. Profile looking Northeast
2. Vertical scale exaggerated for clarity.
3. See map no. 450-418-49 for location of profile.
4. Kf = permeability in inches per hour.
MULTIPLE PROFILE B-B
Note:
1. Profile looking North.
2. Vertical scale exaggerated for clarity.
3. See map no. 450-418-49 for location of profile.
4. Kf = permeability in inches per hour.
EXPLANATION
Clay
Clay Loam
Silt Loam
Sandy Loam
Loamy Sand
Sandy Clay
Silty Clay
Loam
Sand Gravel & Cobbles
Shale
SUNSHINE BENCH
IRRIGABLE
NON-IRRIGABLE
BURNS BENCH
PRESENT RIVER FLOOD PLAIN
BURNS BENCH EXTENSION
ELEVATION (FEET)
Sunshine Canal
W.T. Observation Hole #33
Natural Drainage Channel
W.T. Observation Hole #1
No water table ever observed to this depth (18 ft.)
Burns Bench Canal
W.T. Observation Hole #16
Highway no. 149
W.T. Observation Hole #31
Burton Canal
W.T. Observation Hole #30
W.T. Observation Hole #40 (A.H.P. #1)
W.T. 7-10-65
W.T. 3-15-66
Water Surface Elev. on 3-15-66 (4140 cfs.)
Bank of Green River
Water Surface Elev. on 8-14-57 (3540 cfs.)
Reported depth to shale in abandoned private cased well 70 feet
W.T. Observation Hole #4
No water ever observed to this depth
Utah State highway no. 149
W.T. Observation Hole #15
Burton Ditch
W.T. Observation Hole #14
County Road
W.T. Observation Hole #13
Edge of marsh land
Green River
Dry holes on 3-15-66
FIGURE III-1
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT-UTAH
DRAINAGE INVESTIGATIONS
MULTIPLE PROFILE A-A & B-B
PROVO, UTAH
JAN. 1968
450-418-59


SUNSHINE BENCH
IRRIGABLE
NON-IRRIGABLE
NON-IRRIGABLE
Sunshine Bench Canal
W.T. Observation Hole #6
Natural Drainage Channel
W.T. Observation Hole #5
W.T. Observation Hole #8
Offset 900 North
Burns Bench Canal
Note:
No water table ever observed in holes 5, 6 & 8.
Shale surface exposed in face of escarpment
BURNS BENCH
PRESENT RIVER FLOOD PLAIN
MARSH LAND
NON-IRRIGABLE
County Road
W.T. Observation Hole #45 (see note 5)
Rotary Drill Hole VI
W.T. Observation Hole #28
Offset 400 West
U.S. Highway 40
W.T. Observation Hole #47 (see note 5)
Rotary Drill Hole VII
Rotary Drill Hole IV
Offset 1100 East
W.T. Observation Hole #22
Offset 1000 West
County Road (Section line 20 29)
Depth to shale projected from RDH V located 1850 to the East.
W.T. Observation Hole #41
Escarpment
Marsh Land, Bordering Stewart Lake
Shale Surface
W.T. 7-10-65
W.T. 3-15-66
ELEVATION-FEET
MULTIPLE PROFILE D-D
Note:
1. Profile looking North.
2. Vertical scale exaggerated for clarity.
3. See map no. 450-418-49 for location of profile
4. Kf = permeability in inches per hour.
5. The upper fine textured log of the Rotary drill holes was obtained by conventional Auger method.
BURNS BENCH
IRRIGABLE
NON-IRRIGABLE
IRRIGABLE
PRESENT RIVER FLOOD PLANE
MARSH LAND
W.T. Observation Hole #42 (see note 4)
Rotary Drill Hole #3
Auger Hole for A.H.P. #6
W.T. Observation Hole #19 (see note 5)
Rotary Drill Hole I
South edge of U.S. Highway #40
Auger Hole for A.H.P. #8
W.T. Observation Hole #20
County Road
Auger Hole for A.H.P. #12
W.T. Observation Hole #21 (see note 5)
Rotary Drill Hole #5
Escarpment
Edge of Stewart Lake
W.S. Stewart Lake
Shale Surface
W.T. 7-10-65
W.T. 3-15-66
MULTIPLE PROFILE C-C
Note:
1. Profile Looking East.
2. Vertical scale exaggerated for clarity.
3. See map no. 450-418-49 for location of profile.
4. Kf = permeability in inches per hour.
5. The upper fine textured log of the Rotary drill holes were obtained by conventional Auger method.
EXPLANATION
Clay
Clay Loam
Loam
Sandy Loam
Loamy Sand
Sandy Clay
Sandy Clay Loam
Sand
Sand, Gravel & Cobbles
Shale
FIGURE III-2
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT-UTAH
DRAINAGE INVESTIGATIONS
MULTIPLE PROFILE C-C & D-D
PROVO, UTAH
JAN. 1968
450-418-60


BURNS BENCH
IRRIGABLE
RIVER FLOOD PLAIN
MARSH
Burns Bench Canal
U.S. Highway No. 40
W.T. Observation Hole #26
W.T. Observation Hole #49
Offset 360 East
℄ County Road
Auger Hole for AHP-5
Rotary Drill Hole #2
℄ County Road
Marshy Tract bordering Water Fowl management area
W.T. 7-10-65
W.T. 3-15-66
ELEVATION IN FEET
4800
4750
45
40
35
30
25
20
15
10
5
4700
0+00
10+00
20+00
30+00
40+00
50+00
60+00
EXPLANATION
Clay
Clay Loam
Silty Clay Loam
Sandy Loam
Loamy Sand
Sandy Clay
Loam
Sand Gravel & Cobbles
Shale
Note:
1. Profile looking east
2. Vertical scale exaggerated for clarity
3. See map no. 450 - 418 - 49 for location of profile
4. Kf=permeability in inches per hour
FIGURE III-3
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT-UTAH
DRAINAGE INVESTIGATIONS
MULTIPLE PROFILE E-E
PROVO, UTAH
JAN. 1968
450-418-61

The escarpment separating the Burns Bench from the present river flood plain ranges in height from 3 to 10 feet. The northern part of this escarpment is not well defined. It is obscured somewhat by deposits of slope wash from the higher bench but appears to follow the 4,740-foot contour. This condition can be noted on drainage investigation Map No. 450-418-49 and Multiple Profile B-B. The river flood plain south of Jensen has been set aside as a game bird management area by the Utah Division of Wildlife Resources and is flooded much of the year. North of Jensen, however, the higher part of the river flood plain is cultivated and cropped, and the lower part is utilized as pasture. The cultivated lands have a favorable uniform slope toward the Green River of about 100 feet per mile and sufficient natural drainage to make cropping feasible.

The lowest lying lands of the present Green River flood plain north of Jensen have sufficient elevation above the river to make their use as pasture practical but are subject to periodic flooding. There is, however, a small amount of land on the present river flood plain north of the confluence of Brush Creek and Green River that has favorable elevation and topography such as to make its present use of high production improved pasture possible.

In general, the topography of these bench lands is well suited to irrigation, with the various land tracts being comparatively large and continuous and with moderate slopes that are favorable to irrigated agriculture.

As previously stated, irrigable lands located adjacent to Brush Creek on the present Brush Creek flood plain consist of about 780 acres or approximately 19 percent of the total unit lands. This flood plain is 15 miles long, with a variable width ranging from about 500 to 1,500 feet. The lands are situated adjacent to the creek in about 50 separate tracts. The tracts range from about 3 to 50 acres in size and vary from about 200 feet to nearly 1,000 feet in width. The Brush Creek channel is entrenched to depths varying from 6 to 15 feet below the adjacent borders of irrigable lands. These lands are comparatively smooth, with a significant gradient component toward the Brush Creek channel. These favorable topographic conditions are conducive to good drainage of these lands.

Subsurface Characteristics

Origin and occurrence

As indicated under "Geology," the subsurface materials of the Jensen Unit lands have been deposited primarily by the Green River and consist of two principal layers. The upper layer consists of fine-textured alluvial material. Underlying this fine-textured material is a layer of sand, gravel, and cobble. This layer of coarse material is in turn underlain by the Mancos shale formation.

An analysis of the logs of subsurface exploration holes of the Sunshine Bench shows that the depth of fine-textured material in the southern part of the bench ranges to beyond a maximum explored depth of 25 feet at the upper edge of the bench near the Sunshine Canal. In the middle of the southern part of this bench, as indicated by Multiple Profile D-D, the fine-textured alluvium averages about 20 feet in depth, with another 20- to 25-foot layer of coarse gravel and cobble material situated between the fine alluvium and the shale barrier. On the northern part of the bench, data collected regarding an abandoned cased private well (see Multiple Profile A-A) indicate that the depth-to-barrier materials range to about 65 feet, which is composed of about 20 feet of fine alluvium and 45 feet of highly permeable sand, gravel, and cobble material.

The fine-textured materials of Sunshine Bench have been derived from the adjacent shale hills to the northwest of the bench. Underlying these fine-textured materials are sand and gravel deposited by the Green River. Due to the difficulty in drilling this material and since there were no water tables encountered anywhere within the depth of exploration on Sunshine Bench, no holes were drilled through the gravel layer to the underlying shale.

Subsurface materials of the Burns Bench are much the same as Sunshine Bench except that the fine alluvium that overlies the sand and gravel material is not so deep as on Sunshine Bench. This condition is graphically illustrated by Multiple Profiles A-A, B-B, and D-D. The fine alluvial material of Burns Bench has been deposited partly by the Green River and partly by erosion of the fine alluvial soil mantle of the higher Sunshine Bench. Depths of the fine alluvial material on Burns Bench range from more than 25 feet as shown in observation hole 16 located just below the escarpment that separates the Burns and Sunshine Benches to a minimum of about 2 feet near the outer perimeter of the Burns Bench (see Multiple Profile B-B). Multiple Profile D-D shows that the gravel and cobble material is nearer the surface along the outer perimeter of the bench. It should also be noted from this profile that the underlying shale surface is higher along the outer perimeter of the Burns Bench than it is toward the Sunshine Bench escarpment. As is discussed in the section on "Permeability and Barrier," the shallower depths to gravel along the outer margin of Burns Bench are particularly significant with regard to the drainage requirement in the southern end of the bench near the community of Jensen. Accordingly, this part of the bench, approximately 700 acres, has been divided into two drainage requirement tracts. Tract A embraces the outer margin of the area where the depth to gravel ranges from about 1.5 feet to 10 feet. Tract B covers the inner portion where the depth to gravel is over 10 feet. The boundaries of these tracts are shown on Map No. 450-418-49. As on Sunshine Bench, the fine alluvial material is underlain with gravel and cobble set in a matrix of sand. Since there are water tables near the surface on a large part of Burns Bench, a number of rotary drill holes were drilled to the shale barrier that underlies the cobble and gravel material. These holes show that the cobble layer overlying the shale ranges in thickness from about 10 to 18 feet.

There is a limited acreage of the Jensen Unit lands situated on the present and recent flood plains of the Green River. Soils of these lands have been deposited as a result of frequent flooding by the Green River. The subsurface explorations on these flood plain lands have revealed that the predominant texture is clay loam to a depth of about 10 feet. Some of these lands are underlain with gravel at a depth of about 2 feet (refer to observation hole 13, Multiple Profile A-A). There appears to be no correlation of texture and depth from one subsurface exploration site to another on these river flood plain lands. This condition is undoubtedly due to the many years of lateral and vertical cutting and redeposition by the Green River.

As previously stated, there are many scattered tracts of project land situated on the Brush Creek flood plain. The soil consists of fine-textured alluvium to depths of about 10 feet. The parent material of the alluvium is weathered shale and sandstone from the escarpments that rise above the Brush Creek flood plain. In places the alluvium is underlain with varying thicknesses of gravel and cobble which in turn, with one exception, are underlain with shales and sandstones of the Mancos shale formation. As discussed under "Geology," a short reach of the Brush Creek lands is underlain with the Morrison formation.

Soil texture and structure

As was stated in the preceding section, the subsurface materials of the two benches and the present Green River flood plain that comprise the Jensen Unit are composed of two principal layers. The lower layer of the two principal layers is composed of sand, gravel, and cobble in a matrix of relatively clean sand material. This well graded material ranges in size from medium sand through the gravel sizes to a maximum cobble size of about 10 inches. This lower layer material has been found to underlie all of the Jensen Unit area. Due to this, it will not be discussed further for each topographic subdivision.

An analysis of the logs for the explorations in the upper layer that consists of fine alluvium shows that there is some variation of texture with respect to the two different benches, the present Green River flood plain and the Brush Creek flood plain. The fine alluvium of the Sunshine Bench is predominantly clay, with a slightly smaller amount of clay loam and loam textures. This high percent of clay would be due to slope wash of the weathered shale from the adjacent low shale hills being deposited mainly on this upper bench.

