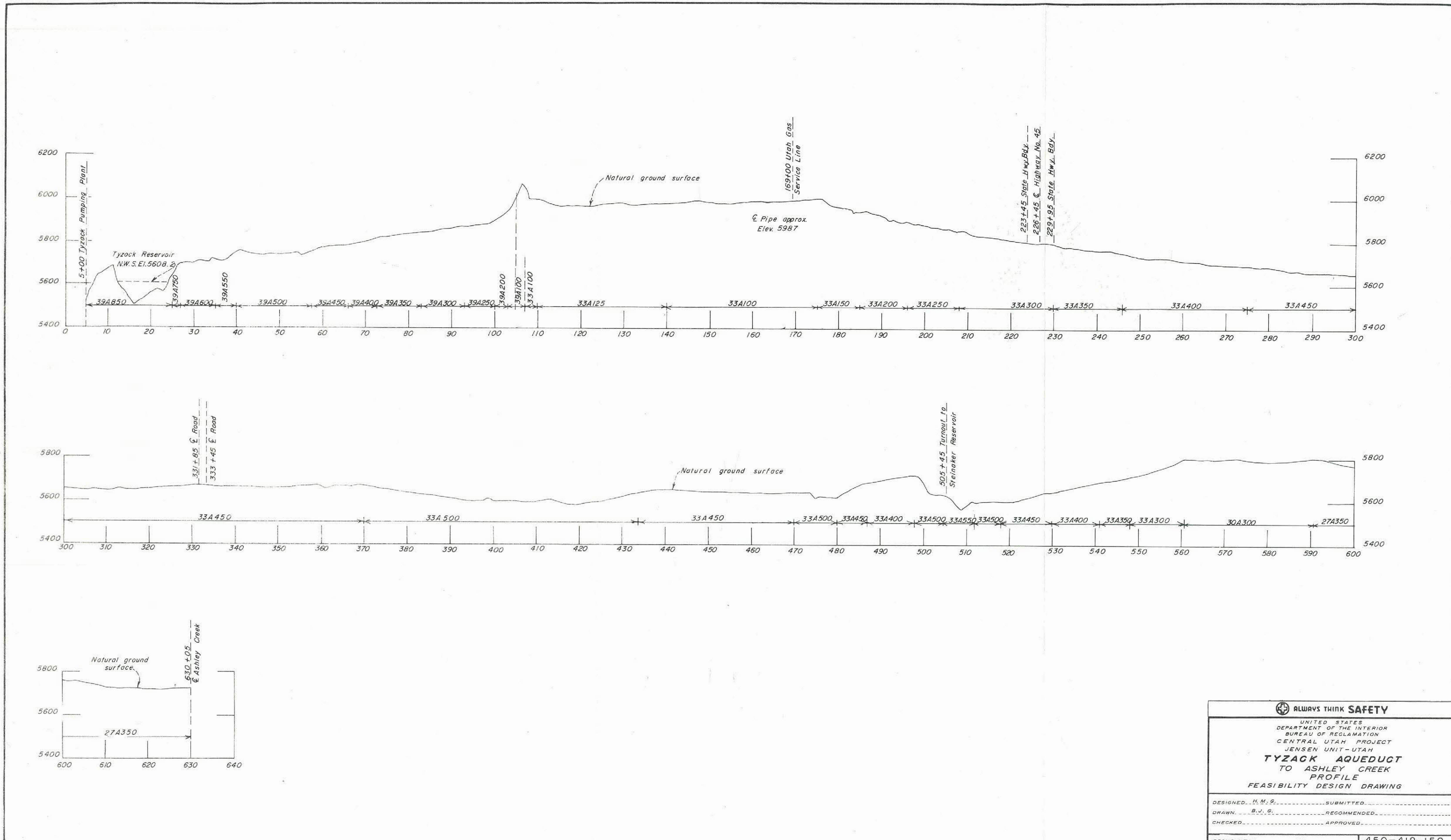
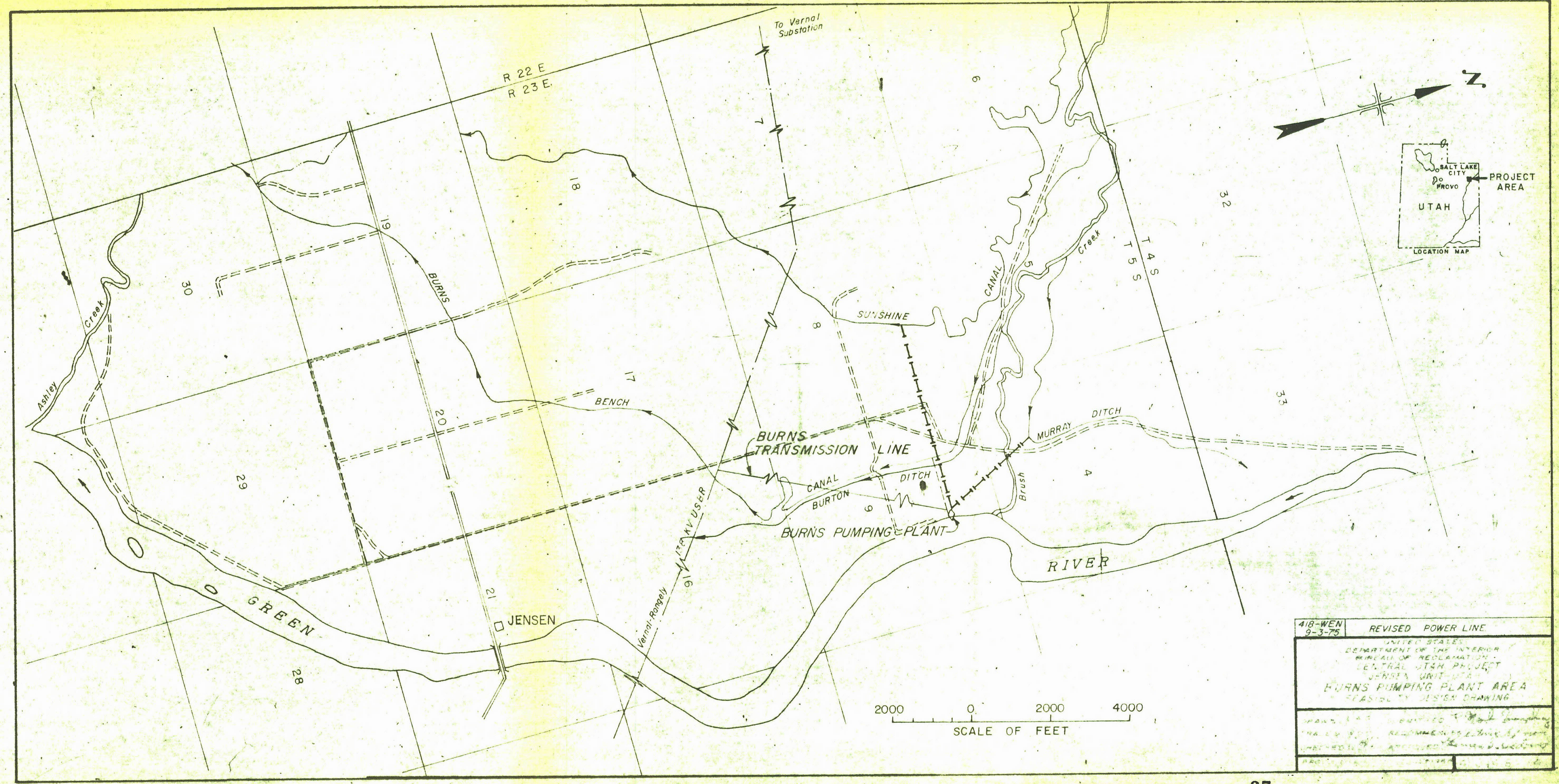
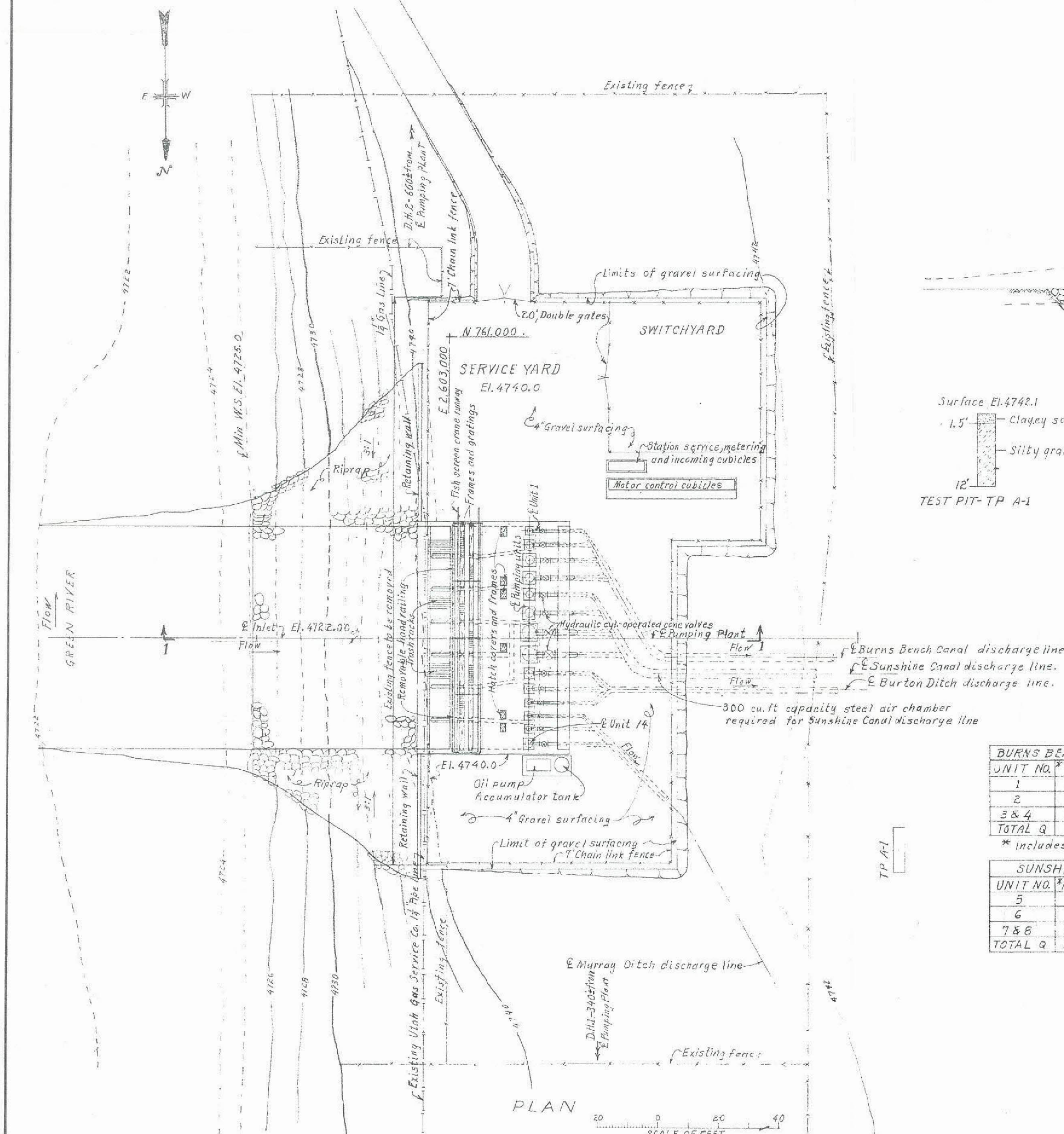
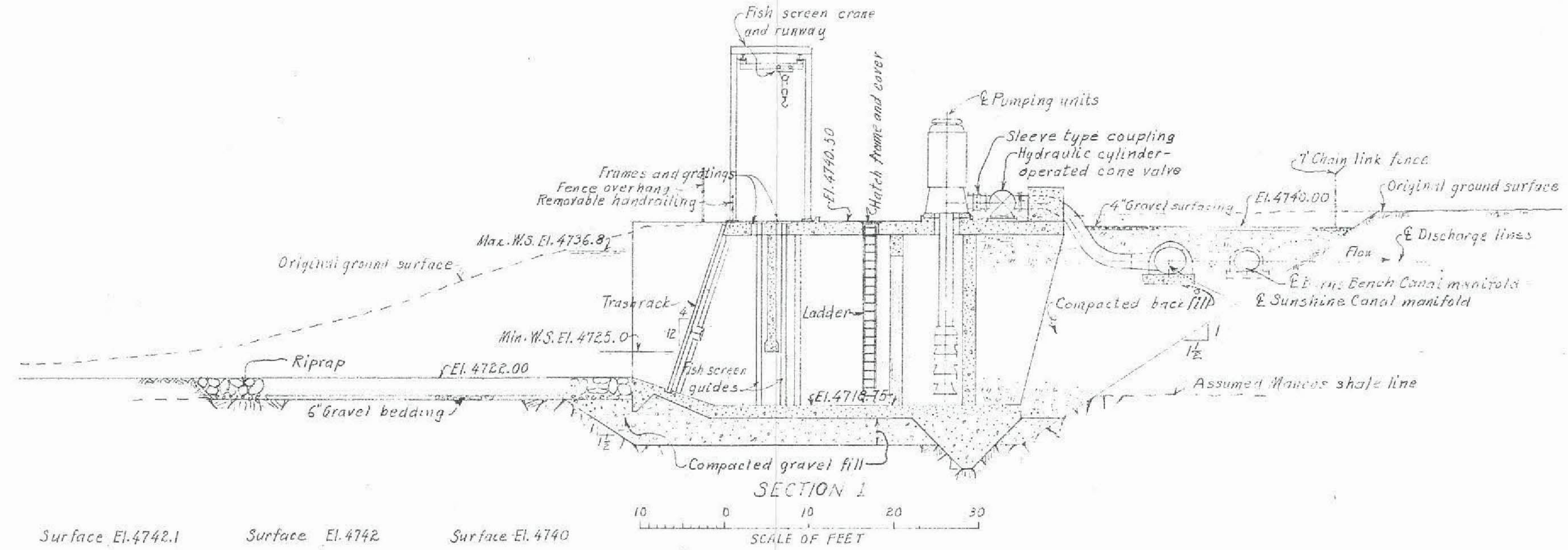
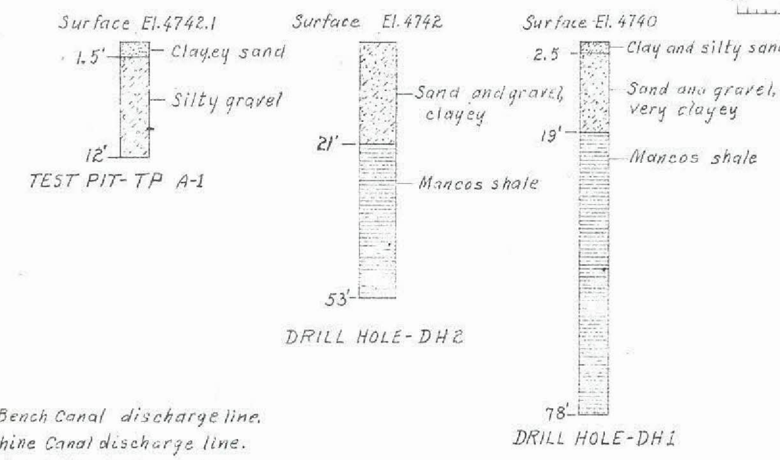

5+00 Tyzack Pumping Plant
Tyzack Reservoir
N.W.S. El. 5608.2
Natural ground surface
169+00 Utah Gas Service Line
℄ Pipe approx.
Elev. 5987
223+45 State Hwy Bdy
226+45 ℄ Highway No. 45
229+95 State Hwy. Bdy.
39A850
39A750
39A600
39A550
39A500
39A450
39A400
39A350
39A300
39A250
39A200
39A100
33A100
33A125
33A150
33A200
33A250
33A300
33A350
33A400
33A450
331+85 ℄ Road
333+45 ℄ Road
505+45 Turnout to Steinaker Reservoir
33A 500
33A500
33A550
30A300
27A350
Natural ground surface.
630+05 ℄ Ashley Creek
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT–UTAH
TYZACK AQUEDUCT
TO ASHLEY CREEK
PROFILE
FEASIBILITY DESIGN DRAWING
DESIGNED H. M. G. SUBMITTED
DRAWN B. J. G. RECOMMENDED
CHECKED APPROVED
PROVO, UTAH
SEPTEMBER, 1975
450-418-150



To Vernal Substation
R 22 E
R 23 E
N
PROJECT AREA
SALT LAKE CITY
PROVO
UTAH
LOCATION MAP
T 4 S
T 5 S
Ashley Creek
Creek
CANAL
SUNSHINE
BURNS
BENCH
BURNS TRANSMISSION LINE
CANAL
BURTON
DITCH
MURRAY DITCH
Brush
BURNS PUMPING PLANT
Vernal-Rangely 138 KV USER
GREEN
RIVER
JENSEN
30
19
18
7
6
5
32
29
20
17
8
9
4
33
28
21
16
2000
0
2000
4000
SCALE OF FEET
418-WEN 9-3-75
REVISED POWER LINE
BURNS PUMPING PLANT AREA







BURNS BENCH CANAL PUMP DATA			
UNIT NO.	* RATED Q	DESIGN Q	HEAD FT.
1	4.1 cfs	3.5 cfs	90
2	8.3 cfs	7.1 cfs	90
3 & 4	16.6 cfs	14.2 cfs	90
TOTAL Q	45.6 cfs	39.0 cfs	90

BURTON DITCH PUMP DATA			
UNIT NO.	* RATED Q	DESIGN Q	HEAD FT.
9	2.32 cfs	2.0 cfs	52
10	4.41 cfs	3.8 cfs	52
11	8.82 cfs	7.6 cfs	52
TOTAL Q	15.55 cfs	13.4 cfs	52

* Includes allowance for wear

SUNSHINE CANAL PUMP DATA			
UNIT NO.	* RATED Q	DESIGN Q	HEAD FT.
5	3.6 cfs	3.0 cfs	195
6	7.2 cfs	6.0 cfs	195
7 & 8	14.4 cfs	12.0 cfs	195
TOTAL Q	39.6 cfs	33.0 cfs	195

MURRAY DITCH PUMP DATA			
UNIT NO	* RATED Q	DESIGN Q	HEAD FT.
12	2.25 cfs	1.8 cfs	70
13	4.25 cfs	3.4 cfs	70
14	8.50 cfs	6.8 cfs	70
TOTAL Q	15.0 cfs	12.0 cfs	70

NOTE

Topography taken from Dwg. 450-418-41

12-31-74 D- H.O.E.	Corrected Rated and Design Q.
6-11-68 D - R.R.O.	Sunshine Canal and Burton Ditch pump data revised.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL [illegible]

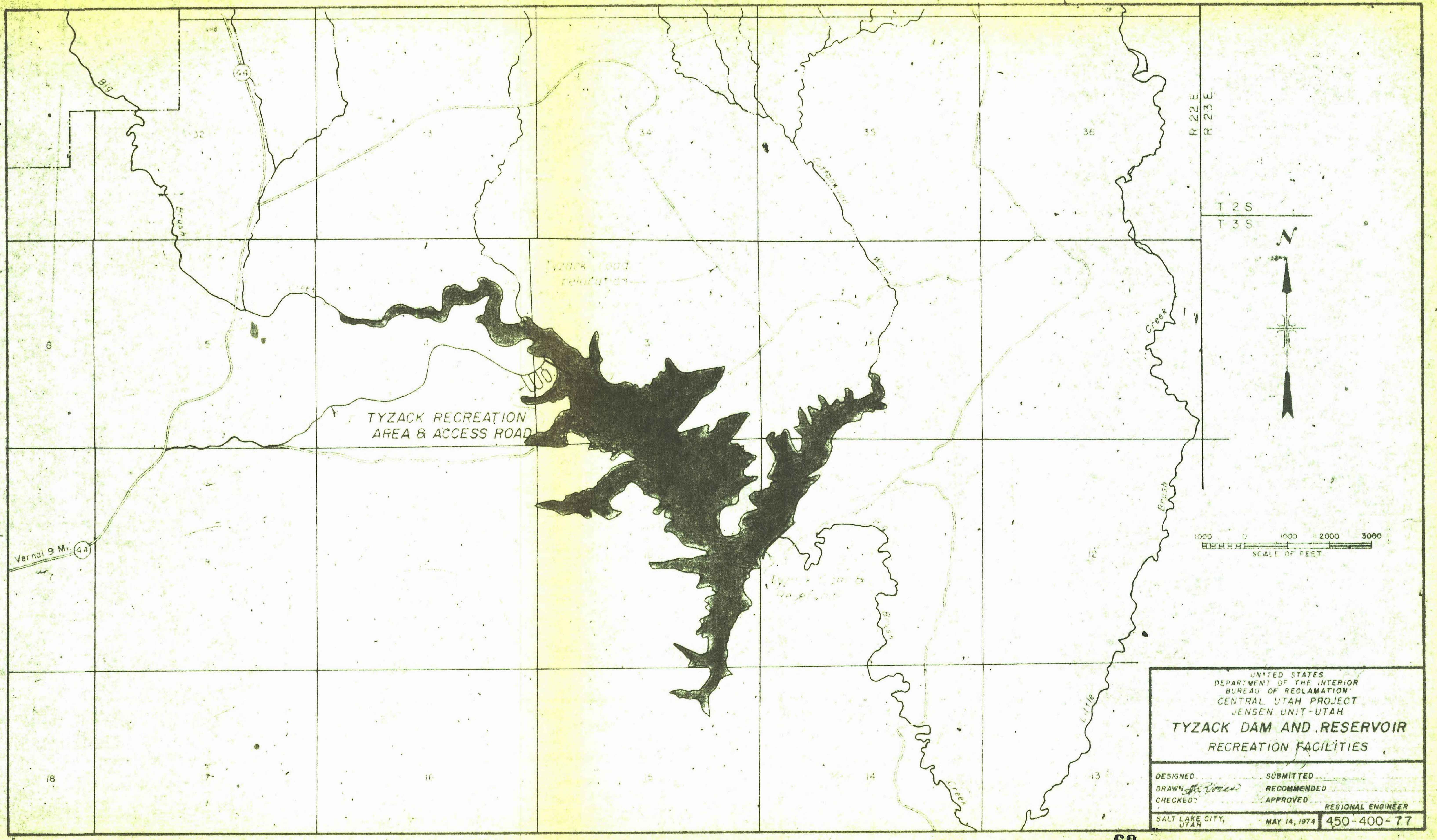
JENSEN UNIT - [illegible]

BURNS PUMPING PLANT

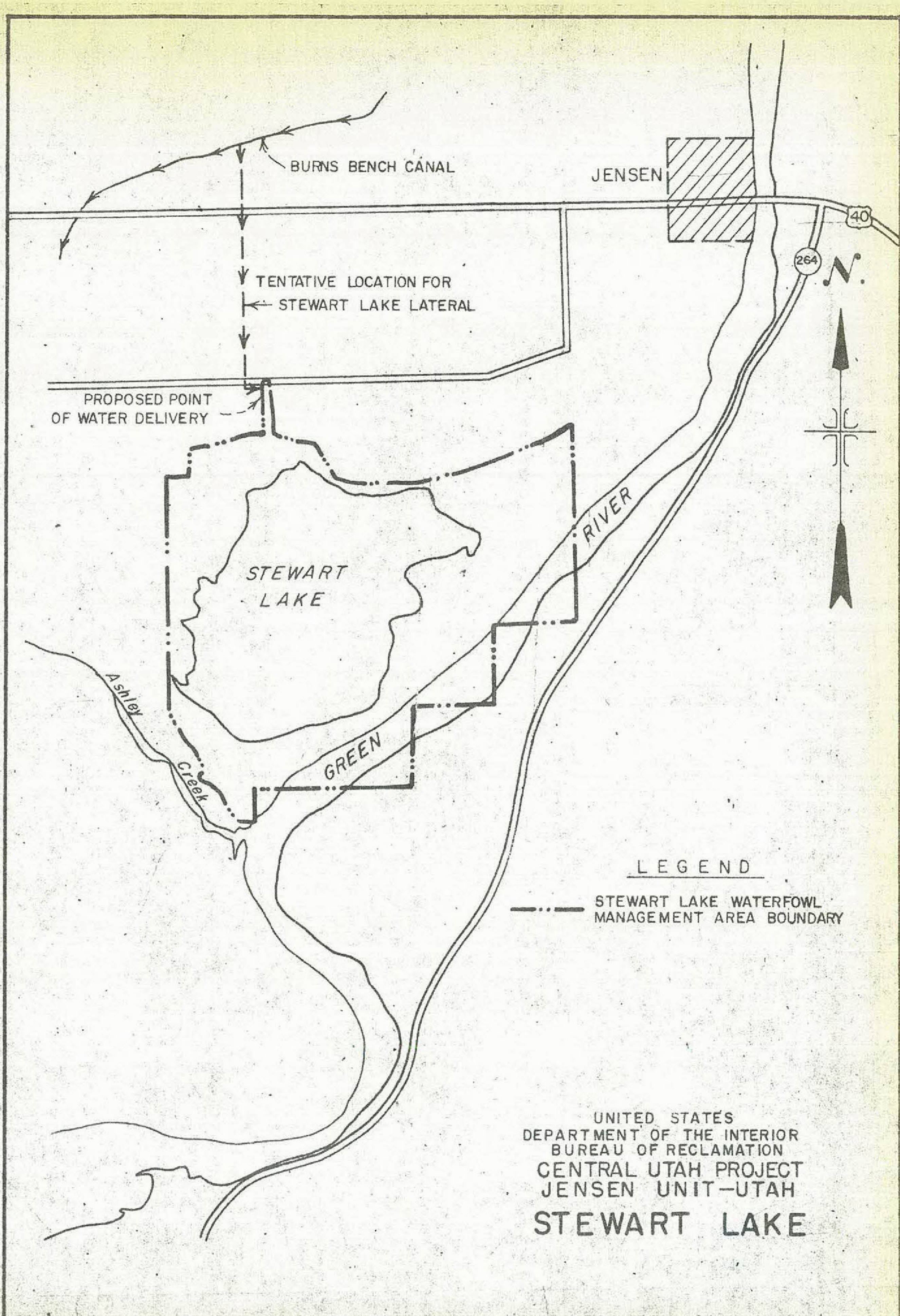
FEASIBILITY E[illegible]

DRAWN M .... SUBMITTED Edwin Rose
TRACED .... RECOMMENDED H. G. Arthur
CHECKED R.R.O. H.B. AR .... APPROVED [signature] CHIEF ENGINEER

DENVER, COLORADO MAR. 11, 1968 450-D-3



TYZACK RECREATION
AREA & ACCESS ROAD
Big
Brush
44
Vernal 9 Mi.
44
32
33
34
35
36
6
5
4
3
18
16
15
14
13
R 22 E
R 23 E
T 2 S
T 3 S
N
Creek
Brush
Little
Creek
1000 0 1000 2000 3000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT-UTAH
TYZACK DAM AND RESERVOIR
RECREATION FACILITIES
DESIGNED
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
REGIONAL ENGINEER
SALT LAKE CITY, UTAH
MAY 14, 1974
450-400-77


BURNS BENCH CANAL
JENSEN
40
264
N.
TENTATIVE LOCATION FOR
STEWART LAKE LATERAL
PROPOSED POINT
OF WATER DELIVERY
STEWART
LAKE
RIVER
GREEN
Ashley
Creek
LEGEND
STEWART LAKE WATERFOWL
MANAGEMENT AREA BOUNDARY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
JENSEN UNIT–UTAH
STEWART LAKE
450–418–101

PLAN FORMULATION

CHAPTER I

INTRODUCTION

Purpose of Appendix

This appendix summarizes the plan formulation studies that resulted in the present development plan for the Jensen Unit. The Jensen Unit is a separable segment of the Central Utah Project that was authorized for construction by P.L. 485 on April 11, 1956, as a participating project of the Colorado River Storage Project. Construction of this unit can proceed independently of the other units of the Central Utah Project. Principal project purposes are municipal and industrial uses, irrigation, recreation, fishery and wildlife conservation, and flood control.

Location

The Jensen Unit is located in Uintah County in the northeastern part of the State of Utah and is shown on the frontispiece map. It is in the Uinta Basin, a portion of the Upper Colorado River Basin. The lands of the unit are situated west of the Green River around the small community of Jensen, which is about 13 miles southeast of Vernal and in narrow strips along Brush Creek. Vernal is the largest town in the area with a 1975 population of about 6,200. Uintah County had a 1970 population of 12,684. The average elevation of the project lands is about 4,800 feet.