Soil structures noted in these soils are fine crumb, moderately subangular, and also some single grain; however, the fine crumb structure predominates. Coloration of the Sunshine Bench soils ranges from light brown to brown.

The soils and subsurface materials of the Burns Bench are somewhat lighter textured than the higher Sunshine Bench. The predominant soil texture on this bench is a clay loam. Other soil textures found on the bench in decreasing order of occurrence are loam, clay, sandy loam, and sandy clay.

Soil structures noted on this bench are similar to those of the Sunshine Bench; namely, fine crumb, moderately subangular, and also single grain. The fine crumb structure is again predominant. Burns Bench soils are predominantly light brown to brown in color.

Soil and subsurface materials of the lands on the present Green River flood plain are similar in texture to the lands of the Burns Bench. The clay loam texture is, however, somewhat more predominant than is found on Burns Bench. Soil textures in order of decreasing occurrence are clay loam, clay, loam, and sandy loam.

The soil structure found in the soils of the present river flood plain is predominantly fine crumb, with moderately subangular and single-grain structure also noted. Soils of the present river flood plain are light brown to brown in color.

Soils and subsurface materials on lands that are situated on the Brush Creek flood plain are predominantly clay and clay loam with blocky structure. Other soil textures found in this locality are loam and sandy loam.

Permeability and barrier

As previously discussed under "Investigations," permeability tests were concentrated on the drainage distress lands which will be provided project drainage. The locations of these permeability test sites can be noted on Map No. 450-418-49. As has been previously described under origin and occurrence, the drainage distress area was divided into two drainage requirement tracts on the basis of the differences in the depth of the finer alluvial materials over the gravel and cobble and a correspondingly wide variation of permeability rates of the fine alluvial material and the underlying strata of gravel and cobble. The boundaries of these tracts are shown on Map No. 450-418-49. Table 1 is a summary of the permeability tests and related data for tract A in which the drainable zone is within the gravelly and cobbly material exclusively. As indicated in the table, the average depth of materials tested is between the average cobble surface at 3.9 feet and the shale surface at an average depth of 19.8 feet. The average permeability rate for this depth range of cobbly material is 59.1 inches per hour. A few shallow auger hole permeability tests were also conducted in tract A; but, due to the shallow depth to cobble, these tests were almost always confined to a shallow depth above 4 feet and therefore were not used in determining drain spacing within tract A.

Table 1
Summary of permeability tests
Tract A

Pumping test site No.	Depth-to-gravel or cobble (feet)	Depth range of material tested (feet)	Permeability (inches/hour)	Depth-to-shale barrier (feet)
RDH-1	4.0	2.5-19.0	64.0	19.0
RDH-3	6.5	2.4-26.0	65.3	26.0
RDH-4	1.5	4.6-19.0	84.8	19.0
RDH-5	5.0	3.0-22.0	1/	22.0
RDH-7	2.5	2.4-20.0	62.0	20.0
RDH-8	5.0	2.5-15.0	19.2	15.0
Average	3.9		59.1	19.8

1/ The measured permeability rate at RDH-5 was extremely high (273 inches per hour); and, due to its location at the outer fringe of the tract, it was not considered to be representative of the area. As a result, it was not included in the determination of the average permeability of the tract.

In tract B there were nine auger hole bailout permeability step tests conducted. As indicated in Table 2, these tests were made in the fine alluvium above the cobble to depths of as much as 13 feet. As further indicated, the average permeability of these fine-textured materials is 2.2 inches per hour.

Table 2
Summary of permeability tests
Tract B

Auger hole bailout (AHP) permeability test site No.	Depth-to-gravel or cobble (feet)	Depth range of material tested (feet)	Permeability (inches/hour)	Depth-to-shale barrier (feet)
AHP-3	9.3	2.9- 8.9	4.2	1/19.0
AHP-4	2/Over 12.0	2.9-10.6	3.5	28.5
AHP-5	2/Over 11.0	1.8-10.8	4.7	1/20.0
AHP-7	2/Over 14.0	5.5-10.0	1.8	1/20.0
AHP-14	9.5	6.9- 9.6	.9	1/20.0
AHP-15	2/Over 10.0	1.1-10.2	1.5	1/20.0
AHP-16	2/Over 16.1	4.3-13.1	1.1	1/26.0
AHP-17	2/Over 12.3	3.5-10.3	.6	1/20.0
AHP-21	7.1	2.2- 7.1	1.7	1/20.0
Average	Over 11.3		2.2	Approx. 22

1/ Depths-to-shale were estimated from known data at the rotary drill holes or multiple profile located in the near vicinity of the respective bailout (AHP) permeability test sites.

2/ Cobble was not encountered in six of the nine holes drilled at the test sites.

In comparing permeability rates of these fine-textured subsurface materials versus depth, it was found that at most test sites permeability rates increased with depth. The coarser-textured materials found at deeper depths would no doubt account for this condition. There is little doubt that the higher permeabilities in the gravels and cobbles below would yield a much higher permeability for figuring the conventional drain-spacing requirements for tract B, but to be conservative this phenomenon was purposely not considered. As will be noted in the table, the underlying shale was considered to be the barrier on both tracts.

Multiple Profiles C-C, D-D, and E-E show the logs of typical subsurface explorations tabulated in Tables 1 and 2 for tracts A and B, respectively. Superimposed on these logs are the permeability rates for the depth range of material tested.

In addition to the auger hole permeability tests run within the drainage-deficient tracts A and B, there were four tests run farther to the north on lands of the Green River flood plain. Three of these tests were run on lands that were eventually found to be infeasible to drain due to their low elevation with respect to the water surface in the Green River. These lands were placed in a 6W land class. The average permeability rate for these three tests was 1.1 inches per hour. The one other auger hole permeability test was run on irrigable permanent pasture land of the Green River flood plain. Here the weighted permeability was found to be 2.7 inches per hour, which is favorable in connection with other factors in maintaining good production.

No permeability tests were conducted on the upper parts of Burns Bench, Sunshine Bench, or lands of the Brush Creek flood plain because the deep water table conditions found in those areas indicate that permeability rates and barrier depths are adequate for good natural drainage when considered in conjunction with the other favorable drainage characteristics.

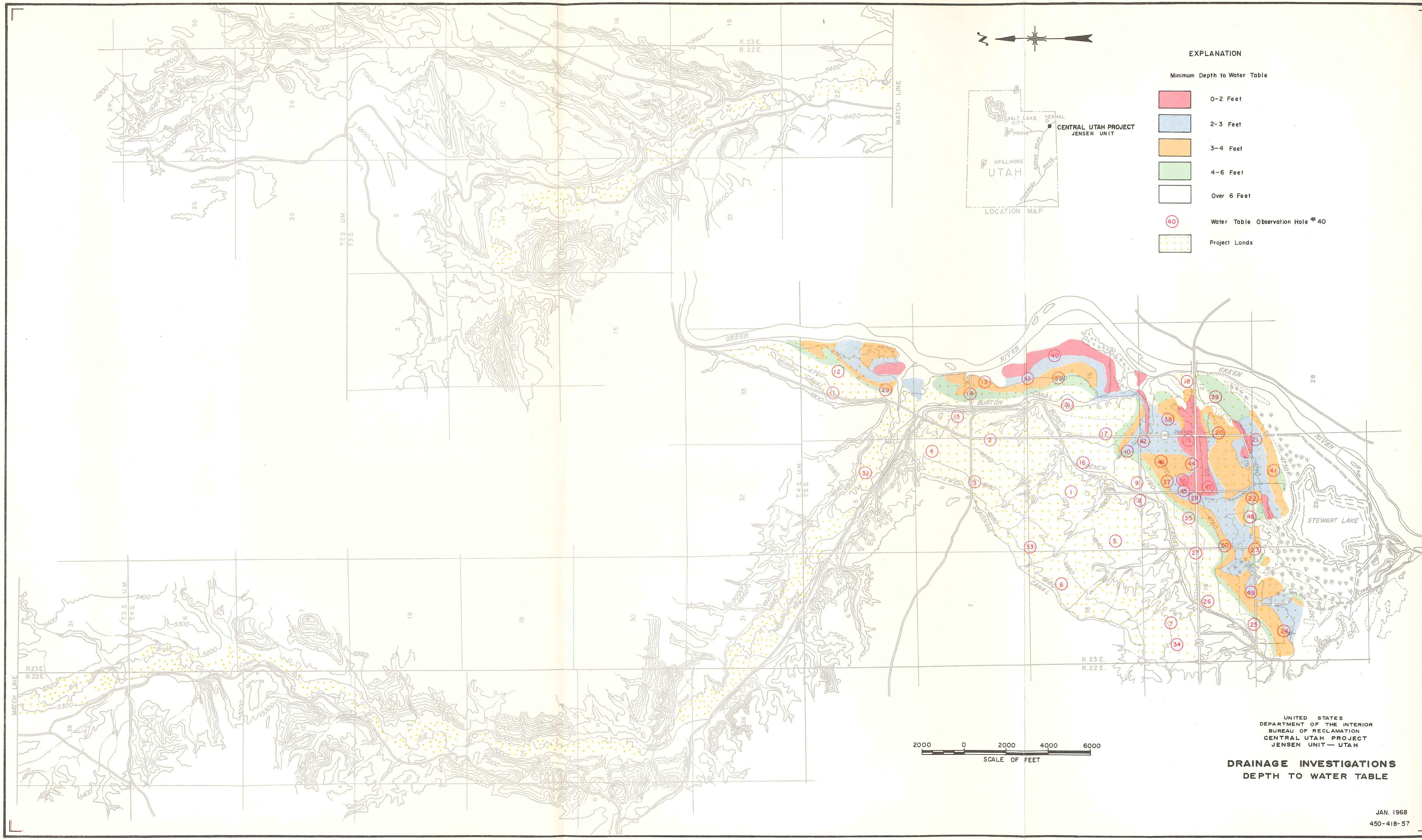
Water Table Characteristics

General

Lifelong residents of Jensen have reported that the present high water table problems on the irrigated lands have existed for many years. The continual practice of irrigating excessively during the period of high spring runoff has contributed to the drainage distress of most of the high water table areas. These areas are, however, quite stable as evidenced by 10 years of water table observations beginning in 1957.

Occurrence

The extent of water tables on Jensen Unit lands and depths of these water tables below the ground surface are shown on Map. No. 450-418-57.


EXPLANATION
Minimum Depth to Water Table
0-2 Feet
2-3 Feet
3-4 Feet
4-6 Feet
Over 6 Feet
Water Table Observation Hole # 40
Project Lands
LOCATION MAP
SALT LAKE CITY
PROVO
VERNAL
FILLMORE
UTAH
CENTRAL UTAH PROJECT
JENSEN UNIT
MATCH LINE
R. 23 E.
R. 22 E.
T. 2 S. U.M.
T. 3 S.
T. 4 S. U.M.
T. 5 S.
GREEN RIVER
BURTON CANAL
BURNS BENCH CANAL
SUNSHINE CANAL
STEWART LAKE
Brush Creek
Big Brush Creek
Jensen
2000 0 2000 4000 6000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT — UTAH
DRAINAGE INVESTIGATIONS
DEPTH TO WATER TABLE
JAN. 1968
450-418-57

Delineated on this map are irrigated lands with water tables that range from 0 to 6 feet below ground surface in increments of 0 to 2, 2 to 3, 3 to 4, and 4 to 6 feet and land with a water table in excess of 6 feet below the ground surface. The minimum depth-to-water tables as shown on this map represent a water table level which is sustained for a period of about 2 weeks. In many cases sharp peaks resulting from a single irrigation rise above the indicated levels, but since they are of short duration they are not considered damaging to plant growth.

It should be noted that during the subsurface explorations, there were no water tables encountered on Sunshine Bench to an explored depth of 25 feet. Subsurface explorations and subsequent water table observations have also revealed that along the higher, steeper slopes of the Burns Bench (lands lying adjacent to Sunshine Bench), water tables range from about 10 to 15 feet below the ground surface. On the flatter land in the southern part of the Burns Bench, and also on the present Green River flood plain lands, water tables range from 0 to 6 feet below the ground surface as may be noted on the depth-to-water table map.

As illustrated on this map, about 71 percent of the irrigable lands of the Jensen Unit has a water table that remains over 6 feet below the ground surface, 7 percent has a water table between 4 and 6 feet, 11 percent between 3 and 4 feet, 9 percent between 2 and 3 feet, and 2 percent that is between 0 and 2 feet below the ground surface for a minimum period of about 2 weeks.

About 700 acres of land are located in the southern portion of the Burns Bench that have been delineated as irrigable but drainage deficient in their present condition. These lands have minimum depths-to-water tables that are less than 4 feet from the surface.