Objectives and Scope of the Plan Formulation Analysis

Plan formulation for development of the water resources of the Jensen Unit has included comparative physical and economic analysis of various promising alternative physical means and purposes of development as an aid in selecting the most desirable plan. The basic data on available water and land resources, water rights and requirements, agricultural economics, and benefits as presented in the other appendixes to the definite plan report were used to compare alternatives in the plan formulation analyses. Preliminary water supply operation studies were made for the various alternatives as a basis for the comparative evaluations. The plan formulation analyses were based largely on reconnaissance and preliminary type designs and cost estimates, but the comparability between plans would still exist.

Table 1 on the following page gives a comparison of the recommended plan, as identified in the formulation studies, based on appraisal designs and cost estimates and the same plan based on feasibility designs and

Table 1
Comparison of the recommended plan based on
appraisal and feasibility designs and estimates

Item	Appraisal design data January 1974 costs	Feasibility design data January 1975 costs
Project lands (acres)		
Full service	440	440
Supplemental service	3,640	3,640
Project water supply (acre-feet)		
Irrigation	4,600	4,600
Municipal and industrial	18,000	18,000
Project storage facilities (acre-feet)		
Tyzack Reservoir	26,000	26,000
Project pumping plants (second-feet)		
Tyzack Pumping Plant	46	46
Burns Pumping Plant	97	97
Project aqueducts (miles)		
Tyzack Aqueduct	11.8	11.8
Project costs ($1,000)		
Construction costs	27,026	1/ 32,514
Interest during construction	1,318	1,840
Total construction costs	1,318	34,354
Annual equivalent costs		
Amortized (3¼% @ 100 years)	961	1,164
Operation, maintenance, and replacement	171	177
CRSP depletion costs ($2/acre-foot)	30	30
Total	1,162	1,371
Project benefits ($1,000)		
Irrigation (direct benefits)	158	158
Municipal and industrial	1,922	2,005
Fish and wildlife	24	24
Recreation	88	88
Flood control	24	24
Total	2,216	2,299
Benefit-cost ratio	2/ 1.9:1	2/ 1.6:1

1/ Costs of investigations prior to authorization and highway improvements to current standards are not included in benefit-cost analysis. Total cost including these items is $33,263,000.

2/ The difference between the 1.9:1 in 1974 and the 1.6:1 in 1975 is reflected in the costs being indexed up but the benefits remaining the same.

cost estimates. The feasibility analyses affect the economic justification of the alternative plans but does not change their relative comparability.

Modification of Plan

Details of the plan for the Jensen Unit have changed from those outlined in the Central Utah Project Feasibility Report of February 1951. The modifications are within the scope of the project as authorized, hence additional authorization is not expected to be required. Tyzack Reservoir is the major feature of both plans; however, the total capacity of the reservoir has been increased from 8,000 acre-feet to 26,000 acre-feet. The project water supply has been increased from 5,300 acre-feet annually to 22,600 acre-feet annually. Table 2 shows the changes in the plan.

Table 2
Plan modification

	1951	Present (1975)
Supplemental service land (acres)	3,220	3,640
Full service land (acres)	1,240	440
Water supply (acre-feet)		
Irrigation	5,300	4,600
Municipal and industrial		18,000
Total	5,300	22,600
Tyzack Reservoir capacity (acre-feet)	8,000	26,000

Facilities have been added to provide municipal and industrial water to the project area and include Tyzack Pumping Plant and Tyzack Aqueduct extending from Tyzack Reservoir to Ashley Creek. This water would serve the projected increase in population in and around Vernal, Utah, resulting from the development of the oil, gas, and oil shale industries. Burns Pumping Plant has been added to the project plan and will pump Green River water for the irrigation of lands near Jensen and for exchange to Tyzack Reservoir for municipal and industrial purposes. Recreation and fish and wildlife conservation facilities have been increased and flood control has been added to the project feature.

The axis of the dam was moved 2,000 feet downstream to give the larger dam a better foundation. The Tyzack Aqueduct was extended to discharge at Ashley Creek above the major irrigation diversions, so Brush Creek water could be exchanged with Ashley Spring water.

Summary and Conclusions

The Jensen Unit will provide municipal and industrial water to augment the existing supplies in the Ashley Valley and supplemental and full service irrigation water to project lands near Jensen, Utah. It also will benefit recreation, flood control, fish, and wildlife. The main project feature will be Tyzack Dam and Reservoir on Big Brush Creek. Project municipal and industrial water will be pumped from Tyzack Reservoir to Ashley Creek by the Tyzack Pump and Aqueduct. Burns Bench Pump will pump water from the Green River for irrigation of lands near Jensen, Utah, and for replacement of municipal and industrial water developed at Tyzack Reservoir.

A summary of the alternatives is presented in Table 3 and is compared with the selected plan. The cost of these plans has been indexed to a base of January 1974. Interest during construction was computed using 3.25 percent and a construction period of 3 years. All plans were expressed in terms of annual equivalents based on a 100-year life and an interest rate of 3.25 percent. The estimated annual operation, maintenance, and replacement cost and the $2 per acre-foot annual stream depletion charge were added to the annual equivalent cost to derive the total annual cost.

The direct annual benefits were then estimated and a benefit-cost ratio was calculated for each plan. In addition, the cost per acre-foot of municipal and industrial water was estimated for comparative purposes. Each alternative is described in greater detail in Chapter IV of this appendix.

Table 3 shows that the selected plan has the best benefit-cost ratio, the greatest net annual benefit, and least cost per acre-foot for municipal and industrial water. The selected plan also provides high quality municipal water that does not require a treatment plant for culinary use.

From the above discussion it is apparent that the selected plan satisfies the needs of the Jensen Unit area better than comparative plans.

Table 3
Summary of alternatives

Item and unit of measure	Proposed plan	Nondevelopment	Partial development									Alternatives				
			Burns Pump (irrigation)	Tyzack Reservoir (irrigation)	Green River Pump (municipal and industrial)	Trout Creek Reservoir	Soldier Park Reservoir with Red Cloud Diversion	Trout Creek Reservoir with Red Cloud Diversion	Boan Reservoir	Brush Creek Diversion	Tyzack Reservoir with minimum fishery bypass (9 c.f.s.)	Green River Pump	Increased use of ground water	Ratliff Reservoir	Brush Creek Tunnel	Buckskin Hills Canal
Project lands (acres)																
Full service lands	440		440	440			440	440	440	440	440	440	440	440	440	440
Supplemental lands	3,640		3,640	3,640			3,640	3,640	3,640	3,640	3,640	3,640	3,640	3,640	3,640	3,640
Water supply (acre-feet/year)																
Irrigation water	4,600		4,600	4,600			4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600
Full service	1,600		1,600	1,600			1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
Supplemental service	3,000		3,000	3,000			3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Municipal and industrial water (acre-feet/year)	18,000				18,000	3,200	4,000	6,800	7,200	7,200	12,900	18,000	18,000	18,000	18,000	18,000
Other project uses																
Recreation (man-days)	40,000			23,000		48,000	12,900	48,000	14,000	11,000	48,000			31,000	31,000	40,000
Fishing and hunting (man-days)	7,850			4,500		9,400	2,500	9,400	2,800	2,200	9,400			6,100	6,100	7.850
Flood control	$24,000			$9,200		$50,000	$7,700	$50,000	$5,500	$4,600	$24,000			$18,600	$18,600	$24,000
Structural measure																
Storage reservoirs (acre-feet, total)																
Tyzack	26,000	NA	NA	10,000	NA	NA	NA	NA	NA	NA	26,000	NA	NA	NA	NA	26,000
Soldier Park	NA	NA	NA	NA	NA	NA	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ratliff	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	26,000	26,000	NA
Boan	NA	NA	NA	NA	NA	NA	NA	NA	6,000	NA	NA	NA	NA	NA	NA	NA
Trout Creek	NA	NA	NA	NA	NA	25,000	NA	25,000	NA	NA	NA	NA	NA	NA	NA	NA
East Upper Steinaker	NA	NA	NA	NA	NA	NA	NA	NA	NA	5,000	NA	NA	NA	NA	NA	NA
Tunnels, canals, and aqueducts (miles)																
Tyzack Aqueduct	11.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	11.8	NA	NA	NA	NA	NA
Red Cloud Diversion	NA	NA	NA	NA	NA	NA	6.6	6.6	NA	NA	NA	NA	NA	NA	NA	NA
Ratliff Aqueduct	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.9	NA	NA
Green River Aqueduct	NA	NA	NA	NA	16.3	NA	NA	NA	NA	NA	NA	16.3	NA	NA	NA	NA
South Fork Feeder Aqueduct	NA	NA	NA	NA	NA	2.8	NA	2.8	NA	NA	NA	NA	NA	NA	NA	NA
Brush Creek Tunnel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.1	NA
Buckskin Hills Canal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	27.2
Boan Aqueduct	NA	NA	NA	NA	NA	NA	NA	NA	11.4	NA	NA	NA	NA	NA	NA	NA
Brush Creek Aqueduct	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.3	NA	NA	NA	NA	NA	NA
Pumping plants (c.f.s.)																
Tyzack	46	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	NA	NA	NA	NA	NA
Burns	97	NA	90	NA	NA	NA	90	90	97	65	87	90	97	97	97	97
Green River Nos. 1, 2, and 3	NA	NA	NA	NA	46	NA	NA	NA	NA	NA	NA	46	NA	NA	NA	NA
Ratliff (To Ashley Creek)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	46	46	NA
Boan Nos. 1 and 2	NA	NA	NA	NA	NA	NA	NA	NA	20	NA	NA	NA	NA	NA	NA	NA
Brush Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	NA	NA	NA	NA	NA	NA
Buckskin Hills	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	46
Estimated costs (January 1974, dollars x 1,000)																
Construction costs	$27,026		$3,640	$11,274	$22,357	$9,897	$12,553	$18,810	$18,051	$10,774	$25,092	$25,997	$24,496	$33,246	$37,936	$32,477
Interest during construction (3¼%-3 years)	1,318		178	550	1,090	483	612	917	880	525	1,223	1,267	1,194	1,621	1,849	1,583
Total costs	28,344		3,818	11,824	23,447	10,380	13,165	19,727	18,931	11,299	26,315	27,264	25,690	34,867	39,785	34,060
Annual equivalent (3¼%-100 years)	961		129	401	795	352	446	669	642	383	892	924	871	1,182	1,348	1,154
Annual operation, maintenance, and replacement	171		21	40	226	65	78	75	192	170	149	247	712	150	108	165
CRSP depletion ($2/acre-foot)	30		6	6	22	4	10	15	14	14	21	30	30	30	30	30
Total annual costs	1,162		156	447	1,043	421	534	759	848	567	1,062	1,201	1,613	1,362	1,486	1,349
Annual direct benefits (dollars x 1,000)																
Irrigation ($34.35/acre-foot)	158		158	158			158	158	158	158	158	158	158	158	158	158
Municipal and industrial ($106.78/acre-foot)	1,922				1,922	342	427	726	769	769	1,378	1,922	1,922	1,922	1,922	1,922
Fish, wildlife, recreation, and flood control	136			73		185	44	185	46	36	159			106	106	136
Total annual benefits	2,216		158	231	1,922	527	629	1,058	973	963	1,695	2,080	2,080	2,186	2,186	2,216
Benefit cost ratio	1.91:1		1.01:1	0.52:1	1.84:1	1.25:1	1.18:1	1.39:1	1.15:1	1.70:1	1.60:1	1.73:1	1.29:1	1.60:1	1.47:1	1.64:1
Net annual benefits	$1,054		$2	$-216	$879	$106	$95	$299	$125	$396	$633	$879	$467	$824	$700	$867
Municipal and industrial water cost ($/acre-foot)	87		NA	NA	90	129	140	121	143	93	104	90	117	106	118	103

CHAPTER II

RESOURCES, PROBLEMS, AND NEEDS

Water Resources

Water supply records were developed for the 42-year period 1930 to 1972. This period includes years of high flow as well as critically low runoff years of the 1930's and 1950's.

Streamflows available for project development include Brush Creek and Green River, both of which traverse the project area. The only other stream that is close enough to enable economical development is Ashley Creek. The Vernal Unit, which was put in operation in 1962, developed most of the flows of Ashley Creek.

The recorded flow of Green River near Jensen averaged 3,067,000 acre-feet annually (1947-72) and is far in excess of the supply required for the Jensen area demands. The minimum flow of record was 102 second-feet on December 6, 1904, and the minimum anticipated release from Flaming Gorge Powerplant is 400 second-feet. Thus, the flow of Green River during the irrigation season would be sufficient to meet all project demands. The choice as to the source of project water, Green River or Brush Creek, was then put to economic and other tests.

The average annual recorded flows of Big Brush Creek near Vernal and Little Brush Creek near the mouth are 26,600 acre-feet and 4,600 acre-feet, respectively. This indicates that about 31,200 acre-feet of water is available to the project area from Brush Creek.

The only diversion from Brush Creek drainage to another drainage is made by the Oaks Park Reservoir and Canal on the headwaters of Big Brush Creek. Winter and high spring flows are stored in the 5,750-acre-foot reservoir and released for irrigation use in Ashley Valley. These diversions were accounted for in the water supply studies. The Oaks Park Dam and Canal were constructed by the Ashley Valley Reservoir Company in 1941 and have been in continuous service since that time.

The 2,650-acre-foot total capacity East Park Reservoir on the headwaters of Little Brush Creek drainage area is the only reservoir storing water for irrigation use in the Brush Creek drainage area. This reservoir and the Sunshine Canal were built in 1914 and provide water for 1,051 acres of presently irrigated land. The Utah State Division of Wildlife Resources purchased an inactive pool of 1,330 acre-feet in this reservoir in 1960.

In 1962, Burns Bench Irrigation Company installed a natural gas-powered pumping unit with a maximum capacity of 16½ second-feet on the Green River about 2 miles north of Jensen. The sediments have caused excessive wear on the pump; thus the plant was regarded as being inoperative and not economically feasible when compared to the proposed Burns Pumping Plant.