In addition, a small acreage of irrigable land is located on the present Green River flood plain immediately north of the confluence of Brush Creek and the Green River that has water tables that are less than 4 feet from the ground surface.

No water table observation holes were installed on the scattered tracts of irrigable lands along the Brush Creek channel. Essentially, however, none of the 5-foot land classification holes drilled during the irrigation season encountered a water table. This healthy water table condition was also evidenced by good crop production on these lands.

Source and movement

The primary source of contribution to the ground water table is deep percolation from irrigation. During periods of excessive irrigation in the spring, deep percolation is also excessive which tends to aggravate the drainage distress areas. Leakage from canals is not considered to be excessive or a major problem in the Jensen area.

The movement of water on the Jensen area benches is predominantly toward the Green River. There are, however, small components of flow toward the few and relatively shallow channels or washes that extend from the upper bench escarpment into the lower bench and river flood plain.

Since there are no irrigated lands located above the Brush Creek flood plain that contribute any surface or ground water to the flood plain area, the only source of water that contributes to the water tables on these lands is deep percolation from irrigation. Movement of the ground water on these lands is primarily toward the Brush Creek channel which provides adequate subsurface drainage relief to all adjacent irrigable lands.

Fluctuation

The 1962-66 period of record of irrigation diversions to Jensen Unit lands was selected as the period to represent the water table occurrence and fluctuation patterns in the area. The existing water supply for these years approximates the total water supply under project conditions, and therefore water table conditions for this period can also be anticipated under project operations. Project drainage, however, will alter this to the extent of providing adequate water table control on project lands.

Figure III-4 with hydrographs of observation holes 17 and 25 shows the water table fluctuations on lands that are not subject to high water tables. These observation holes are located in a favorable position on Burns Bench (see map No. 450-418-57 for location). The magnitude of water table fluctuation for these lands varies from a high of about 6 feet to a low of about 9 feet below the ground surface. The sharp rise in water table corresponds with the beginning of the irrigation season. When the irrigation season begins in late May or early June, the water table rises sharply and peaks with every irrigation. The rate of water table decline after the application of irrigation water ceases indicates that these lands have good natural drainage capacity.

Figure III-5 with hydrographs of water table fluctuations in observation holes 19, 21, and 36 shows the typical water table conditions on irrigable lands that are subject to high water tables. These observation holes are located in tracts A and B which, as previously described, are located in the southern part of the Burns Bench. Water tables on these drainage-deficient lands vary from a maximum depth of about 8 feet during the winter months to a minimum of about 2 feet below the ground surface during the irrigation season. It can be noted that water tables rise sharply with the beginning of the irrigation season. Staying relatively high, the water tables continue to fluctuate with a peak at each irrigation. At the end of the irrigation season, the water table levels generally show a slow declining trend, reaching maximum depths of 5 to

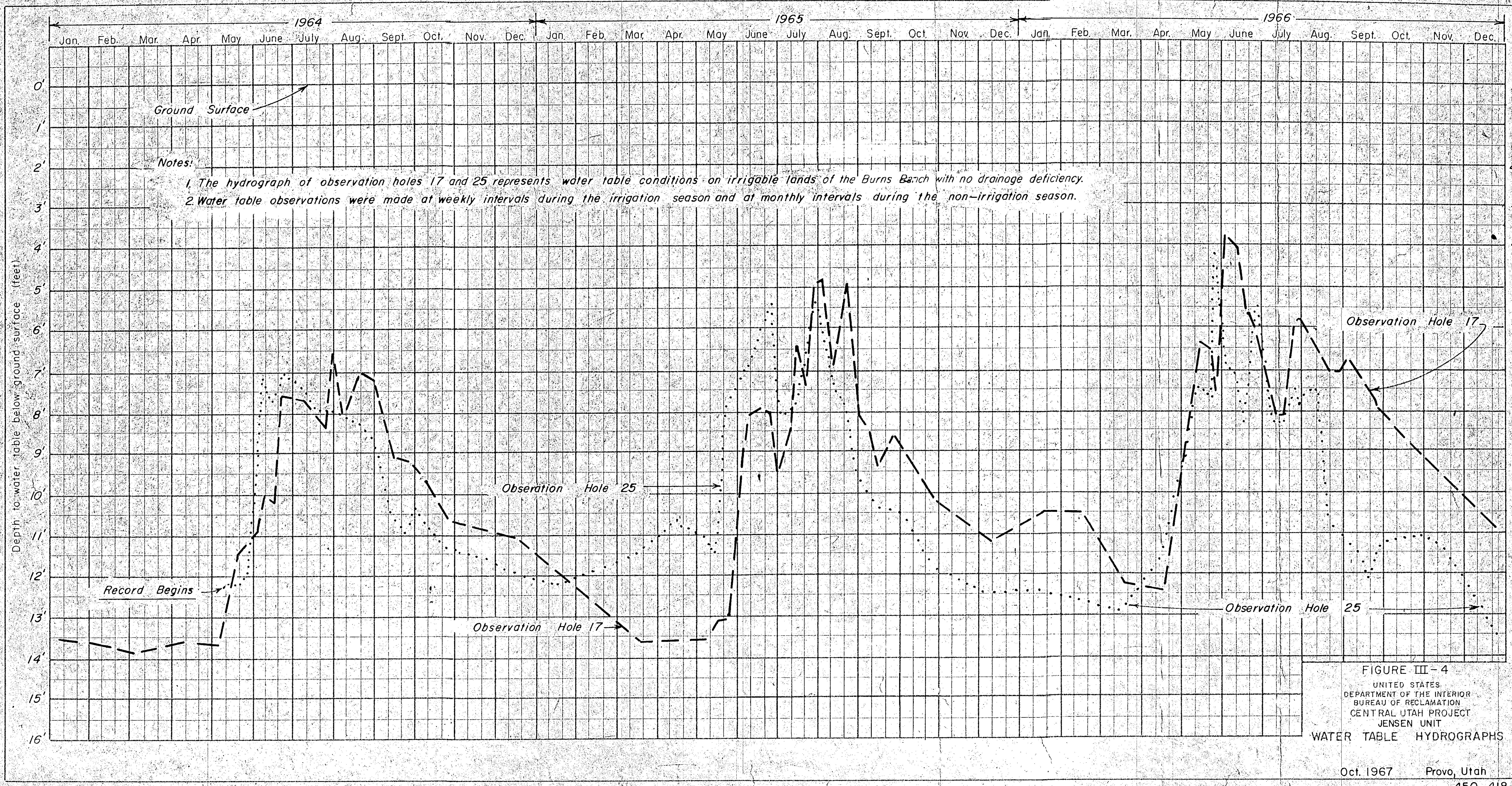


FIGURE III-4
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT
WATER TABLE HYDROGRAPHS

Oct. 1967 Provo, Utah

450-418-56

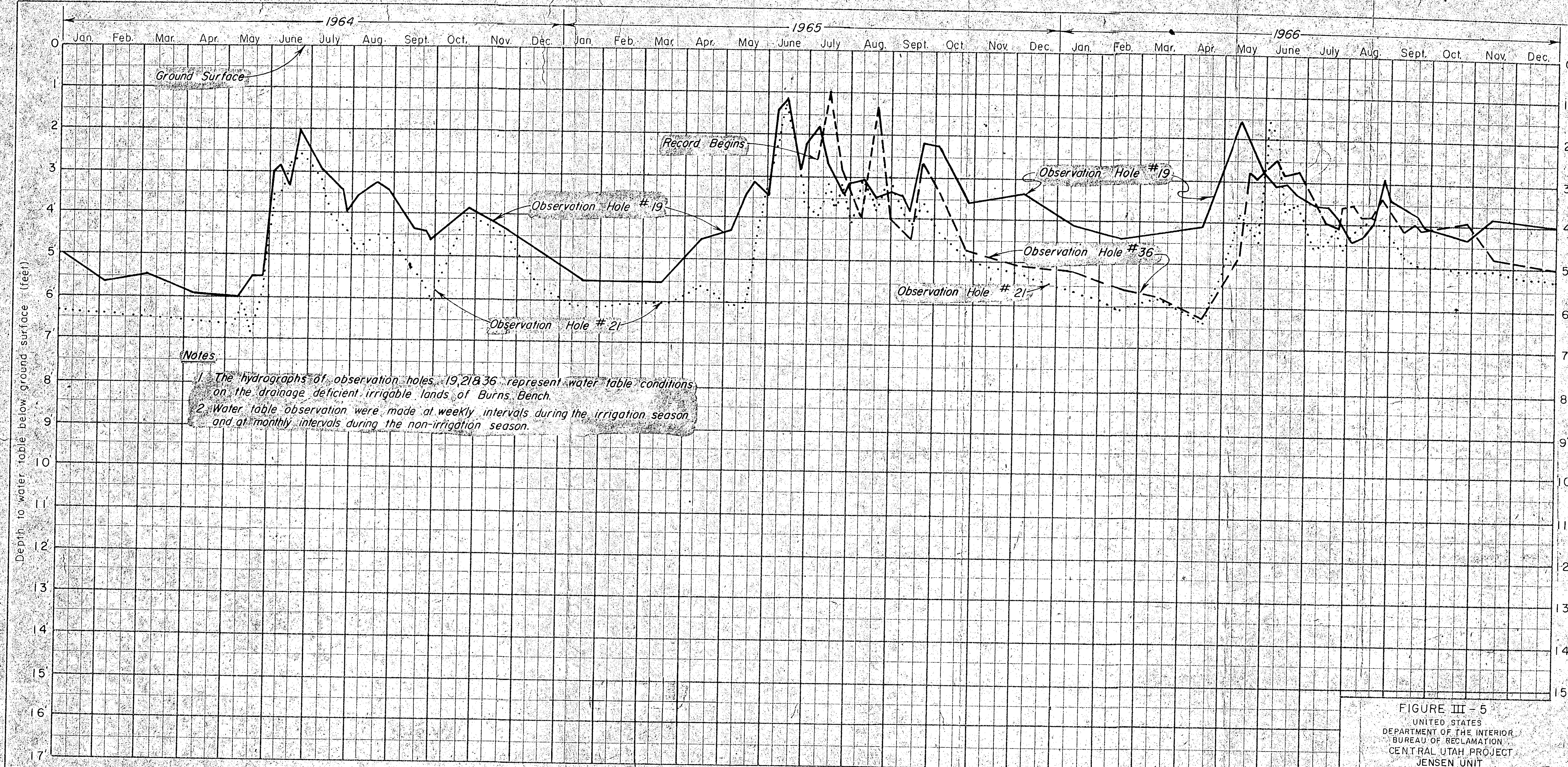


FIGURE III - 5
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT
WATER TABLE HYDROGRAPHS

Oct. 1967 Provo, Utah

450-418-55

7 feet prior to resumption of irrigation for the following season. These relatively high winter water table levels and trends are evidence that the natural drainage capacity in the area is inadequate in spite of high subsurface permeability of the underlying gravels. The probable reason for the water table remaining comparatively high during the winter is that the water table gradients are limited by the relatively flat barrier surface and in some places reverse gradients of the shale barrier (see Multipe Profile D-D and C-C).

Irrigation Supply

As previously mentioned, the waters of Brush Creek were first diverted in 1878 for use on Jensen Unit lands. After that time, irrigation became increasingly more extensive in the area until 1896 when the flows of Brush Creek were considered to be fully appropriated and were adjudicated by court decree. Since that time little new land has been placed under irrigation. In 1962 a 16-second-foot capacity pump was installed on the banks of the Green River to supplement the irrigation needs of the Burns Bench Canal.

Present conditions

A comparison of the present water deliveries (by major canals for the 1962-66 period of record) with the ideal irrigation requirements is shown in Table 3 on the following page. This summary indicates that the average annual diversion for all major canals is equivalent to a full irrigation requirement on an annual basis but does not occur in the desired distribution. For instance, during the high flow period in April, May, and June, 0.64 acre-foot per acre is diverted in excess of the ideal requirement, whereas an irrigation shortage exists in July and August. This is the general pattern for each of the canals; however, the average annual diversion (1962-66 period) varies from 2.81 acre-feet per acre for the Sunshine Canal to 4.50 acre-feet per acre for the Burton Canal. The reason for the wide variation in diversions is due to a corresponding difference in water rights of the individual canal companies.

A review of the Brush Creek flows over the long time period, 1930-66, also indicates that the average irrigation season diversion to the Jensen Unit lands has slightly exceeded the ideal requirement on a total irrigation season basis with excessive diversion in the early spring and shortages in the summer.