Minerals, Oil, and Natural Gas

Phosphate

There are vast deposits of phosphate rock in the northern part of Uintah County. In 1959, San Francisco Chemical Company, which later became a division of Stauffer Chemical Company, purchased the Humphrey's deposit 15 miles north of Vernal and began intensive development work. A concentrator was constructed at the open pit mine in 1960. Output of phosphate concentrates is now approximately 350,000 to 400,000 tons per year, most of which is trucked to the Union Pacific Railroad at Phoston, Wasatch County, Utah, where a pulverizing plant further reduces the material. From that point, a substantial amount goes to Stauffer Chemical Company's fertilizer plant in Salt Lake County and the remainder to widely scattered custom fertilizer plants in the west.

There are an estimated 2,458,000,000 tons of phosphate-bearing rock in Uintah County, of which about 784,000,000 tons of +20 percent P_2O_5 are controlled by Stauffer Chemical Company. The Stauffer Chemical Company is presently considering enlarging its operation by 50 percent to 100 percent. They have sufficient water for their present operation and as soon as they expand, additional water may be purchased from the Jensen Unit. They have already approached officials of the Uintah Water Conservancy District about the possibility of purchasing water from the Jensen Unit.

Oil shale

Vast fields of oil shale stretch through Uintah County. Undeveloped as yet, they give promise of future development as methods of extracting oil are perfected. Two Federal leases figure prominently in the development of a shale oil industry in Utah border the White River in Uintah County 40 miles southeast of Vernal, each covering 8 square miles. One lease is held by Phillips Petroleum Company and Sun Oil Company, awarded May 1, 1974, for a high bid of $75 million. The other was awarded to White River Shale Oil Corporation June 1, 1974, for $45 million. These two companies plan a joint development of their leases. If the technology now being tested proves out, a 100,000-barrel-per-day plant could be constructed and in partial production by 1980 and full production by 1985. The initial plant could attract about 13,000 new people to Uintah County, many of whom would live in the Vernal and Jensen areas.

The Utah State Oil and Gas Conservation Division gave approval in September 1974 for The Oil Shale Corporation (TOSCO) to begin preliminary planning for an oil shale plant 30 miles south of Vernal on State owned land. The TOSCO plant would be a 75,000-barrel-per-day commercial oil shale complex and would bring about 6,000 new people into Uintah County during the next 7 to 9 years.

The assumption is that Jensen Unit project water would not be used in the oil shale process but would be used to provide municipal water for the workers in the oil shale industry, their families, and related service people who settle in the existing communities of Uintah County.

Bituminous sands and oil

Large deposits of bituminous sand or native asphalt lie about 5 to 10 miles west and south of Vernal. The Utah State Oil and Gas Conservation Division estimates the oil reserves in this deposit are in excess of 1,048,000,000 barrels of bitumen in place.

In September 1974, the State of Utah gave the Sohio Petroleum Company approval to start strip mining bituminous sands on the south end of Asphalt Ridge 7 miles south of Vernal. A work force of about 60 employees is planned for a 7,000-barrel-per-day operation. If the operation proves satisfactory the project could last for 80 years at a 20,000-barrel-a-day production. The city of Vernal would provide most of the day-to-day support and service for this operation and provide facilities for this increase in work force and the related influx of families.

The oil and gas industry has taken first place among the raw materials industries of Uintah County. Some 16 or 17 fields are actively producing in the county. In May 1974 there were 358 producing wells out of 471 "producible." Crude oil from Uintah County is transported to Salt Lake Valley refineries by means of a pipeline and tank trucks.

It is anticipated that the additional industrial water requirement for development of bituminous sands and oil by 1985 will be small and will, therefore, not require project water. But project water would be used to provide municipal water for the workers, their families, and related service people who will settle in the existing communities of Uintah County.

Gilsonite

The only supply of gilsonite in the United States is mined at several points near the project area. The American Gilsonite Company is the only company engaged in the mining of gilsonite and is currently producing about 50,000 tons of ore per year. Gilsonite, a solid hydrocarbon, is used as a source of road oil, liquid fuels, paving binder, battery lining, oil well mud, cement additive, protective coatings, and asphalt tile.

Projection of the water needs for the gilsonite industry to the year 2000 shows the company has more than sufficient water to meet their industrial needs.

Population projections associated with plant expansion would be minimal as mining methods and technologies will be improved so that productivity per miner will be increased. Present employment at the mine is 80 persons which could expand to about 105 if production were increased.

Figure 1 shows where the various minerals mentioned in this section are located in the Uintah Basin.

Population Growth and Municipal and Industrial Water

Population growth in the Jensen Unit area approximated the State average of about 2 percent per year between 1940 and 1970. Since 1970 there has been a significant population increase due to accelerated development of oil and gas. The area now stands on the threshold of a population boom of large proportions associated with the budding oil shale industry. Future municipal and industrial water requirements are based on development of oil shale deposits and other natural resources.

It is very difficult, although necessary, to project population growth associated with oil shale development. Recognizing this, population estimates for Ashley Valley were made for three levels of oil shale development and are shown in the table below.

Estimated population of Ashley Valley
(1980-2000)

Year	Prototype development	Moderate commercial development	Accelerated commercial development
1980	32,600	33,300	35,100
1985	34,000	35,600	42,400
1990	30,000	39,000	46,900
1995	32,200	47,100	49,100
2000	34,500	54,200	56,100

New municipal water requirements for the projected increases in population have been based on 0.25 acre-foot per capita per year. The new water requirement for industrial water has been based on a moderate expansion of the phosphate, gilsonite, petroleum, natural gas, and tar sands in or near the Jensen Unit area.

Agricultural Lands and Irrigation Water

Most of the unit irrigation lands lie above the west bank of the Green River in the vicinity of Jensen and comprise an area roughly 2 miles

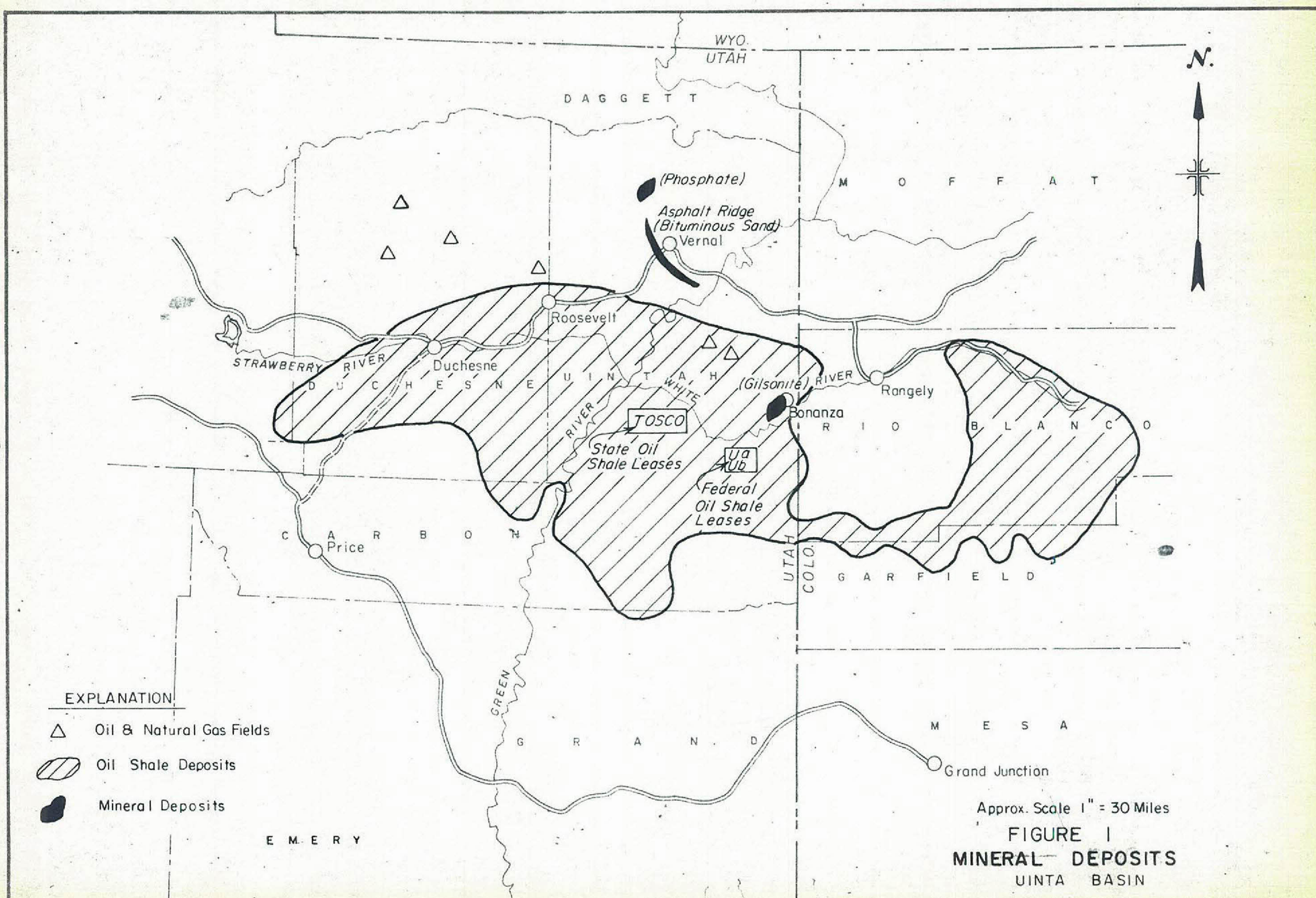


FIGURE 1
MINERAL DEPOSITS
UINTA BASIN

wide and 5 miles long from north to south. These lands are located on two benches or river terraces formed by coalesced alluvial fans and on the river flood plain. The remaining lands are located on Brush Creek and Big Brush Creek in long, narrow strips on both sides of the streams.

Soils of the Jensen area were derived mainly from eroded and slightly modified old alluvial sediments composed principally of Mancos shale. Throughout much of the area these old sediments have been eroded down, removed, and replaced by more recent alluvial deposits, giving the area its local topography of low ridges, washes, and mesas. Soils along Brush Creek are derived from the surrounding rock formations through which Brush Creek has cut and are usually stratified and predominantly medium textured.

The topography of the area, excluding the lands along Brush Creek, is usually smooth to very gently rolling with tracts of sufficient size to facilitate favorable irrigation practices, while lands that lie adjacent to the stream channels are rolling to gently rolling, small or irregular in shape, and have moderate slopes.

The plan formulation studies considered all presently irrigated lands along Brush Creek and several large tracts of potentially arable land between Ashley Valley and Brush Creek. Most of the later lands proved uneconomical to develop because of the high cost of transporting the water to the area. Project lands consist of 3,640 acres of supplemental service land and 440 acres of full service land.

The present average annual water shortage to lands in the project area is about 3,000 acre-feet or 22 percent but ranged from 0 percent to 52 percent over the 42-year study period. An increased, dependable irrigation water supply is needed and would greatly benefit the area. In addition there are 440 acres of nonirrigated land which require a full supply of about 1,600 acre-feet annually.

Estimates of agricultural resources were based upon farm budgets prepared for the Jensen area. Only one significant farm operation exists, that of raising livestock, either beef or sheep, or a combination of the two. There is essentially no dairying. The crops produced are feed crops for livestock and include alfalfa, barley, corn for silage, and pasture. Crop yields and land-use patterns are those expected with a full water supply. A linear relationship is assumed for each increment of water for both the repayment and benefits, hence payment capacity and benefits for project water are proportional to the amount of water furnished by the project.

The recommended water charge is estimated at $4.50 per acre-foot. The direct irrigation benefits are estimated at $34 per acre-foot.

Recreation, Fish, and Wildlife

The Jensen Unit area is in the vicinity of several tourist attractions and points of interest. The streams, lakes, and scenic beauty of the Ashley National Forest and Uinta Mountains attract many recreationists and tourists. The High Uintas Primitive Area, located about 45 air miles northwest of Vernal in the Wasatch and Ashley National Forests, provides opportunities for recreationists to enjoy conditions similar to those existing in the early days of the West. The High Uintas Primitive Area contains 237,177 acres of mountains, timber, lakes, and streams. Proposed legislation recommended by the President would enlarge this area to 322,998 acres and designate it a wilderness area.

The northeast slope of the Uinta Mountains is the southern limit of Flaming Gorge National Recreation Area, where boating and fishing water backs up from Flaming Gorge Dam for nearly 50 miles. This recreational area is located on the Green River in northeastern Utah and southwestern Wyoming, about 40 miles north of Vernal over State Highway 44.

The Dinosaur National Monument is on the eastern border of the Jensen Unit area, about 6 miles north of Jensen over State Highway 149. This area is also a popular spot for vacationers. Other recreational sites are the Red Cloud Loop, the Drive Through the Ages Geologic Area, Merkley Park Picnic Area, and the Natural History State Museum in Vernal. The Green River below Flaming Gorge Dam and the Yampa River are popular for float trips, both commercial and private.

Bottle Hollow Complex, owned and operated by the Ute Indian Tribe near Roosevelt, provides water-oriented recreational opportunities to residents of the area and tourists. Bottle Hollow Reservoir, hub of the development, was constructed as a segment of the Bonneville Unit.

The Vernal Unit's Steinaker Lake State Recreation Area is the only major recreational site in the immediate Jensen Unit area. The Utah Division of Parks and Recreation estimated an average of about 45,000 recreation days of use per year for Steinaker Lake for the period 1971 through 1973. This usage included sightseeing, picnicking, camping, swimming, waterskiing, boating, fishing, and hunting. Steinaker Lake offers 820 acres of water surface as compared to 520 acres at the proposed Tyzack Reservoir. It is estimated that Tyzack Reservoir will provide about 40,000 recreation days of use.

Many trout inhabit the lakes and streams of the Ashley National Forest. Big Brush Creek and Ashley Creek both contain manageable populations of game fish, particularly trout; however, the quality of the fishery varies depending on location. The lands of the Jensen Unit provide habitat for a variety of birds and mammals both game and nongame species. The area around Dinosaur National Monument is heavily inhabited with deer and pheasant, making it a favorite area for many of Utah's hunters.

CHAPTER III

PLAN SELECTION

General

Practical development of water resources in the Jensen Unit is limited by the amount of water physically available, a lack of suitable sites for water storage, and inadequate conveyance facilities for delivery of water to places of need. Other related factors considered in the plan formulation studies are present water rights and requirements, present developments and utilization of water resources, future developments of natural resources, and effects of future water deliveries on other water uses in the area, such as fishing, stockwatering, flood control, and recreation.