Project conditions

Under project operation, storage of early season excess flows would be provided by the proposed Tyzack Reservoir. The stored water would be released to satisfy industrial and municipal project demands plus some late-season demands of project lands. Thus it is anticipated

Table 3
Ideal farm irrigation requirements
compared with present irrigation deliveries
(Based on 1962-66 period of record)

	April	May	June	July	August	September	October	Total
Percent	4.8	16.0	24.1	27.8	21.4	4.3	1.6	100
	Acre-feet per acre							
Ideal farm delivery	0.15	0.50	0.76	0.88	0.67	0.14	0.05	3.15
Present farm delivery								
Average--all canals 1/	.31	.84	.90	.55	.32	.23	.09	3.25
Sunshine Canal	.23	.79	.83	.61	.25	.10		2.81
Burns Bench Canal	.31	.68	.79	.52	.35	.29	.13	3.07
Burton Ditch	.43	1.32	1.33	.56	.40	.31	.15	4.50
Murray Ditch	.43	1.10	1.10	.47	.33	.26	.13	3.82

1/ Includes only the four major canals here shown. Excluded are several very small canals serving the scattered tracts along the Brush Creek Channel.

that the excessive irrigation now being diverted during the spring would be mostly eliminated.

The only irrigated lands which would receive a significant increased supply over past conditions are lands on the Sunshine Bench where about 0.3 acre-foot per acre would be added. Also the 440 acres of new land would receive a full supply of 3.15 acre-feet per acre at the farm. These new lands are scattered throughout the project on Burns Bench, Sunshine Bench, and on Brush Creek flood plain.

It is anticipated that this small total increase in supply to project lands will not change the favorable drainage conditions on adequately drained lands but may slightly degrade the conditions of the drainage-deficient lands.

Quality of Water

Irrigation supply

Brush Creek and the Green River are the present sources of irrigation water to the Jensen Unit.

Big and Little Brush Creeks head in the Uinta Mountains to the northwest of Jensen at an elevation of about 10,500 feet above sea level, then join to form Brush Creek about 15 miles north of Jensen. Melt water from the winter snow pack and mountain springs is the source of water in this stream. At least part of the water supply for the Jensen Unit would be diverted from Brush Creek through regulation by the proposed Tyzack Reservoir.

A program of sampling the waters of Brush Creek has been carried on by the Bureau of Reclamation for several years. From several sampling sites on Brush Creek the location referred to as "Brush Creek above Burns Bench Canal heading" was selected as being most representative of the Brush Creek water diverted for use on lands of the Jensen Unit. From the time the sampling program was started in 1958 to early 1966, a total of 54 water samples was collected and analyzed. The average total dissolved salts above the Burns Bench Canal heading were 430 parts per million for the period of study. With an average sodium percentage of 10 percent and an average boron content of only 0.12 part per million, this water presents no hazard to crop production in the project area.

The waters of the Green River, another source of supply for the Jensen Unit, are similar in quality to Brush Creek. The Green River waters, however, carry considerably more sediment than Brush Creek waters. The sampling station chosen to be representative of the Green River water that would be supplied to the Jensen area is "Green River near Jensen." A water quality sampling and analysis program for this station has been carried on by the Bureau from May 1960 to the present time and is being continued. During this period a total of 43 water samples has been collected and a complete analysis made in the Regional laboratory. These tests indicated that the total dissolved salts averaged only 370 parts per million for the period of study. The sodium content averaged 31 percent and the boron content 0.16 part per million. With these low salt concentrations the waters of Green River are also considered to be of good quality for any crop adapted to the Jensen Unit.

For additional detail on water quality see the Water Supply Appendix.

Drainage water

In order to ascertain the quality of the drainage water of the Jensen Unit, a sampling program was initiated in 1964 on a shallow existing drain in the project area and also on a natural seep at the lower fringe of the area. A total of 35 samples has been collected and analyzed in the Regional laboratory from these two sampling stations. In addition, water samples were collected at the beginning and end of eight different pumping permeability tests conducted in holes drilled through the cobble to the underlying shale. The electrical conductivity for these 16 water samples was determined in the Office of Utah Activities laboratory.

A total of 15 water samples was collected from the shallow drain on project lands. The analysis for these samples showed an average total dissolved salt content of 1,870 parts per million. The average sodium adsorption ratio was found to be 2.8. These waters are currently being used for irrigation with no visible adverse effects. The reason is that the principle salt is calcium sulfate which is not injurious to crops grown in the area. Under any plan, however, to reuse this water as part of the project water supply, it would be diluted sufficiently to reduce the concentration to about 1,000 parts per million.

The quality of the natural seeps is very similar to that of the drain.

The average total dissolved salts for the 16 samples collected in connection with the eight permeability pumping tests were about 2,200 parts per million. Again, an analysis made of these samples showed that the salts are predominantly calcium sulfate. In the case of drainage by pumping, however, these waters will be diluted with irrigation water of better quality if they are to be used for irrigation purposes.

Salinity and Alkalinity

The salinity and alkalinity data for the Jensen Unit indicate that the irrigated irrigable lands have no appreciable problem from soluble salts. An analysis of the laboratory data shows a range of salt contents from a high of about 0.37 to a low of 0.02 with an average of about 0.08 percent salt in the upper 10 feet of the profile on the irrigated irrigable lands.

Irrigated irrigable lands with the highest concentration of salt are located on the Sunshine Bench and are situated adjacent to the shale hills that form the western boundary of the Jensen lands area. These soils are influenced by the high salt content of the marine shale from which they were derived. In most cases, the salt content found on irrigated lands increased with depth.

On irrigated nonirrigable lands, the salt concentrations are somewhat higher, averaging about 0.36 percent with a range of concentration from 0.07 to 1.27 percent.

Jensen Unit lands with the highest salt concentrations are the nonirrigated tracts that are scattered throughout the unit area. This observation clearly points out the effectiveness of the leaching process carried out on the irrigated land.

With the small amount of additional water of good quality to be supplied by the project to presently irrigated lands, little or no change is expected in the saline sodic content of the soils and subsurface materials. On new lands to be irrigated, however, some leaching of salts will take place resulting in a decrease in the saline content of the upper profile.

Drainability

Land with no drainage deficiency

It has been determined as a result of the comprehensive drainage investigation, along with the land classification data, that about 3,400 acres or 85 percent of the irrigable lands of the Jensen Unit have adequate natural drainage capacity for continued irrigation and good crop production under project conditions. These lands, with no drainage deficiency, are located on the Sunshine Bench, parts of the Burns Bench, the present Green River flood plain, and the Brush Creek flood plain.

The favorable drainage characteristics of these lands that are located on Sunshine Bench are as follows:

1. Adequate depth-to-barrier. Depths-to-barrier materials exceed the explored depth of 25 feet. Indications are that the depth-to-barrier materials on the southern part of the bench would be about 45 feet with about 20 feet of this material being highly permeable sand, gravel, and cobble. On

the northern part of the bench, indications are that depths-to-barrier materials range to as much as 65 feet with about 45 feet of highly permeable sand, gravel, and cobble material.

2. Favorable topographic position. No irrigated lands are situated at a higher elevation that would contribute, either through surface or subsurface flow, to a general buildup of water tables on Sunshine Bench.

3. Surface gradients of the irrigable lands are adequate for good surface drainage. Slopes of these lands range from about 60 to 100 feet per mile and facilitate good surface drainage.

4. The southern part of the bench is dissected by natural drainage channels that extend from its eastern escarpment back into the bench. These natural channels provide outlet for surface runoff and subsurface drainout.

The existing conditions that contribute to adequate natural drainage on part of the Burns Bench lands are as follows:

1. Adequate permeability and depth-to-shale barrier. The depth-to-barrier in this area exceeds about 20 feet (refer to Multiple Profile C-C and D-D) with about 15 feet of highly permeable sand and gravel overlying the barrier.

2. Adequate gradients for good surface drainage.

A portion of the present Green River flood plain has adequate natural drainage for the following reasons:

1. Gradients of the higher, steeper lands are such that surface runoff is good and subsurface drainout to the river is not restricted.

2. Adequate barrier depth. As projected from known data on the southern part of Burns Bench, barrier depths are estimated to be at least 20 feet.

The favorable drainage characteristics of those lands located on the Brush Creek flood plain are as follows:

1. Well developed river channels. The Brush Creek channel has entrenched to a depth of 6 to 15 feet and provides subsurface drainage relief to the adjacent small scattered tracts of irgated lands.

2. Adequate gradients for good surface drainage. Gradients range from 120 to 160 feet per mile.

3. Short irrigated fields. The irrigated fields extend from about 200 feet to a maximum of about 1,000 feet from the Brush Creek channel which makes this channel more effective as a natural drain.

4. Permeability is adequate for good natural drainage capacity when coupled with other favorable drainage characteristics.

Land with a drainage deficiency

Irrigable Lands

Approximately 700 acres or 15 percent of the irrigable land of the Jensen Unit are presently drainage deficient. These lands are all located on the Burns Bench and will receive project drainage.

The predominant factor that makes drainage of these lands feasible is the very high permeability rates of the underlying coarse sand, gravel, and cobble material. The conditions which contribute to their natural drainage deficiency are as follows:

1. An undulating surface that results in a number of topographic lows in which much of the irrigable land is situated. Both surface and subsurface water collect in these lows resulting in high water tables.

2. Relatively flat surface gradients, especially in the topographic lows; slopes in these places range from about 10 to 20 feet per mile longitudinally along the lows.

3. Absence of natural channels within the topographic lows to provide sufficient surface or subsurface drainout of the adjacent lands.

4. Poor topographic position resulting in surface runoff and subsurface drainout from higher irrigated lands causes elevated water tables on the lower-lying, flatter drainage-deficient lands.

5. A reverse gradient of the shale barrier which limits the gradient of the water table thus reducing the volume of water that can move through the subsurface materials (see Multiple Profile D-D).

Nonirrigable Lands

Those lands of the Jensen Unit that are located on the present river flood plain and are subject to high water tables have the following drainage deficiencies:

1. Low topographic position with respect to the high flow elevations of the Green River. This condition limits the subsurface drainout to the river.

2. No well developed natural drainage channels to convey surface runoff to the river or to provide relief for subsurface water.

Drainage Requirement--Conventional Drainage System

The drainage requirements of the drainage-deficient land tracts of the Jensen Unit have been estimated using presently accepted Bureau of Reclamation criteria as developed and discussed in the Investigations Chapter (Chapter II) under the topic, "Determination of Drainage Requirements--Conventional Drainage System." The following is a tabulation of specific criteria upon which the drain spacing for each drainage requirement tract was based.

1. Depth of drains	10.0 feet
2. Minimum depth-to-water table	4.0 feet
3. Specific yield	10.0 percent
4. Farm delivery requirement (as determined by the Water Resources Branch)	3.15 ac.-ft./ac.
5. Irrigation interval	21 days
6. Number of irrigations per season	6
7. Application--each irrigation	0.525 ac.-ft./ac.
8. Deep percolation--each irrigation	0.0525 ac.-ft./ac.

The following is a summary of the estimated drainage requirements for each drainage requirement tract as determined using the previously mentioned criteria.

Drainage requirements

	Tract A	Tract B	Total
Permeability rate (feet/day)	118.2	4.4	
Average barrier depth (feet)	19.8	22.0	
Drain-spacing requirement (feet)	6,670	1,390	
Length of drains required (miles)			
Open (outlet)	0.9	0.5	1.4
Closed (lateral)	1.6	3.1	4.7

After the drain-spacing requirements were calculated, a tentative layout was made of the entire drainage system. The layout includes the closed tile lateral drains and the open outlet collector drains that will discharge the water into either the Green River or the Stewart Lake Waterfowl Management Area that lies adjacent to the Green River.

Included in the drainage system are 4.7 miles of closed lateral drains and 1.4 miles of open outlet drains. The open outlet drains will serve as an outlet for the closed lateral drains and will also receive surface waste water from the surrounding irrigated lands where present surface drainage systems are inadequate. This would eliminate the need for any project surface drains in connection with the conventional drainage plan.

The tentative drain layout was made for cost estimating purposes and is on file at the Office of Utah Activities.

Drainage Costs--Conventional Drainage System

The cost estimate for the conventional drainage system for the Jensen Unit was made on a per mile basis. Originally the Columbia Basin Project drain costs were used as the basis for the cost estimate of the Jensen Unit drains. Since that time local experience has been gained in the Vernal Unit which is here applied as a basis for the Jensen Unit drainage cost. These costs, as shown below, are indexed to the January 1975 price level.

Summary of costs--conventional drainage system

Type of drain	Total length (miles)	Contract cost (per mile) 1/	Total cost (per mile)	Total cost
Open outlet drain	1.4	$67,500	2/$126,900	$178,000
Closed lateral drain	4.7	67,500	2/126,900	596,000
Total	6.1			774,000

1/ Based on information available from the Vernal Unit, there is no justification for showing a difference in cost as betwen open and closed drains.

2/ These costs include field contingencies estimated to be 25 percent and engineering and overhead estimated to be 50 percent.

The total estimated drainage construction cost of $774,000 represents a cost of about $189 per acre based on a total of 4,080 acres of project lands or $1,100 per acre based on the 700 acres of drainage-deficient land.

Drainage Requirement--Pumping Method

As was related in Chpater II after completion of the detailed studies it became evident that, in spite of these detailed studies, it was impossible to forecast the total well requirement for the project; and if such an estimate were to be made it would not be reliable. For preliminary cost comparative purposes, however, an evaluation was made of the most optimistic pump drainage plan. This pump drainage (alternative) plan included a battery of 11 shallow wells 12 inches in diameter and averaging about 20 feet deep, 11 small electrical pumping units, a pipe system for the disposal of drainage water, and 1 1/2 miles of surface drains.

The cost of such a plan proved to be competitive with the equivalent cost of the conventional drainage plan.

Selection of Drainage Plan

As previously indicated, the optimistic pump drainage plan would not be adequate in providing effective project drainage. This plan did not account for the complex array of geologic boundaries which become evident during the detailed studies.

Additional explorations, testing, and evaluations to provide a firm pump drainage plan would be very costly. Therefore, the additional cost coupled with the many unknown complex aquifer characteristics preclude further consideration of the pump drainage plan. As a result, the conventional drainage plan has been selected as the official drainage plan for the Jensen Unit.

GROUND WATER

GROUND WATER

Introduction and Purpose of Appendix

The Jensen Unit of the Central Utah Project would supply 18,000 acre-feet of municipal and industrial water to the Ashley Valley area, supplemental irrigation water to about 3,640 acres of presently irrigated land in the Jensen area, and a full irrigation supply to about 440 acres of new land in this same area. The project will also make possible more efficient use of water supplies to the Stewart Lake Waterfowl Management Area. In this appendix, the Jensen area is defined as those portions of the project service area located on Brush Creek and its tributaries and along the Green River in the vicinity of the town of Jensen. The Ashley Valley area is defined as that portion of Ashley Valley that can be served from the Ashley Valley water system. This area also includes the Ashley Valley Oil Field which is located at the southeast end of the valley. An illustration of these areas is shown on Plate I.

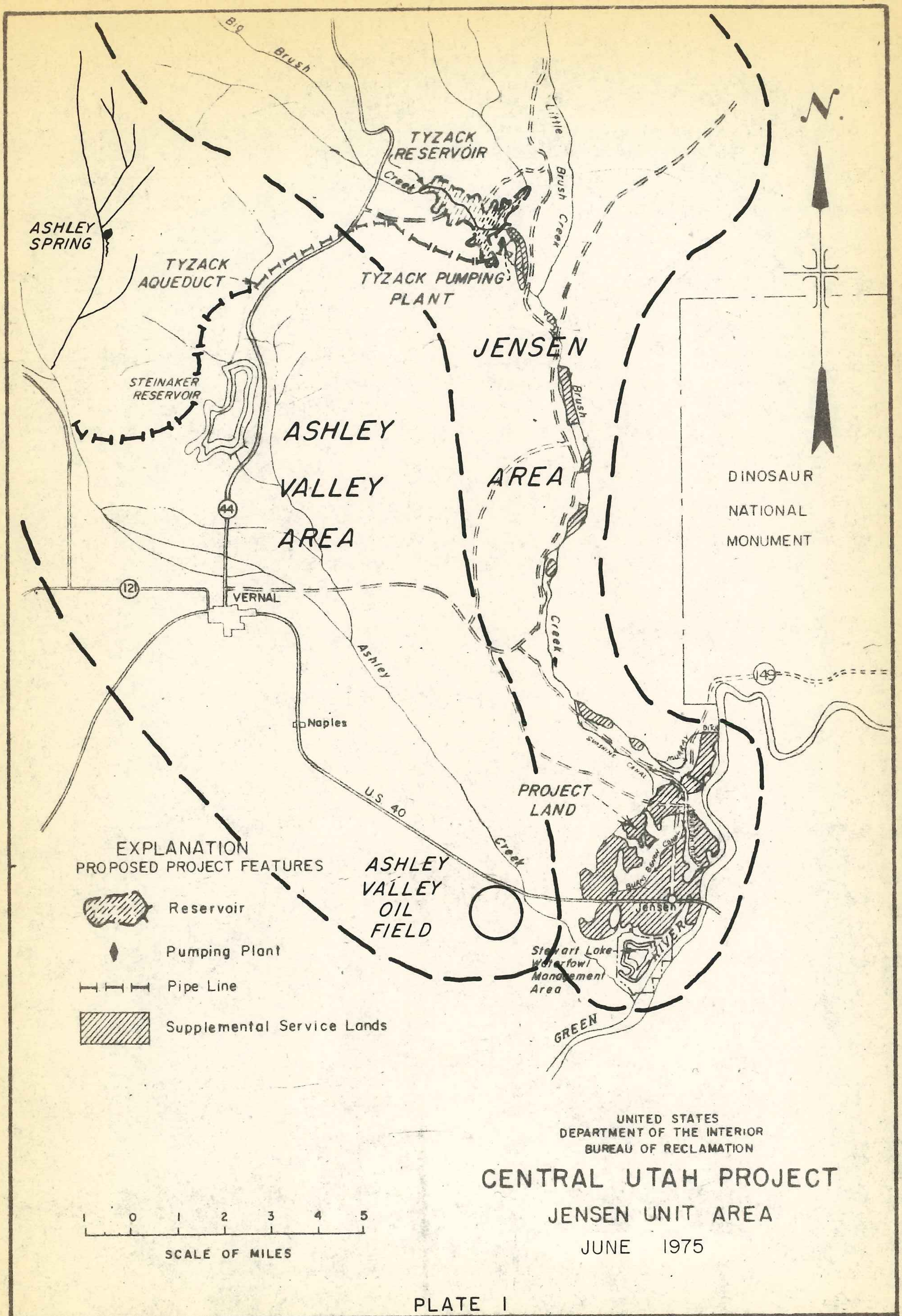
In reporting on the possible development of ground water as a source of project water, this appendix summarizes the data collected and results of studies made by several agencies. These include the Bureau of Reclamation, the U. S. Geological Survey, the U. S. Soil Conservation Service, the Utah Geological and Mineralogical Survey, the Utah Oil and Gas Conservation Commission, the Utah State Department of Health, the Utah Department of Natural Resources, and the Utah State Engineer.

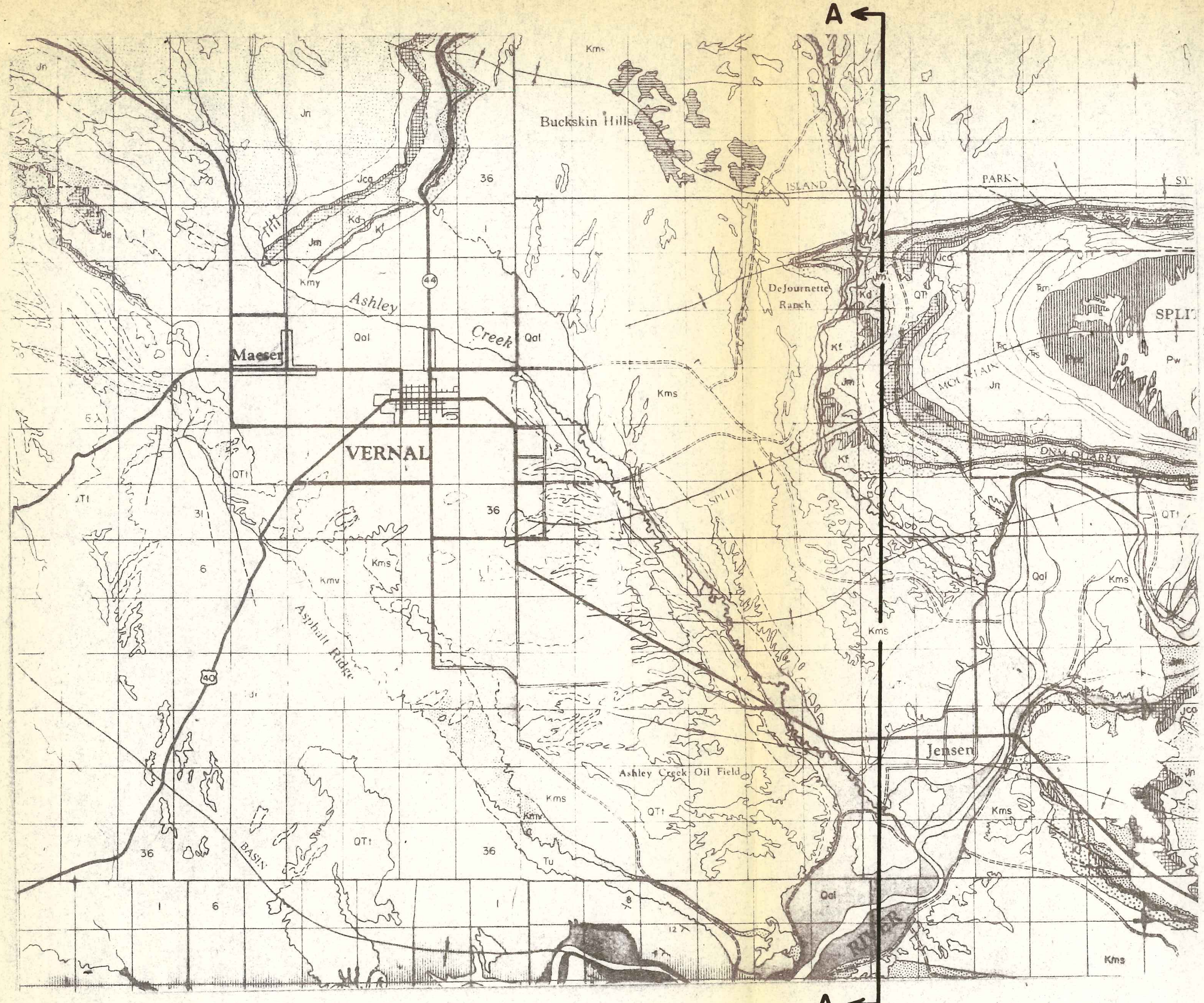
Geology

The Jensen Unit area is situated against the southeast flank of the Uinta Mountain Range in eastern Utah. Peaks in the Uinta Mountains range in elevation from 10,000 to 13,000 feet. The uplift which formed the mountains has warped the rock formations underlying the project area and in general has tilted them upward to the north, northwest, and northeast. Subsequent erosion has progressively exposed older rock formations. Distribution of these formations is shown on Plate II. The effect of erosion and how it has exposed the several formations is shown in the subsurface profile on Plate III.

Most of the area to receive project water is covered with a relatively thin layer of silt, sand, gravel, and cobbles (alluvium) with an average thickness of 27 feet. Immediately under the alluvium is a layer of Mancos shale with a thickness of up to 5,000 feet.

Table 1 categorizes the deposits found in the project area according to age, characteristics, thickness, and water-bearing properties.