Plan formulation analyses have included studies of potential dam and reservoir sites for long-time holdover storage capacity and methods of conveyance from the reservoir to Ashley Valley. The most economical and practical means of delivering replacement water from the Green River to the irrigated lands also received consideration. Studies were made for the conservation of fishery, wildlife, and recreational resources and to integrate potential municipal and industrial developments into the overall plan.

General information related to plan formulation problems is included in Chapter II. Details of these problems, physical setting, and present water resource developments are discussed in the definite plan report. The plan formulation studies were made with these problems in mind and are divided into four categories: (1) nondevelopment, (2) partial development, (3) alternatives to the proposed plan, and (4) alternative features and operations of the proposed plan.

Recommended Plan

Development of a water supply

The plan recommended for the Jensen Unit will provide project water annually in the amount of 18,000 acre-feet for municipal and industrial use and 4,600 acre-feet for irrigation. The project water will be obtained from storage regulation of Big Brush Creek in Tyzack Reservoir and by pumping from the Green River. There are three major features of the recommended plan: (1) Tyzack Dam and Reservoir, (2) Tyzack Pumping Plant and Aqueduct, and (3) Burns Pumping Plant.

The need for water in the project area is much greater than can be supplied from the available resources. Consequently, the size of the Tyzack Reservoir is based upon an economic capacity in consideration with the available water supply rather than providing a predetermined specified supply.

Municipal and industrial water use

The proposed plan will provide high quality spring water from Ashley Springs for municipal and industrial use by exchanging Tyzack Reservoir water pumped to Ashley Creek through the Tyzack Aqueduct. Ashley Spring water will be piped directly from the springs to the city of Vernal and surrounding area. Replacement would be made from Tyzack Aqueduct on a steady flow pattern and on a replacement-as-used basis. The aqueduct will have an outlet to Steinaker Reservoir enabling the aqueduct flows to be released directly to Steinaker Reservoir if required. The spring water presently meets State health requirements for municipal use, thereby the plan of water exchange will avoid the high cost of a water treatment facility. Growth and development of the Uinta Basin are directly proportional to the oil and oil shale industries. With a viable oil and oil shale industry the growth rate will be of boom proportions. The task of projecting the population increase and where these people will live is difficult and speculative.

The industrial water for the actual oil shale processes would not come from the Jensen Unit as these developments would probably receive water from the White River, Green River, or other sources. It was assumed that the municipal and light industrial (manufacturing) water increase would be in the established communities, because a portion of the personnel associated with the oil shale industry would be integrated into these communities. The municipal and industrial water releases from Tyzack Reservoir could be made available anywhere along Brush Creek or in Ashley Valley.

The 18,000 acre-feet of municipal and industrial water should be sufficient for the projected demands until about the year 1995, assuming a new oil shale city is not established and most of the oil shale and allied workers and their families chose to live in the Jensen Unit area. The oil companies awarded the Federal leases, however, have indicated that a new city will be established near the town of Bonanza, Utah. The Bureau of Reclamation has estimated that if the new city were established about 60 percent of the people associated with oil shale would live there. About 30 percent would live in the Jensen Unit area and about 10 percent would settle west of the Jensen Unit area. If about 30 to 40 percent of the people settle in the Jensen Unit area, then the projected demands would be met until about the year 2000. These municipal and industrial demands were based on population projections made by the U.S. Bureau of Reclamation which were based on the Oil Shale Environmental Statement. The municipal and industrial water requirements are further explained in Chapter III of the Water Supply Appendix.

To insure that the plan as formulated is the most economical means of obtaining municipal and industrial water supplies and to insure further that the recommended plan does not preclude development of an alternative less costly source, the alternates described under "Alternative Plans" were considered and are presented in Table 3 in Chapter I. A comparison of the annual costs in the table mentioned above shows the advantages of the proposed plan.

The development of municipal and industrial water by adding storage in Tyzack Reservoir is limited by the water supply of Brush Creek and the physical conditions of the dam site. Brush Creek flows are inadequate to provide a yield of much more than 18,000 acre-feet from Tyzack Reservoir. Constructing Tyzack Reservoir larger than 26,000 acre-feet soon becomes very expensive and uneconomical as shown in Table 4.

Irrigation

The presently irrigated project lands receive water from Brush Creek and a small pumping plant on the Green River. Under the proposed plan most of the lands, including the new lands, will receive water from the Green River through the Burns Pumping Plant on an exchange basis for the Brush Creek water which will be stored in Tyzack Reservoir for municipal and industrial use.

There are 133 acres of irrigated land along Big Brush Creek between the Tyzack Reservoir site and the junction of Big and Little Brush Creek. In addition, there are 672 acres of irrigated land along Brush Creek between the junction of Big and Little Brush Creek and the point of service of the Burns Pumping Plant. This is a total of 805 acres which will receive water from the natural flow of Little Brush Creek plus supplemental water from natural flows of Big Brush Creek which will be released from Tyzack Reservoir to give the lands a full water supply. The natural flow of Big Brush Creek exceeds the amount of supplemental water needed, therefore, irrigation storage will not be required in Tyzack Reservoir. All of the remaining project lands will receive water from the Burns Pumping Plant.

Economic capacity of Tyzack Reservoir

Tyzack Reservoir is a multipurpose feature to be formed by a 145-foot-high earthfill dam.

The reservoir was sized by determining the maximum economical, municipal, and industrial diversion to Ashley Valley taking into consideration the advantages to irrigation, fish and wildlife conservation, recreation, and flood control associated with the various alternative municipal and industrial supplies. The maximum economical diversion was found to be 18,000 acre-feet annually, which would require a 24,000-acre-foot active capacity reservoir. Based upon this economic capacity and future growth

Table 4
Incremental analysis

Item	Incremental sizes			
	1	2	3	4
Tyzack Reservoir capacity (acre-feet)				
Active	12,000	18,000	24,000	32,000
Total	14,000	20,000	26,000	34,000
Tyzack Pumping Plant capacity (c.f.s.)	36	41	46	51
Burns Pumping Plant capacity (c.f.s.)	97	97	97	97
Municipal and industrial yield (acre-feet)	14,700	16,400	18,000	18,800
Irrigation yield (acre-feet)	4,600	4,600	4,600	4,600
Costs indexed to January 1974 ($1,000)				
Tyzack Dam and Reservoir	$11,840	$13,650	$15,410	$17,820
Tyzack Pumping Plant and Aqueduct	5,463	6,146	6,829	7,512
Burns Pumping Plant	2,851	2,851	2,851	2,851
Switchyards and transmission lines	644	668	691	715
Drains	619	619	619	619
Recreation	399	504	590	716
Fish and wildlife	24	31	36	44
Subtotal	21,840	24,469	27,026	30,277
Interest during construction	1,064	1,193	1,318	1,476
Total costs	22,904	25,662	28,344	31,753
Annual equivalent costs				
Amortized (3¼% for 100 years)	776	870	961	1,076
Operation, maintenance, and replacement	159	165	171	177
CRSP depletion costs ($2/acre-foot)	26	28	30	31
Total annual costs	961	1,063	1,162	1,284
Incremental costs		102	99	122
Annual direct benefits				
Irrigation	158	158	158	158
Municipal and industrial	1,570	1,751	1,922	2,007
Fish, wildlife, recreation, and flood control	88	114	136	160
Total annual benefits	1,816	2,023	2,216	2,325
Incremental benefits		207	193	109
Incremental benefit-cost ratio		2.0:1	2.0:1	0.9:1
Incremental net benefits		105	94	-13

anticipated, Vernal City passed a resolution on October 23, 1974, indicating a desire for 18,000 acre-feet of water from the project. Table 4 on page 16 shows the incremental step analysis used to determine the maximum economical diversion.

Tyzack Pumping Plant and Aqueduct

Tyzack Pumping Plant will be located adjacent to Tyzack Dam and will pump water to Ashley Creek above the major irrigation diversion. The water will then be exchanged for the high quality Ashley Spring water. The 46-second-foot-capacity pumping plant will pump 18,000 acre-feet annually into the Tyzack Aqueduct under an average maximum head of 518 feet. By utilizing the spills of Steinaker Reservoir, it would be possible to reduce pumping to about 15,800 acre-feet. The pump was sized at 46 second-feet based on the coordinated operation of Tyzack Reservoir and the monthly municipal and industrial demand.

Burns Pumping Plant and Discharge Lines

The 97-second-foot design capacity Burns Pumping Plant will be located on the west bank of the Green River about 2½ miles north of Jensen, Utah, as shown on the frontispiece map. The plant will have separate discharge lines to four existing canals--Sunshine, Burns Bench, Burton, and Murray--and will provide capacity to meet the maximum demand of the canals.

The capacity of the canals based on the maximum historical diversion is as follows.

	Second-feet
Sunshine Canal	47
Burns Bench Canal	40
Burton Ditch	18
Murray Ditch	12

The existing canals can carry the project deliveries to the project lands with minor extensions and cleaning.

The maximum demand will occur in July of several years when no water will be divertible from Brush Creek for irrigation. The average annual discharge will be 9,900 acre-feet of which 230 acre-feet would be pumped during off-peak periods and delivered to Stewart Lake Waterfowl Management Area.

The design capacity of the pumping plants and the sizes and lengths of the discharge lines are as follows.

Pumping plant design data

Canal	Pumping plant Head (feet)	Capacity (second-feet)	Discharge line Diamater (inches)	Length (feet)
Sunshine	195	33	33	4,950
Burns Bench	90	39	36	1,550
Burton	52	13	21	1,350
Murray	70	12	24	2,750

Other project uses

Fish and Wildlife

Several specific measures in the Jensen Unit will be beneficial to fish and wildlife resources. Stream fishing opportunities on Big Brush Creek between Tyzack Dam and the confluence of Little Brush Creek would be reduced. Reservoir fishing opportunities will be greatly enhanced by the 2,000 acre-feet of inactive and dead capacity provided in Tyzack Reservoir.

The project would enhance the operation of the Stewart Lake Waterfowl Management Area by delivery of water via project drains, the existing Burns Bench Canal, and the proposed Stewart Lake Lateral to a more desirable point of delivery in the waterfowl management area. The delivery of water through these facilities would replace supplies presently obtained from diversions from Ashley Creek and from the Green River by pumping.

Approximately 500 acres of range will be rehabilitated to mitigate the loss of deer winter range that will result from inundation of the reservoir basin and construction of access roads around the reservoir.

Several meetings were held with the U.S. Fish and Wildlife Service and the Utah State Division of Wildlife Resources during which they recommended that a minimum pool of 2,000 acre-feet in Tyzack Reservoir be provided and concurred with the plan of no stream fishery bypass at Tyzack Dam. Although minimum fishery releases from the reservoir were not requested, an alternative with minimum streamflows was studied. The section "Alternative Plans" describes this alternative in detail. The fish and wildlife benefits are estimated to be $24,000 annually.

Recreation

Recreation potential at Tyzack Reservoir is limited by topography, but there are two sites with sufficient size to meet the expected use. A site on the north shore could be used for recreational development at some time in the future, and a site on the south shore would be developed. Recreation facilities include those for boating, picnicking, camping, and administration. The Utah Division of Parks and Recreation is presently administering recreation facilities at Steinaker Reservoir and is recommended as the administering agency for the recreation area at Tyzack Reservoir.

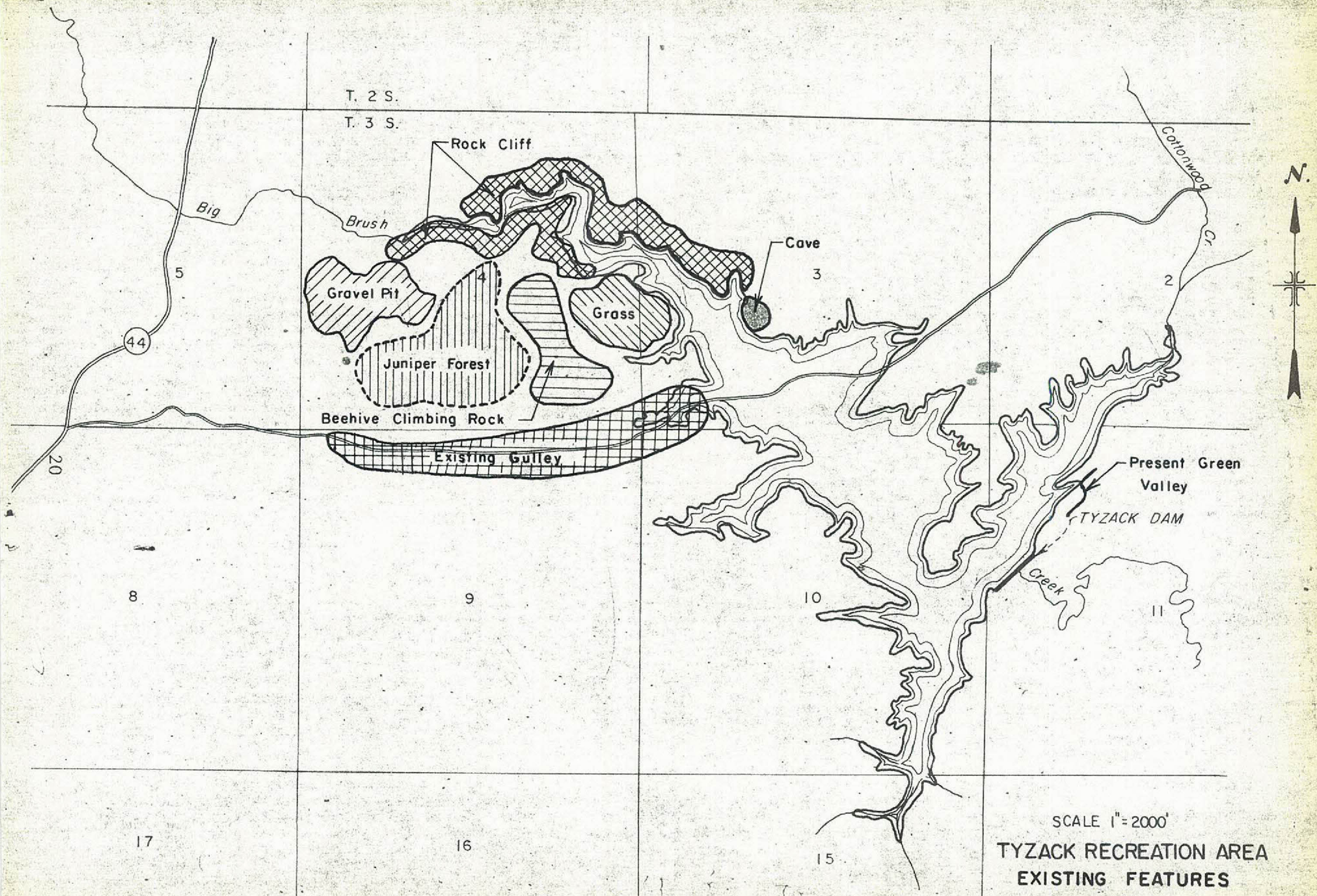
The natural characteristics of the south shore recreational area are shown in Figure 2. The west border is a gently sloping hillside covered with a juniper forest. Along the north and east is a deep gorge with a steep yellow sandstone cliff and on the southeast there is a small flat grassy and sagebrush covered plateau overlooking the proposed reservoir. The area is bounded on the south by a deep wash. Three basic arrangements are illustrated in Figures 3 through 5.