Big Brush
TYZACK RESERVOIR
Creek
Little Brush Creek
N.
ASHLEY SPRING
TYZACK AQUEDUCT
TYZACK PUMPING PLANT
JENSEN
Brush
AREA
STEINAKER RESERVOIR
ASHLEY VALLEY AREA
DINOSAUR NATIONAL MONUMENT
44
121
VERNAL
Creek
Ashley
149
Naples
PROJECT LAND
U.S. 40
Creek
ASHLEY VALLEY OIL FIELD
Jensen
Stewart Lake Waterfowl Management Area
GREEN RIVER
EXPLANATION
PROPOSED PROJECT FEATURES
Reservoir
Pumping Plant
Pipe Line
Supplemental Service Lands
1 0 1 2 3 4 5
SCALE OF MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT AREA
JUNE 1975
PLATE I



CENOZOIC *(Quaternary)*

Qal	Alluvium
QTt	Terrace deposits

MESOZOIC *(Cretaceous)*

Kmv	Mesaverde formation
Kms	Mancos shale
Kf	Frontier sandstone
Kmy	Mowry shale
Kd	Dakota sandstone

MESOZOIC *(Jurassic)*

Jm	Morrison formation
Jc	Curtis formation
Je	Entrate sandstone
Jcd	Carmel formation
Jn	Navajo sandstone

MESOZOIC *(Triassic)*

₸c	Chinle formation
₸s	Shinarump conglomerate
₸m	Moenkopi formation

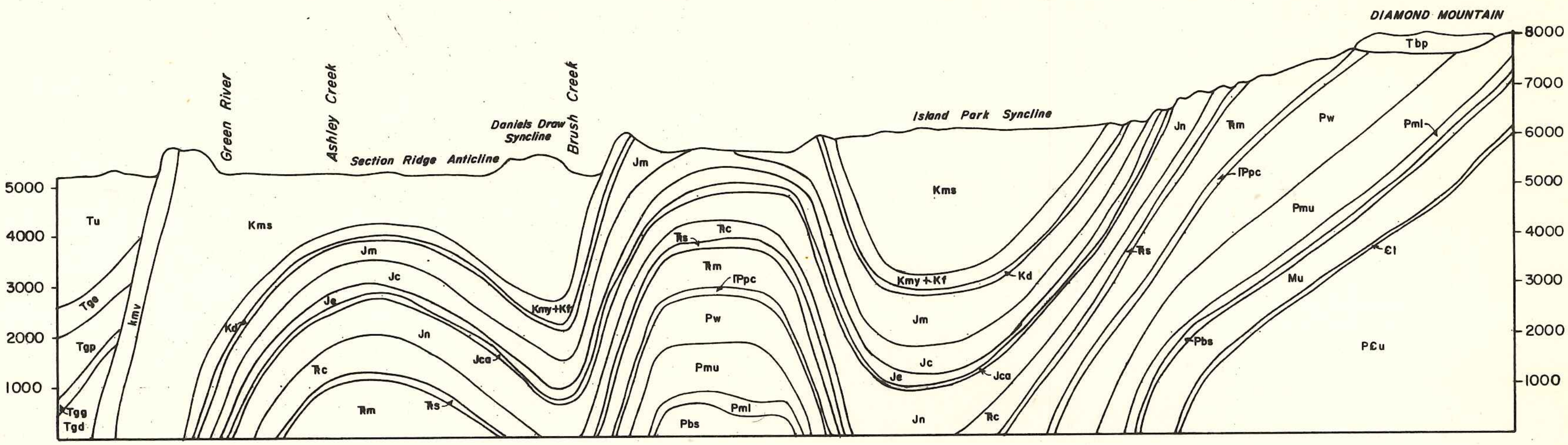
PALEOZOIC *(Permian)*

ℙpc	Park City formatio

PALEOZOIC *(Pennsylvanion)*

Pw	Weber sandstone

Plate II- Stratigraphic distribution of rock formations in the Jensen Unit area



LEGEND

CENOZOIC *(Tertiary)*

Tbp	Browns Park formation
Tu	Uinta formation
Tge	Evacuation Creek (Green River formation)
Tgp	Parachute Creek (Green River formation)
Tgg	Garden Gulch (Green River formation)
Tgd	Douglas Creek (Green River formation)

MESOZOIC *(Cretaceous)*

Kmv	Mesaverde formation
Kms	Mancos shale
Kf	Frontier sandstone
Kmy	Mowry shale
Kd	Dakota sandstone

MESOZOIC *(Jurassic)*

Jm	Morrison formation
Jc	Curtis formation
Je	Entrata sandstone
Jca	Carmel formation
Jn	Navajo sandstone

MESOZOIC *(Triassic)*

Ꞧc	Chinle formation
Ꞧs	Shinarump conglomerate
Ꞧm	Moenkopi formation

PALEOZOIC *(Permian)*

ꟾPpc	Park City formation

PALEOZOIC *(Pennsylvanian)*

Pw	Weber sandstone
Pmu	Morgan formation
Pml	Round Valley
Pbs	black shale unit

PALEOZOIC *(Mississippian)*

Mu	Mississippian undivided

PALEOZOIC *(Cambrian)*

Ꞓl	Lodore formation

PRECAMBRIAN

P-Ꞓu	Uinta Mountain Group

* Note: Profile adapted from the "Geologic Map of Uintah County, Utah" published by the Utah Geologic and Mineralogical Survey.

2 0 2 4

SCALE OF MILES

PLATE III — SUBSURFACE PROFILE A-A*

July 1968

Table 1 -- Generalized description and water-bearing properties of the principal rocks in the Jensen Unit area

System	Formation	Map symbol	Thickness (feet)	Description	Distribution and structure	Water-bearing properties
Quaternary	Alluvium and outwash gravel	Qao	1 - 60	Gravel, sand, and clay; generally unconsolidated	Gravel and sand are prominent on terraces and along stream channels. Flood plains and alluvial fans cover most stream valleys	Probably will supply water to shallow wells wherever it is more than 20 feet thick
Tertiary	Browns Park formation	Tbp	1 - 300	Conglomerate of rounded to subangular boulders in sandstone matrix	South slope of Uinta Mountains dipping gently away from mountains	Unknown
Cretaceous	Mesaverde formation	Kmv	400 - 1,200	Fine- to medium-grained sandstone, dark-gray shale, lignitic shale and lignite. Sandstone predominates in lower half of formation, and lignitic shale and lignite are present only in upper part	Crops out along the west and south edges of Ashley Valley. Probably underlies entire basin except in the Vernal-Split Mountain area	Probably can supply small quantities of water to wells from sandstone
	Mancos shale	Kms	1,000 - 5,000	Gray marine mudstone with eastward-thinning sandstone lenses	Crops out in the buckskin hills area and along the west edge and south half of Ashley Valley. Underlies the entire area.	Sandstone lenses may supply water to wells, which is likely of poor quality because enclosing shale contains gypsum
	Frontier Sandstone	Kf	200 - 280	Gray, tan or white, uniformly fine to medium grained and brown-weathering. Above the basal sandstone occur gray to brown lignitic and sandy shales with thin coal seams	Ridge & slope forming. Exposed along north side of basin and at Split Mountain	Basal sandstone has supplied small quantities of poor quality water to springs in Dinosaur National Park
	Mowry shale	Kmy	30 - 125	Hard, gray, silver-weathering siliceous shale	Ridge and slope forming. Crops out around base of Split Mountain and along north side of basin	Probably poor
	Dakota sandstone	Kd	34 - 50	Conglomeratic sandstone that represents advance of Cretaceous sea; transects time lines	Crops out north and northeast of basin. Probably underlies entire basin	Rock is probably too dense to supply water to wells in quantity

Table 1--Continued

System	Formation	Map symbol	Thickness (feet)	Description	Distribution and structure	Water-bearing properties
Jurassic	Morrison formation	Jm	745 - 1,000	Varicolored mudstone and claystone	Crops out north and northeast of basin. Probably underlies entire basin	Probably poor
	Curtis formation	Jc	150 - 300	Fossiliferous, glauconitic sandstone, shale, and sandy limestone	do.	do.
	Entrada sandstone	Je	100 - 240	Unfossiliferous, gray to buff, locally reddish, clear medium-grained quartz sandstone, Weathers to smooth, rounded backs and knobs	do.	Can supply small quantities of good water to wells
	Carmel formation	Jca	125 - 170	Soft red sandstone, shale, and siltstone. Contains 4 foot layer of gypsum north of Vernal	do.	Probably poor
Triassic	Navajo sandstone	Jn	700 - 1,000	Crossbedded, massive, poorly cemented, light gray to buff, fine to medium grained. Iron and calcareous concretions are common.	do.	Can supply moderate quantities of good water to wells near outcrop area on south slope of Uinta Mts. Quality of water may be poor where Navajo is 2,000-3,000 feet or more below surface
	Chinle formation	TRc	235 - 276	Red and varicolored calcareous shales with lenses of mud-silt conglomerates and sandstone	do.	Probably poor
	Shinarump conglomerate	TRs	35 - 75	Buffish, poorly sorted, conglomeritic quartz sandstone	do.	Can supply small quantities of good water to wells
	Moenkopi formation	TRm	700 - 950	Red beds of unfossiliferous sandstone, siltstone, and claystone both above and below a middle fossiliferous limestone member	do.	Probably poor due to the abundance of gypsum
Permian	Park City formation	Ppc	1 - 200±	Thick limestone with intercalated quartzite and sandstone	do.	Supplies water from springs in Ashley Creek Valley north of Vernal

Table 1--Continued

System	Formation	Map symbol	Thickness (feet)	Description	Distribution and structure	Water-bearing properties
Pennsylvanian	Weber sandstone	Pw	1,000 - 1,200	Massive, crossbedded, fine- to coarse-grained sandstone	Crops out north and northeast of basin. Probably underlies entire basin	In Ashley Valley field water produced from 4,000 ft. below surface is usable for irrigation
	Morgan formation	Pmu	1,100 - 1,300	Thick-bedded, cherty, fossiliferous limestone in lower member and red sandy shale, buff and red crossbedded sandstone, and thin beds of gray to pink cherty limestone in upper member	do.	Probably poor
Mississippian	Mississippian undivided. Probably includes rocks equivalent to Manning Canyon shale, Humbug formation, Deseret and Madison limestones	Mu	1,000±	Principally massive limestone with a black fissile shale unit at top	do.	May supply water from caverns or solution channels
Cambrian	Lodore formation	Єl	100 - 1,200	Thick-bedded, coarse-grained, arkosic sandstone and arenaceous shale	do.	Unknown
Precambrian	Uinta Mountain Group	p€v	12,000 - 20,000	Red, pink or white quartzitic sandstone, with thin shale partings, and thin-bedded sericitic and sandy shale interbedded with slabby sandstone	Forms core of Uinta Arch in eastern part of Uinta Mountains	do.

GROUND WATER

Ground Water Occurrence

Within the project area, ground water has been obtained from two major systems. The first system consists of shallow, unconfined water in the form of a water table in the alluvium. Water in this system is of poor quality, a factor that is discussed later in this appendix. This poor quality limits the possible use to irrigation. In addition, since this water is tributary to the fully appropriated surface streams in the area and development of the shallow ground water zones would deplete existing surface rights, the shallow ground water has been excluded as a possible source of project supply. An exception is the drainage waters delivered to the Stewart Lake Waterfowl Management Area. Only the unconfined ground water in the Jensen area will be discussed in this appendix. Some data relative to the unconfined ground water in the Ashley Valley area, however, will be used in tables and figures.

The second ground water system consists of confined artesian aquifers existing in various permeable layers of bedrock strata. Development and use from this system are also limited except where large yield, high quality bedrock springs are available. These large springs, however, are tributary to the surface streams and part of the existing surface supplies. Wells drilled into the bedrock aquifers are very expensive and generally have low yields and high pumping lifts. Except for utilization of the bedrock springs by exchange, development of ground water from the confined bedrock aquifers, likewise, has been excluded as a possible project water supply.

Unconfined ground water

Jensen Area

The unconfined ground water in the Jensen area occurs in the form of a shallow water table in the silt, sand, gravel, and cobble alluvium which overlies the Mancos shale.

The major source of recharge to the unconfined ground water aquifer occurs as the result of deep percolation of applied irrigation water, canal leakage, and seepage losses from surface streams as they cross porous alluvial deposits. Water table in the irrigated areas generally builds up during the period of irrigation and declines during the nonirrigation season. Water table increases of 4 to 8 feet are not uncommon during high flow periods in some areas. A hydrograph of a representative well near Jensen which shows this characteristic buildup is shown in Figure 1. Some recharge to the unconfined system also results from precipitation on the basin. This quantity, however, is limited due to an average precipitation of only 8 inches per year, much of which occurs as summer thunderstorms with both rapid runoff and high consumptive use.

Movement of water in the shallow aquifer is controlled to a large extent by the topography of the land and the underlying shale formation.

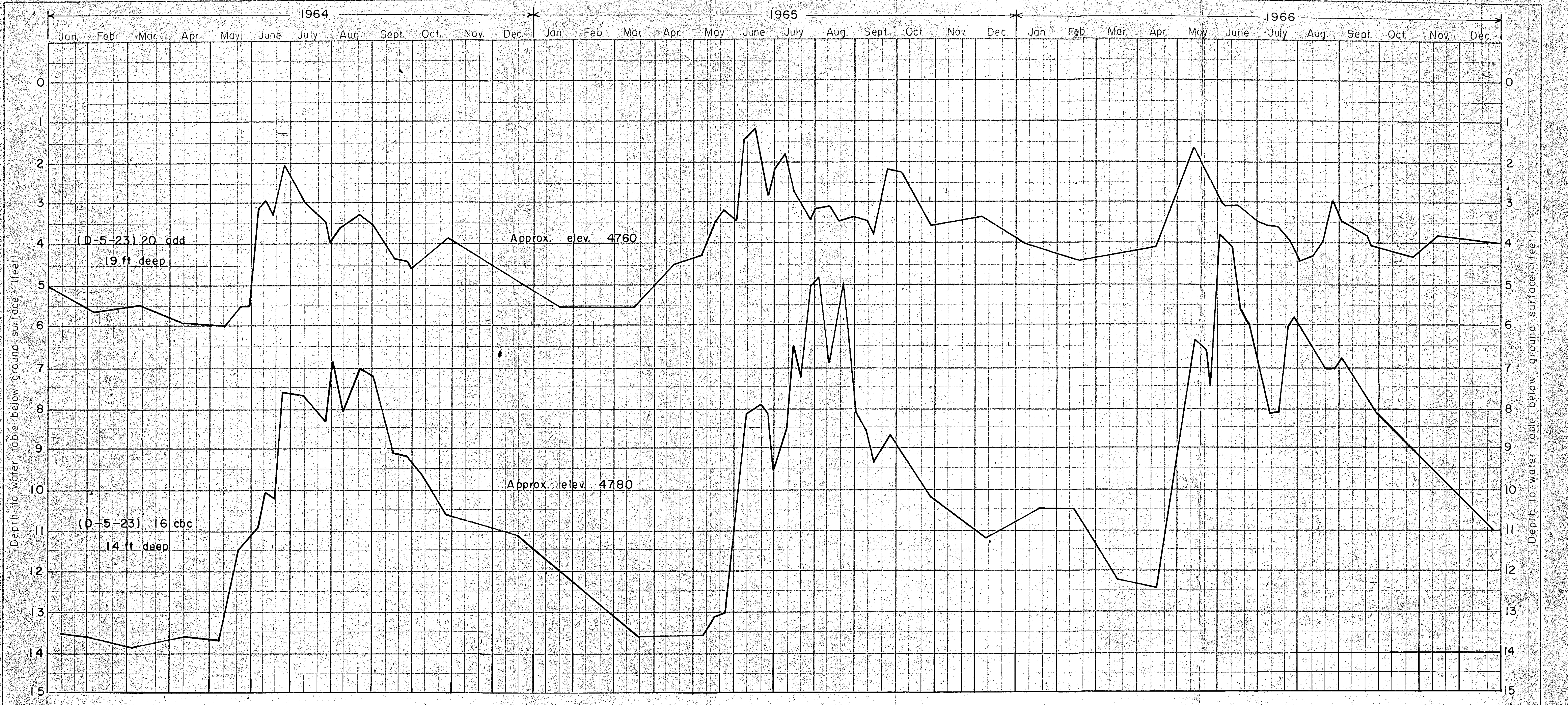


Figure 1. – Well hydrographs near Jensen, Utah

The direction of flow appears to follow the same pattern as surface runoff. Because of this, existing stream channels or natural drainageways act as open drains. In the Jensen area, the unconfined ground water is directly tributary to Brush Creek, the Green River, and Stewart Lake. Development of the unconfined aquifer could deplete the supply of these streams with the possible exception of Stewart Lake where some water could be saved from evapotranspiration loss.

Water rights on the surface streams in the Jensen area generally exceed the available flows except during short, high runoff periods.

Confined ground water

The confined ground water system consists of various water-bearing sandstone formations. These include the Weber, Dakota, Navajo, Entrada, and the highly fractured and cavernous limestones of the Pennsylvanian and Mississippian age. Of these, the principal aquifer with the best quality of water is the Weber sandstone. At the Ashley Valley Oil Field, water is obtained from the Weber at a depth of about 4,100 feet. In the portion of Ashley Valley located north of Vernal and also at the extreme north end of the Jensen area, the Weber is encountered at about 1,000 to 1,500 feet. This is due to the upward tilting rock formations.

Recharge to the confined aquifers occurs as precipitation and runoff over exposed areas of bedrock on the south flank of the Uinta Mountains and on Split Mountain northeast of Jensen. Some contribution probably occurs from deep percolation through fractures, faults, and solution caverns. Little, if any, recharge is received from the basin areas due to the great thickness and impermeable nature of the overlying shales. In addition, the piezometric surfaces of the aquifers are above the land surface in the lower elevations of the basin. This upward pressure tends to prohibit the entrance of downward percolating waters.

Ashley Spring, a relatively large (15 to 90 second-feet), high quality bedrock spring tributary to upper Ashley Creek, has been partly developed to supply the Ashley Valley public water system. About 3,000 to 4,000 acre-feet of high quality water is presently diverted for municipal and industrial use from this spring. An estimated additional 15,000 to 20,000 acre-feet of water could be diverted from Ashley Spring provided replacement is made to the downstream irrigators who presently use the water discharged by this spring. Ground water tracing tests, using fluorescent water tracer dyes, have recently been conducted by the Bureau of Reclamation and others. The tests showed that the recharge areas for the spring are the sinks and stream channel losses occuring on the upper reaches of the adjacent Dry Fork tributaries and that the water moves to the spring through solution channels, fissures, and joints in the Mississippian limestone formation.

Chemical Quality of Ground Water

The chemical quality of the ground water in the Jensen area varies considerably. An analysis of 61 water samples shows a range from about 250 parts per million (p.p.m.) to about 6,000 p.p.m. These dissolved solids occur in the water as sodium sulphate, calcium sulphate, magnesium sulphate, and calcium bicarbonate. The most common of these substances is the sulphate salts. The quantity of sulphate salts in the water is sufficient in many areas to cause cathartic effects. Figure 2 shows the relationship of sulphate to the total dissolved solids for water samples from wells, springs, and drains in the Jensen area.

Samples of Ashley Spring collected at the spring or at points along the Ashley Valley culinary system show the spring water to be a very high quality calcium bicarbonate type water with a reported TDS only in the 70- to 106-p.p.m. range. The water is chlorinated as it enters the upper end of the Ashley Valley system at Merkley Park.

A partial list of the recommended limits for mineral content of culinary water supplies serving 50 or more persons is shown in Table 2.

Table 2
Mineral limits for municipal water supplies*

Mineral	Recommended limit (p.p.m.)
Chloride	250.0
Fluoride	1.5
Iron	.3
Nitrate	45.0
Sulphate	250.0
Magnesium	125.0
Total solids	500.0

*As established by the U.S. Public Health Service.

Within the project area, ground water that meets the above standards or the extended standards shown on Figure 2 occurs in three areas:

(1) Springs, shallow alluvial wells, and deep bedrock wells located adjacent to high mountain drainages at the north end of Ashley Valley;

(2) Deep oil wells in the Ashley Valley Oil Field; and

(3) Springs, shallow alluvial wells, and deep bedrock wells located adjacent to high mountain drainages at the north end of the Jensen area.

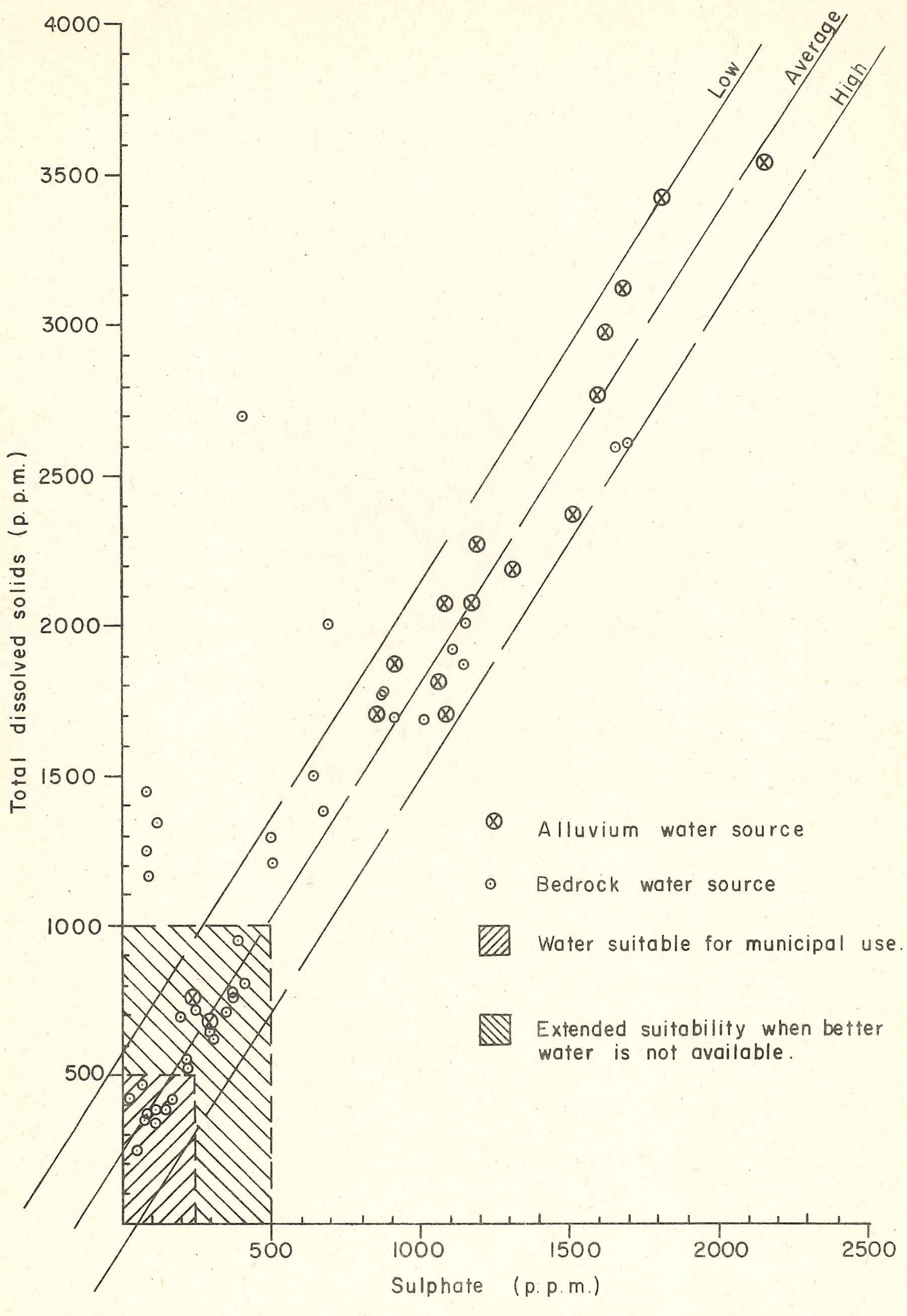


Figure 2 – Ratio of sulphate to total solids for ground water in the Jensen Unit.

GROUND WATER

Generally water produced from the unconfined ground water system is highly mineralized due to the underlying gypsiferous Mancos shale. Deep oil test wells scattered over the project area have occasionally encountered small quantities of highly mineralized water. Early reports also indicate the presence of excessive quantities of iron in water produced from deep bedrock wells. Table 3 summarizes the quality of water from wells.

Table 3
Summary of water samples from wells

Area	Samples	Total dissolved solids (average p.p.m.)	Principal water type
Bedrock wells			
North portions of of Ashley Valley and Jensen areas	7	569	Calcium sulphate 1/
Ashley Oil Field	22	810	Calcium sulphate 1/
Shallow wells			
Ashley Valley	25	1,252	Magnesium-calcium sulphate 2/
Jensen area	9	2,968	Calcium sulphate

1/ Sodium and bicarbonate also important constituents.
2/ Sodium and magnesium also important constituents.

Existing and Potential Well Development

Records of approximately 456 shallow and deep wells drilled in the Jensen Unit area were examined. Of these, about 73 percent contained some data useful to this study. Generally the yield from wells is low and the quality of water poor. The water table is high enough in most areas that many shallow wells are constructed by hand or with farm equipment. This poor method of well construction is largely responsible for the low yields. Well development in the project area can be divided into two types.

(1) Shallow alluvial wells drilled by or for individual users for small irrigation requirements, stockwater, or less commonly, domestic purposes and

(2) Oil test wells drilled in bedrock at great depths.

Table 4 shows the development of wells in the Jensen Unit area.

Table 4
Well development in the Jensen Unit area

Area	Aquifer	Number of wells	Depth (feet) Range	Depth (feet) Average	Yield (g.p.m.) Range	Yield (g.p.m.) Average
Ashley Valley area	Alluvium	179	5-100	29	1-125	21
Jensen area1/	Alluvium	78	5-70	18	1-65	24
Ashley Valley area2/	Bedrock	15	138-2,660	1,503	0-800	229
Ashley Oil Field	Bedrock	28	4,130-4,393	4,271	4-270	82
Jensen area3/	Bedrock	8	168-5,068	1,859	0-100	16

1/ Does not include the United States Bureau of Reclamation test wells drilled in 1968 or the Chevron Oil Company wells adjacent to the Green River.

2/ Includes only those wells located at the north end of the valley.

3/ Includes wells drilled at Dinosaur National Park which are near but outside the project area. Their yields are useful as an indicator of aquifer characteristics within the project area.

Ashley Valley area

The Jensen Unit of the Central Utah Project will provide municipal and industrial water for the Ashley Valley area. Most of the municipal and industrial water is to be delivered to Ashley Creek in exchange for high quality water diverted at the springs. The quality of the unconfined water in Ashley Valley is not suitable for municipal and industrial use (see Tables 2 and 3). Therefore, deep bedrock wells are the only wells discussed in this section.