Arrangement 1, shown in Figure 3, would place the camp site in the juniper forest. This plan would provide very desirable camping since the campers would be located among the trees. This arrangement would save the best scenic areas for trails. The remoteness between the camp site and the reservoir with its boat ramp facilities and partial destruction of the forest would be negative factors for this alternative.

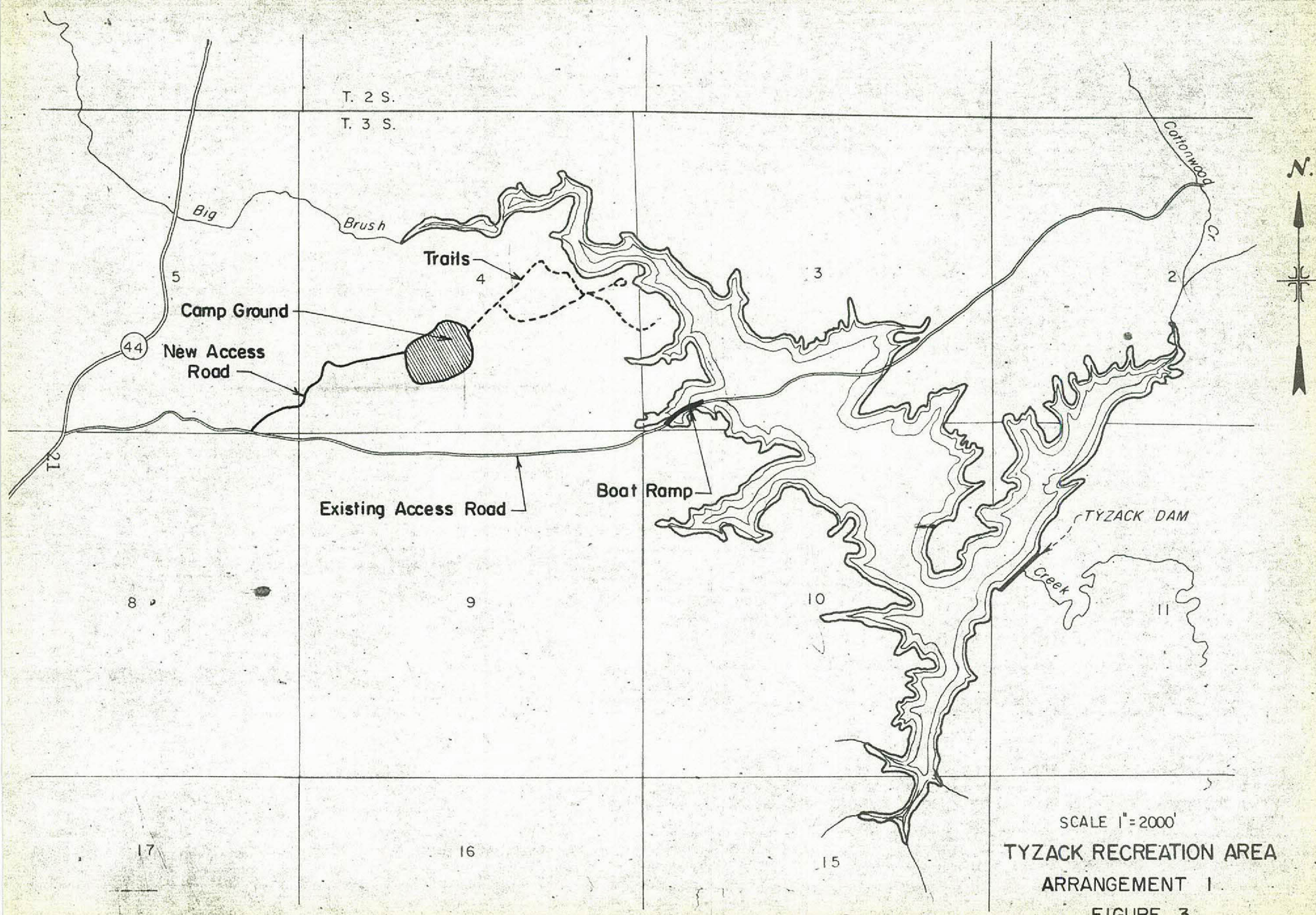
Figure 4 shows arrangement 2 and would locate the camp site on the existing gravel pit. The advantage here would be that damage caused by the construction of the camp site would occur on an area already damaged, thus minimizing scarring of the natural landscape. Also, the gravel pit is located looking northward with a very dramatic view over a very steep cliff. This plan would save the area's most desirable trails for the juniper forest. The major disadvantage is that the camp site would be both visibly and functionally away from the lake.

Arrangement 3, Figure 5, is based on the premise that the way to minimize ecological damage from road building is to utilize as much as possible the present access road. This plan results in the shortest lengths of the new road to the camp site on the grassy plateau. This camp site location is considered best for view and proximity to the lake and also for construction. The shortness of the road and its location in relatively unimportant terrain from the visual point of view result in minimum ecological damage. Low road construction costs would be somewhat offset by the fact that a bridge is necessary over one ravine, and deeper roadcuts would be required. The major visible advantage of arrangement 3 is that it saves the best area for trails yet keeps the camping site at the best location. This plan also moves the boat ramp closer to the low water shoreline, utilizes the old road structure for this function, and does not prevent a future small campground expansion into the juniper forest.

Additional recreation opportunities are currently being evaluated which could be included as part of the Jensen Unit recreation plan. The Tyzack Aqueduct and power transmission lines' right-of-way and easements could provide a natural trail system for off-road vehicles to use as a

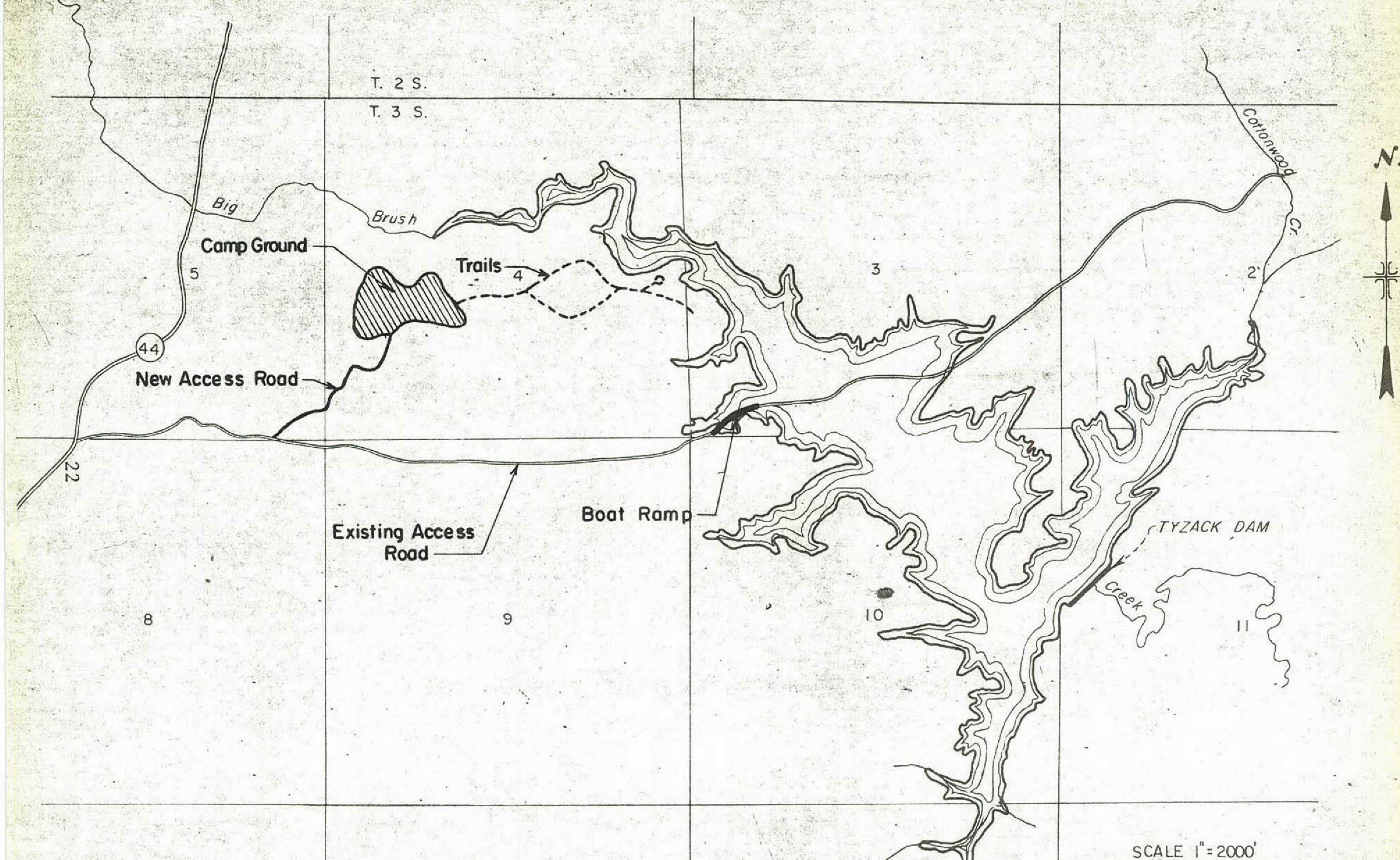


TYZACK RECREATION AREA
EXISTING FEATURES
FIGURE 2



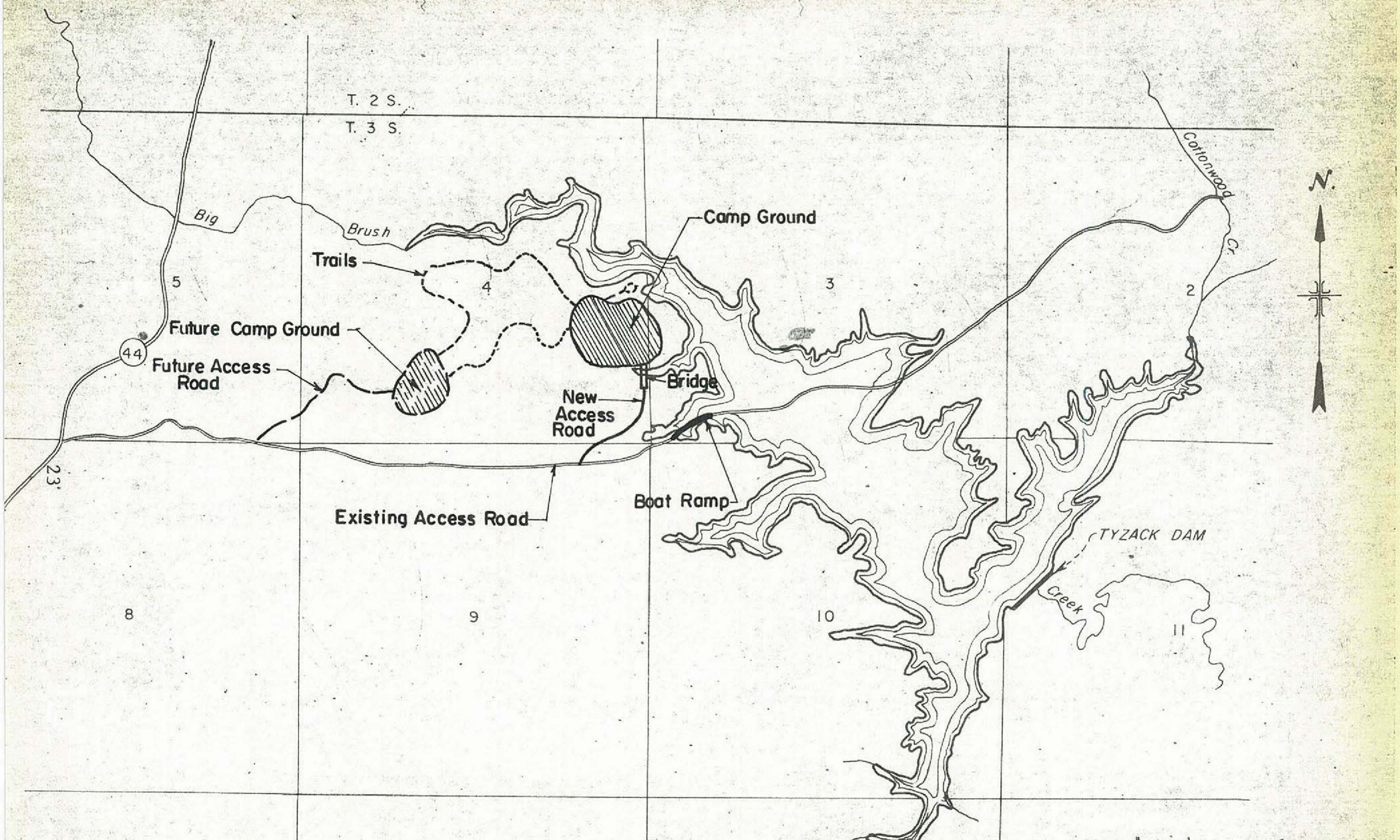
SCALE 1" = 2000'

TYZACK RECREATION AREA
ARRANGEMENT I
FIGURE 3



SCALE 1" = 2000'

TYZACK RECREATION AREA
ARRANGEMENT 2
FIGURE 4



TYZACK RECREATION AREA
ARRANGEMENT 3
FIGURE 5

tie between Steinaker Reservoir and Tyzack Reservoir. The gravel pit near the Tyzack Reservoir site will be used as a borrow area for the recreation access road. With proper dressing and contouring it could also provide additional opportunity for recreational vehicles.