The depth of the overlying Mancos shale prohibits the economic development of most bedrock wells. This is the case in the valley areas around and south of Vernal. North of Vernal, however, on the lower slopes of the Uinta Mountains the uplifted formations are nearer the surface. Several oil companies have constructed test wells in this area. A few of these encountered water in sufficient quantities and at depths that may warrant completion of the existing wells by private interests. The communities of Vernal and Maeser have both acquired water rights on various oil test wells; however, no real development has been undertaken. Maeser currently exchanges 2 second-feet of water from a flowing well just below Merkley Park in Ashley Canyon for better quality Ashley Spring water. A group of wells located about 1 to 2 miles west of Maeser in Coal Mine Basin has been intermittently used for irrigation. Most of the bedrock wells yield water with a fairly strong taste of iron. Filtration and possibly chlorination would be required to make these waters acceptable for culinary use.

The ability of an aquifer to produce water is indicated by the specific capacity of wells. Specific capacity is a ratio between the yield of a well and the drawdown at that yield. The relationship is such that the specific capacity decreases as the yield increases due to the natural friction and turbulence in the aquifer and efficiency of the well itself. Because of these characteristics, well performance plots as a curve and can be used to determine the maximum practical water production. Figure 3 shows specific capacity curves of bedrock wells in the north portion of Ashley Valley.

To adequately develop this source of water for municipal and industrial purposes would require complete development of existing wells, construction of several new wells, and a filtration plant to eliminate the objectionable taste.

Drilling deep wells in bedrock is very expensive. The yield of each well would probably be from 1 to 2 second-feet. The high cost of construction as compared with this relatively low yield makes development of this source of water economically infeasible.

Ashley Oil Field

The Ashley Oil Field is located on a 300-foot structural closure on the westward-plunging Section Ridge anticline. Oil and water are produced simultaneously. Hydrostatic pressures are sufficient to maintain flowing wells; however, pumps have been installed to increase the production of oil. This has also resulted in an increased yield of water. Approximately 2,400 acre-feet of water is produced annually from about 27 wells in the field. This is representative of a combined flow of about 3 1/3 second-feet. Chemical analyses of 22 of these wells show an average of only 810 p.p.m. of dissolved solids. This is considerably better than corresponding samples taken from lower Ashley Creek which flows nearby.

Local farmers have obtained rights to the water in the Ashley Valley Oil Field. By burning off the surface oil film, they have successfully irrigated with this water. It is felt, however, that project development of this source of water would not be practical and that its use can best be utilized through the current practice of individual filings on water as it is produced by the oil wells.

Jensen area

Development of wells in the Jensen area has been greatly hindered by low yields and poor quality. As shown in Table 3, the average content of dissolved solids is near 3,000 p.p.m. Most wells are poorly constructed and do not adequately penetrate the producing aquifers. Most oil test holes and water wells drilled in bedrock have been dry. One bedrock well located at the extreme north end of the Jensen area is reported to flow 100 gallons per minute (g.p.m.) from Weber sandstone 1,100 to 1,102 feet below ground surface. Aquifer depth and characteristics are the same as those in the north portion of the Ashley Valley area. Figure 3 shows the capability of bedrock wells in these areas.

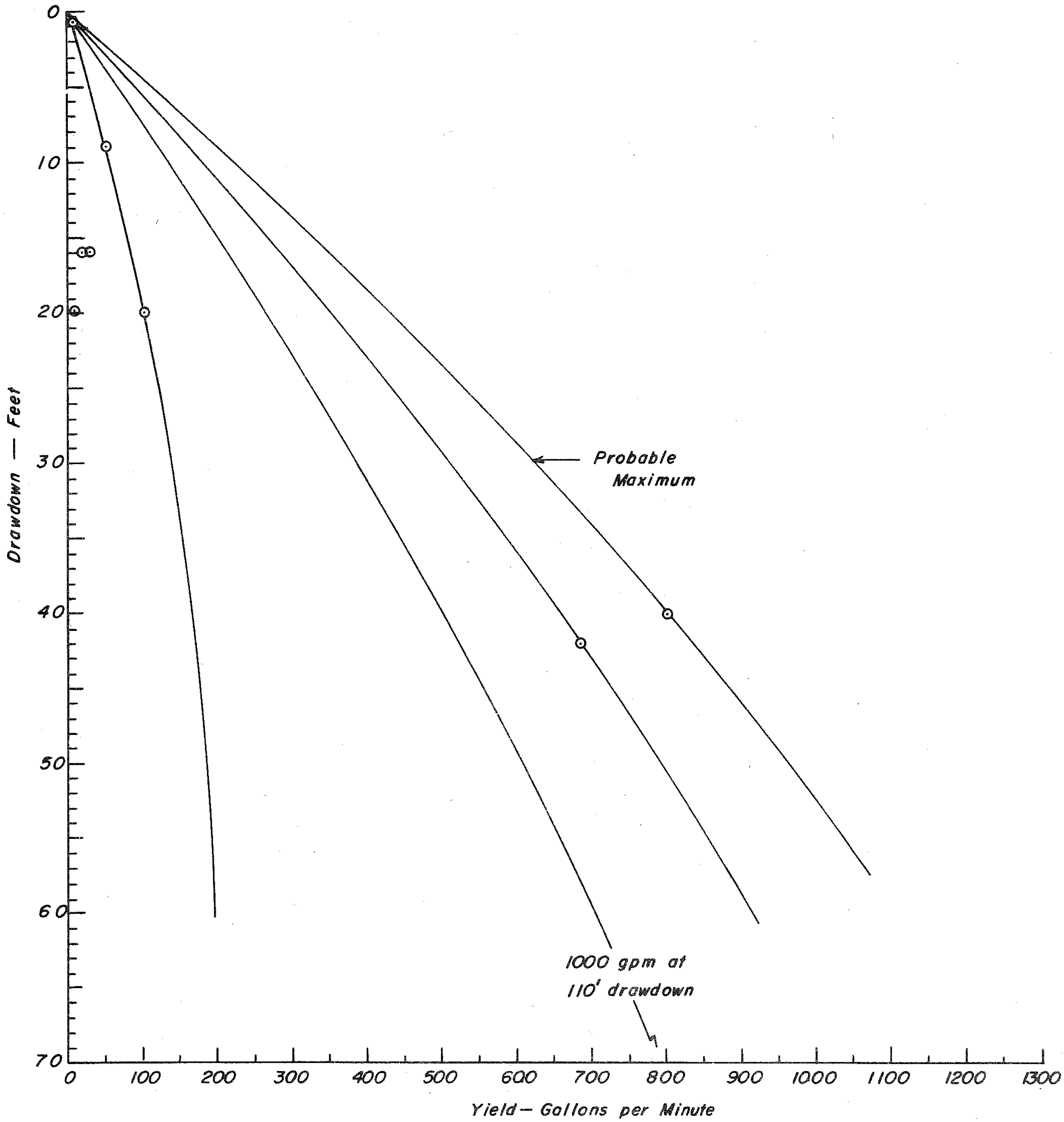


Figure 3 — Specific capacity curves for bedrock wells

GROUND WATER

The lands adjacent to Brush Creek and at the south end of the Jensen area are covered with a deposit of alluvial material averaging about 21 feet thick. Generally this lies on top of the Mancos shale which is up to 5,000 feet thick in this area. Much of the productivity of the land is hindered by a high water table. The average water level is only 5.8 feet below the ground surface, but in some areas it may range within 1 foot of ground surface. Several springs and seeps discharge naturally into a lower area along the Green River known as Stewart Lake. This lake is operated by the Utah Division of Wildlife Resources as a waterfowl management area.

A careful analysis of well logs in the south portion of the Jensen area indicates the presence of a competent gravel aquifer resting on top of the Mancos shale. Between 1961 and 1964 both the Rasmussen Ranch and the Chevron Oil Company constructed several wells along the Green River about 4 1/2 miles south of Jensen. These wells were of optimum design. They were drilled through the entire aquifer depth, special casing and screens were installed, and each well was gravel packed. When these wells were tested their yields ranged from 180 to 503 g.p.m. with only moderate drawdowns. During August 1968 the Bureau of Reclamation constructed two test wells near Jensen. These were also of optimum design. Extensive testing of these wells has been conducted. The specific capacity curves illustrated in Figure 4 show the potential of wells in this area. Preliminary analyses of water samples taken from the Bureau of Reclamation wells indicate total dissolved solids range from about 1,400 to 2,800 p.p.m. with about 30 percent sodium. Water of this quality ranges from permissible to unsuitable for irrigation. If used, this water would have to be mixed with better quality water from some other source.

Summary and Conclusions

1. Only limited quantities of water can be developed from wells in the Jensen Unit area.

2. Due to poor chemical quality the water would have limited application in the unit area.

3. Development of deep bedrock wells is not economically feasible.

4. Water from existing bedrock wells can best be utilized through private enterprise.

It is therefore concluded that well development should not be made a part of the Bureau of Reclamation's Jensen Unit plan.

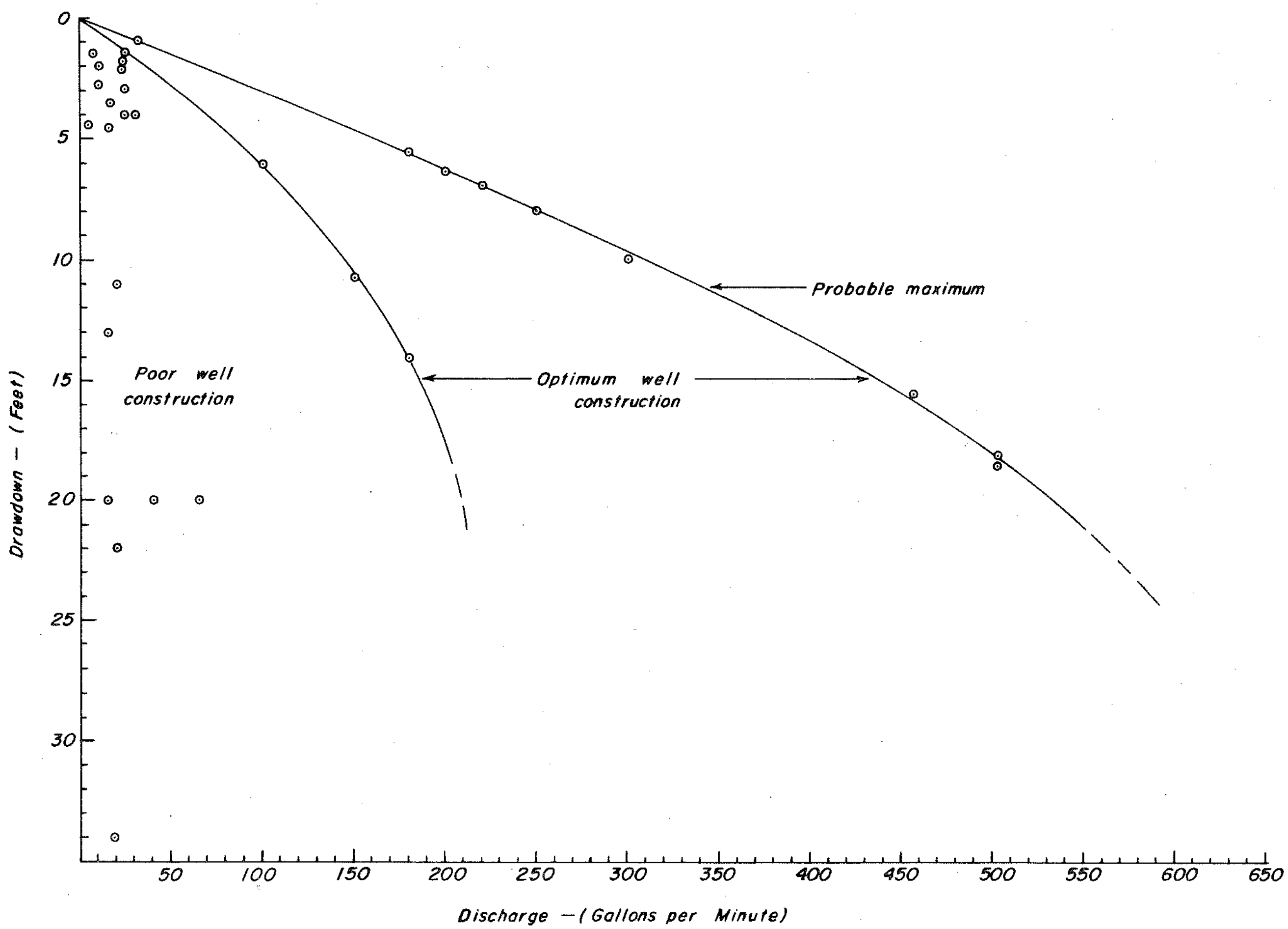


Figure 4.—Specific capacity curves for shallow alluvial wells