The Utah Division of Parks and Recreation has expressed particular interest in including the lower Brush Creek gorge area into the Tyzack Reservoir recreation area. There might possibly be an opportunity for developing the hiking and fishing potential of this area. Presently, access to the gorge is on Stauffer Chemical Company's land above a large spring. An old walkway up through the mouth of the gorge has since been washed out but could be rebuilt if easements were obtained.

According to the U.S. Fish and Wildlife Service there may be an opportunity for enhancement of fishery and wildlife values in lower Ashley Creek, between Vernal City's sewage treatment plant and the Green River. The Bureau of Reclamation has the capability to acquire access to specific areas for hunting or fishing purposes. If the benefits of this suggestion prove sufficiently high to justify land acquisition proceedings, the bureau could cooperate with the U.S. Fish and Wildlife Service in this regard. Sufficient data are not available to make a decision at this time, but upon receipt of additional data from the Fish and Wildlife Service, the suggestion could be further investigated.

The annual benefits from recreational development at Tyzack Reservoir have been estimated by the National Park Service and amount to an average of $88,200 annually over a period of 100 years.

Flood Control

Preliminary studies have been made by the Corps of Engineers and included field investigation of past flood damages. The benefits for control of floods not exceeding the 100-year event have been estimated at $24,000 annually.

Stage Construction

Before the energy shortage, stage construction of the Jensen Unit had considerable merit because the requirement for municipal and industrial use was projected to develop more slowly, whereas the irrigation requirement was well known and existing.

During the earlier Jensen Unit plan formulation, two different plans for timing of construction of the features were considered. The first plan consisted of immediate construction of Tyzack Dam and Reservoir, with later construction of Tyzack Pumping Plant and Aqueduct and Burns Pumping Plant. The second plan called for immediate construction of Burns Pumping Plant, with later construction of Tyzack Dam, Pumping Plant, and Aqueduct.

Analysis of the two plans showed the second to be the most economical, although not the most preferred. Local water users have expressed a strong desire for a reservoir to store and regulate irrigation water, provide flood protection, and enhance recreation, fish and wildlife, and scenic values associated with the reservoir.

As the result of the energy shortage, municipal and industrial water would be needed earlier than expected. To meet these needs, Tyzack Dam, Pumping Plant, Aqueduct, and Burns Pumping Plant would need to be constructed as a single stage development.

Economic Justification of Jensen Unit

The economic justification of the Jensen Unit on a benefit-cost comparison basis is discussed in the Financial and Economic Analyses Appendix, and details are summarized in the summary sheets at the front of this appendix.

For a 100-year period of analysis with interest at 3¼ percent, the estimated direct benefits for all project purposes are $2,299,000 annually. The estimated total annual benefits, including indirect and public irrigation benefits, are $2,324,000.

The average annual equivalent of the total estimated costs of the development, annual operation, maintenance, and replacement, and stream depletion allowance for the 100-year analysis period is $1,371,000 as of January 1975. The annual direct benefits compared with the total average annual equivalent cost is a ratio of about 1.68:1 and the annual total benefits compared with the costs is a ratio of about 1.70:1. Thus the Jensen Unit would be justified using only direct benefits.

CHAPTER IV

ALTERNATIVES

General

By definition an alternative is a proposition or situation offering a choice among two or more things or courses. An alternative that would satisfy all conditions equally is unlikely. The validity or reasonableness of an alternative must be established by considering: (1) its ability to satisfy demonstrated needs, (2) relative cost, (3) time frame of availability, (4) social acceptance, and (5) its adaptability to changing or future conditions.

Alternatives to the Jensen Unit discussed below are (1) nondevelopment of water supply, (2) partial development of the water supply, (3) alternates to the proposed plan, and (4) alternative features and operations of the proposed plan. Table 3 shows a summary of the most practical alternatives discussed in this section.

Nondevelopment of the Water Supply

Under this alternative, none of the features of the proposed plan would be constructed and the existing and projected water requirements would be largely ignored. Growth and development of the area and its resources would be limited and the out-migration of people from farms, resulting from the unstable agricultural economy, would probably continue. Without additional water supplies, landowners in the Jensen Unit area would be deprived of optimum production from their property. Growth that could result from development of energy resources would be stymied.

Some of the impacts of this alternative would be far reaching to the local residents. Rural development would stagnate because it would be impractical to expand agricultural enterprises without adequate water supplies to sustain crop growth. Development of the natural resoures of the Uinta Basin would be curtailed. Many people, especially the younger generation, would be forced to seek employment elsewhere, likely in the densely populated Wasatch Front area. Water and land used for agriculture would gradually be converted to municipal and industrial use. This would probably continue until the total existing water supply became reapportioned for municipal and industrial use.

The Ashley Valley water users have extended municipal water lines to the town of Jensen based on replacing present supplies from the Jensen Unit. If the Jensen Unit were not developed, there would not be enough municipal water to supply existing users with a full water supply.

Partial Development of the Water Supply

Irrigation only

Jensen Unit water would be supplied to 3,640 acres of supplemental service land and 440 acres of full service land. The unit would provide 4,600 acre-feet of water annually to meet the irrigation requirements of these lands by one of the following described methods or alternatives.

One alternative plan would be to meet this 4,600-acre-foot demand by pumping from the Green River at Burns Pumping Plant near Jensen, Utah. The pump would have a capacity of 90 second-feet which would allow for peaking. The construction cost of this alternative would be $3,818,000. The annual operation, maintenance, and replacement costs would be $21,000.

The second alternative for irrigation only would be the construction of Tyzack Reservoir with a smaller capacity than in the proposed plan. The reservoir would store 10,000 acre-feet of water and would provide an annual yield of approximately 4,600 acre-feet. Water from this reservoir would serve the same lands as the Burns Pumping Plant alternative. The construction cost of this alternative would be $11,824,000. The annual operation, maintenance, and replacement costs would be $40,000. The local water users would prefer the reservoir alternative to the pumping plant alternative. Figure 6 is a sketch drawing of the irrigation only alternatives.

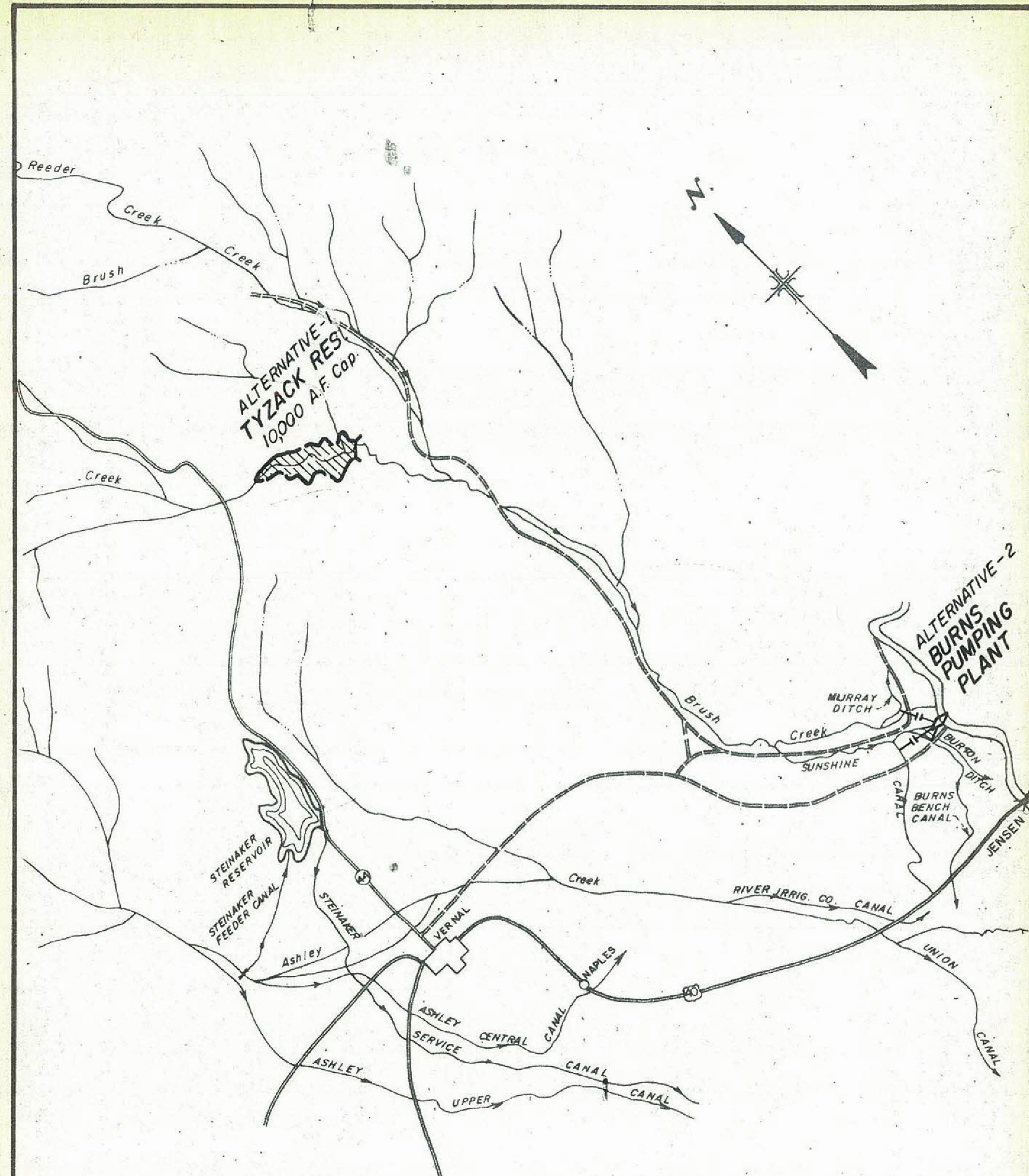
Municipal and industrial water only

This alternative would provide a municipal and industrial water supply to the project area by pumping from the Green River near the proposed Burns Pumping Plant site. The plan would include three pumping plants and a 16.3-mile-long aqueduct. Green River Pumping Plant No. 1 with a capacity of 46 second-feet would pump 18,000 acre-feet of water annually through the Green River Aqueduct to Pumping Plant No. 2 which would then lift the project water to Pumping Plant No. 3 which would pump the water into Ashley Creek just above the first major diversion for irrigation. Water could be diverted into Steinaker Feeder Canal at the third pumping plant and delivered to Steinaker Reservoir. The alternative is shown on Figure 7.

Alternative sources of water

Water Production from Oil Wells

Water is brought to the surface with oil in nearly all oil wells in the Uinta Basin. The quantity and quality of water produced vary from one well to another within an oil field and, to an even greater degree, between oil fields.



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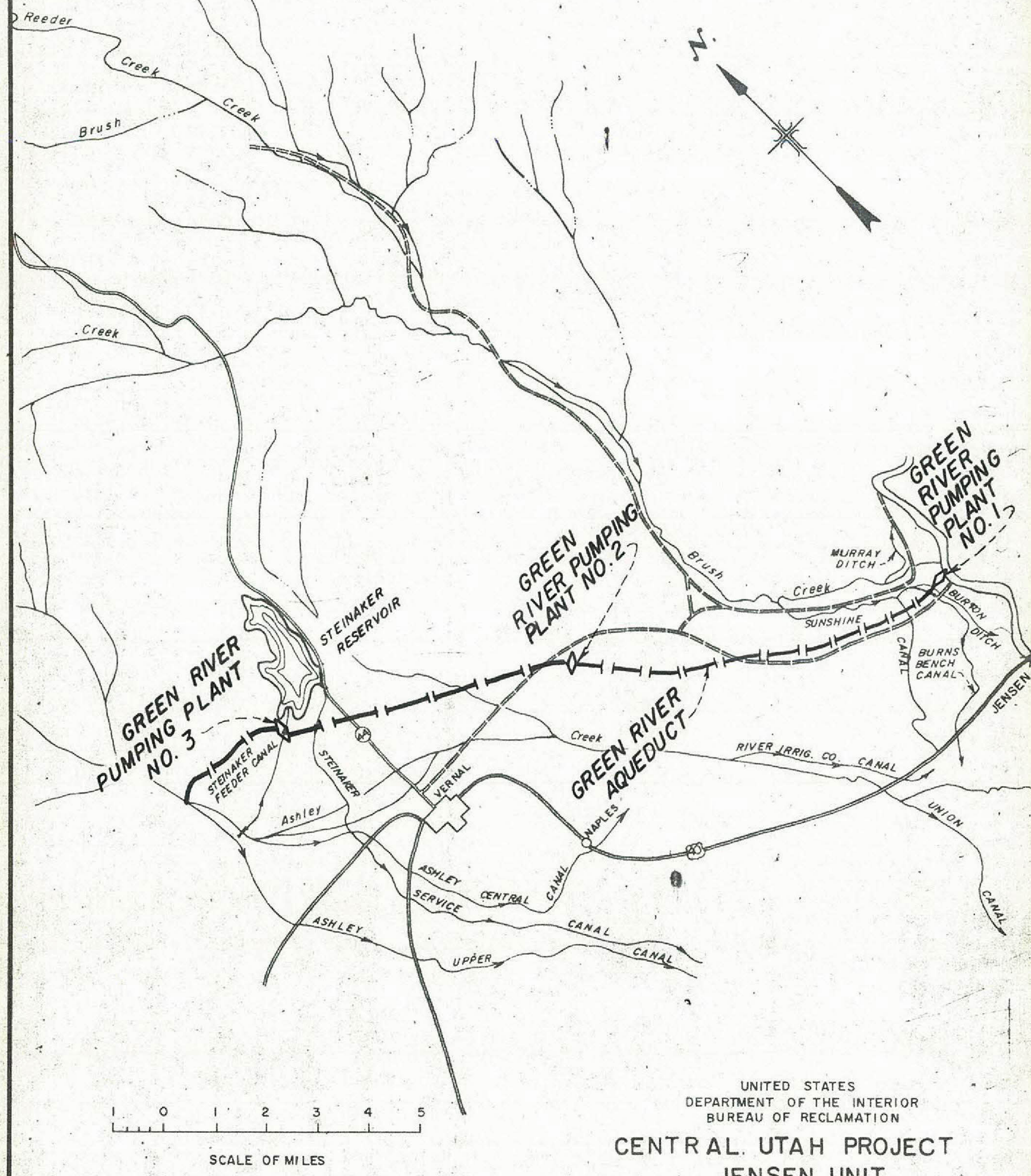
JENSEN UNIT
IRRIGATION ONLY ALTERNATIVE

SEPTEMBER, 1975

FIGURE 6



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CENTRAL UTAH PROJECT
JENSEN UNIT
MUNICIPAL AND INDUSTRIAL WATER
ONLY ALTERNATIVE
SEPTEMBER, 1975
FIGURE 7

The Ashley Valley Oil Field located about 8 miles southeast of Vernal, Utah, is the main water producer. Water production from the Ashley Valley field during 1960 accounted for about 91 percent of the total water produced from all Uinta Basin oil fields. The water yield from the Ashley Valley field has increased from nothing in 1948, 18,700,000 barrels (2,400 acre-feet) in 1960, to 35,152,000 barrels (4,500 acre-feet) in 1973.

A 1962 study indicated the sum of the dissolved solids of the water from oil wells in the Ashley Valley Oil Field to range from 500-2,000 parts per million. The water at that time was being used for irrigation purposes in the vicinity of the oil field and eventually drains into the Green River. The water is principally a calcium sodium sulfate type, having bicarbonate as an additional important consitituent.

A high sodium content is the principal reason that much of the water from the Ashley Valley field is classified as doubtful to permissible for irrigation use. Unless compensated for by gypsum in the soil or in the water, high sodium content in irrigation water causes clayey soils to deflocculate and to become hard and impermeable. Fortunately, in the Ashley Valley area, gypsum derived from the Mancos shale makes it possible to use some of this water for irrigation purposes. Use of ground water containing greater than 500 mg/l of total dissolved solids is not recommended for household use if water of better quality is available.

Weather Modification

Weather modification represents a source of new or additional water by producing runoff from precipitation that normally would not have fallen in the area. During the colder seasons (November-April) the mountains act as a natural storage area for precipitation in the form of snow. Research programs now in progress under the direction of the Bureau of Reclamation (Project Skywater) and others indicate a good possibility of increasing precipitation and streamflow about 15 percent. Cloud seeding is still in the developmental stages and is successful only under certain circumstances. Nature has to first provide the clouds. Perhaps in a few more years it will be the least expensive tool in water-resource development, but now it can only help under ideal circumstances.

Weather and atmosphere modification could be considered as an alternative source of water for the Jensen Unit, although quite speculative at the present time. Assuming the weather could be modified to produce about 15 percent more precipitation and runoff, it is very doubtful that the existing reservoirs would have enough long-term carryover storage to hold the additional water. For example, Steinaker Reservoir empties about 10 years of 43 years historically, and during these shortages the extra 15 percent could be claimed by the present water users. Based on historical records, about 25 years out of 43 years Steinaker Reservoir would spill and this additional 15 percent could not be stored and would be lost. It is possible that the Tyzack Reservoir watershed could produce the additional water supply. The prime target area would be the Ashley and Brush Creek drainages north and west of Vernal, Utah. The increased runoff would be stored in the existing reservoirs and proposed Tyzack Reservoir. Figure 8 shows the hydrologic cloud seeding potential of the Jensen Unit area.

Silver iodide, the most commonly used nucleative agent, is also the most water insoluable salt known according to Merck Index. Many tests have been made which indicate that silver iodide residue resulting from normal cloud seeding operations would not likely have significant ecological impact. It did not appear to be a hazard to humans and would not be ingested to any appreciable extent by animals and fish according to the test conducted by the Bureau of Reclamation.

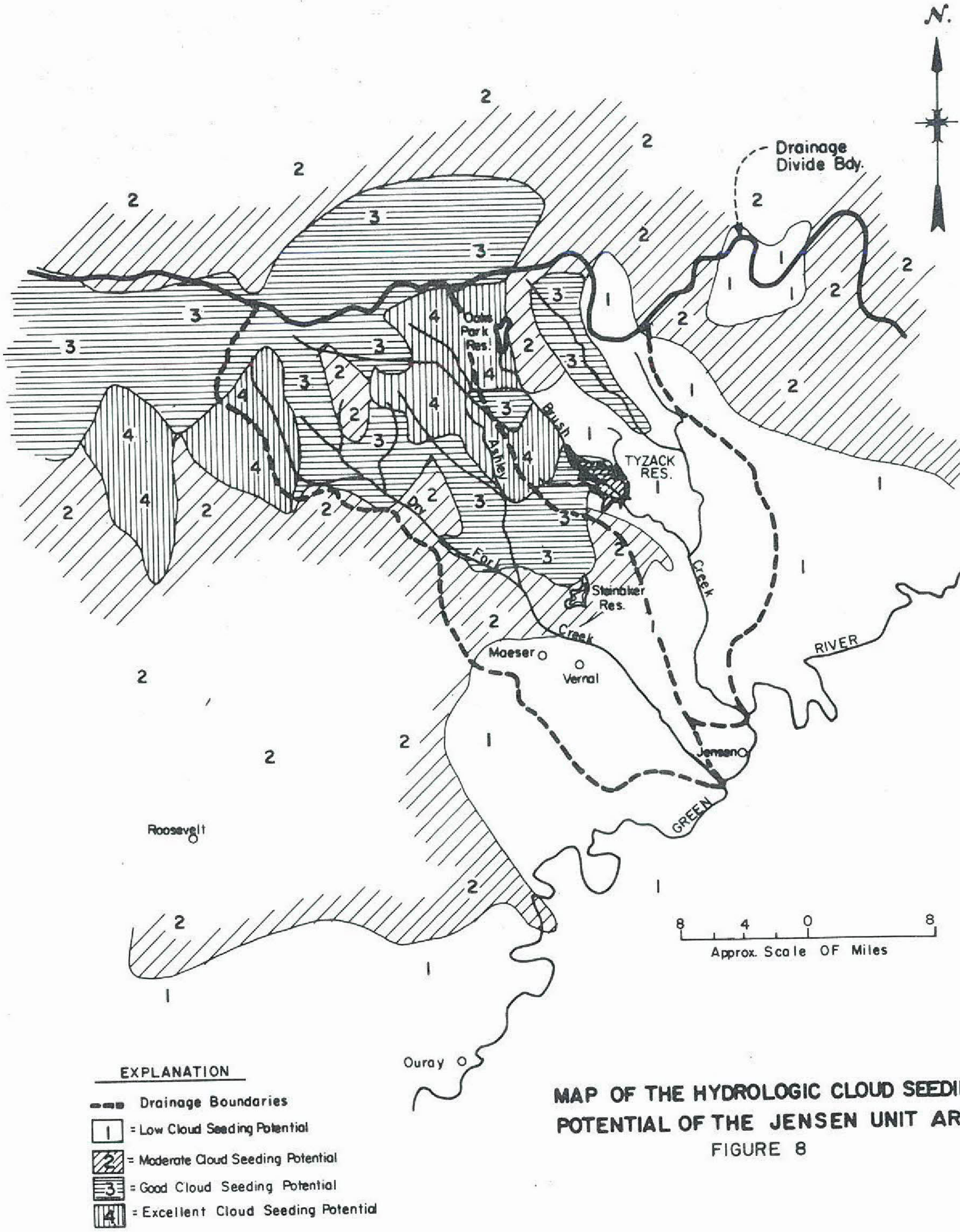
The environmental impacts of increased snowfall are difficult to assess. The pattern of snowfall, distribution, and snowmelt would probably not change as the total precipitation increased. Tests are being conducted but are as yet inconclusive on (1) the effects of cloud seeding downwind, (2) effects of increased precipitation on avalanche occurance, (3) increased erosion, and (4) increased cost and problems associated with snow removal. Indications are that the adverse impact in these areas would not be substantial. It will take several years of data gathering and analysis to answer all the questions related to weather modification, therefore it is not considered a reasonable alternative.

Water Saving Measures

In water planning and use, numerous conservation and reuse measures could be implemented. Some of these might be considered as alternatives to the Jensen Unit. In all water-resource planning, consideration should be given to such things as phreatophyte control, control of evaporation resulting from water impoundment, increased efficiency of present and future water systems, pricing of water to restrict wasteful uses, recycling and reuse of sewage effluents including tertiary treatment, and better management techniques. The potential for development of these possibilities in the Jensen area is presently inconclusive. The list of available water saving measures and water saving management methods that can be employed for more efficient water uses is long and varied. Most are not real alternatives to water resource development but part of it.

Importation of Water from Another Drainage

Importation of water from an adjoining drainage would be possible but improbable in the foreseeable future. The flows of Brush Creek if developed appear adequate for the present and projected future municipal and industrial needs in the project area until year 2000 or later. Sufficient water is readily available in the Green River to satisfy the agricultural requirement.



MAP OF THE HYDROLOGIC CLOUD SEEDING POTENTIAL OF THE JENSEN UNIT AREA

FIGURE 8

Longer range planning involving possible augmentation of the Colorado River from other river basins could conceivably include water transfers and exchanges affecting the unit area.

Trout Creek Dam and Reservoir

The proposed reservoir is located on the North Fork of Ashley Creek in sec. 16, T. 1 S., R. 20 E., Salt Lake Meridian, immediately below the confluence of Trout Creek and the North Fork of Ashley Creek. The reservoir would have 25,000 acre-feet total capacity. The Vernal Unit develops nearly all of the water on Ashley Creek; therefore firm yield of Trout Creek Reservoir, when considering a municipal supply with no shortages, would average about 3,200 acre-feet annually. A 2.8-mile-long feeder pipeline from the South Fork of Ashley Creek to the reservoir would be needed to firm up the 3,200-acre-foot yield. The reservoir would also act as a flood control reservoir for Ashley Creek.

Estimated cost of the dam, reservoir, and feeder canal according to Bureau of Reclamation standards is $10,380,000 indexed to January 1974. Details of the plan are shown in Figure 9.

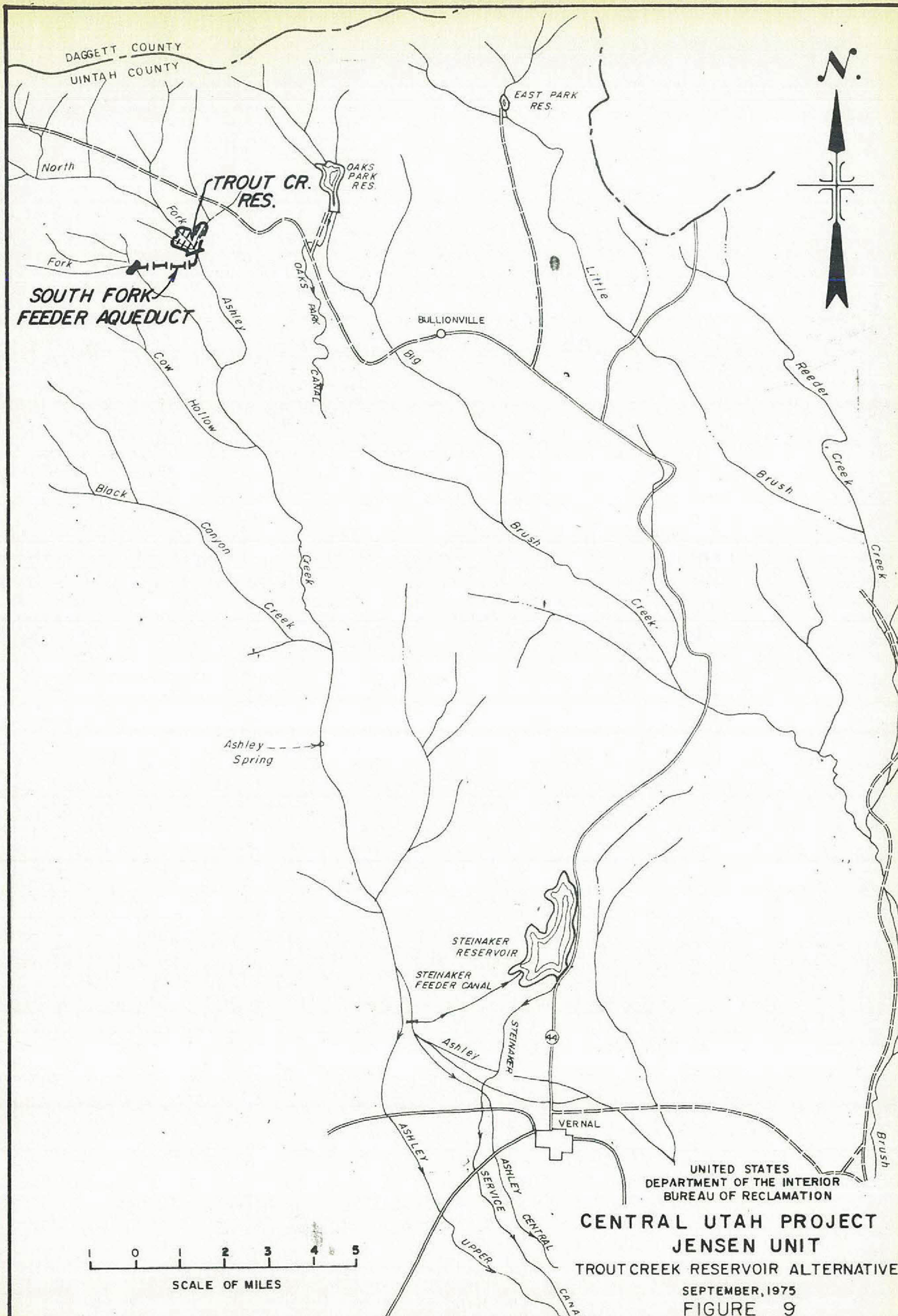
Soldier Park Reservoir with Red Cloud Diversion Dam

Under this plan of development, storage would be provided at the Soldier Park Reservoir site on the North Fork of Ashley Creek. The Red Cloud Aqueduct would divert flows from Big Brush Creek to Ashley Creek at a point just below its confluence with Anderson Creek. The reservoir and aqueduct would develop 4,000 acre-feet of water annually which would be used for municipal and industrial purposes. This would be about one-fourth the amount developed by the proposed plan for this purpose. Burns Pumping Plant on the Green River would supply irrigation water as in the proposed plan but would pump an average of 7,000 acre-feet annually. Part of this water would be replacement water diverted by Red Cloud Aqueduct.

Soldier Park Reservoir would have an active capacity of 5,000 acre-feet and would inundate about 167 acres. The Red Cloud Aqueduct would be approximately 6.6 miles long and have a capacity of 35 second-feet. The flows would be diverted downstream in Ashley Valley to the point of use or to Steinaker Reservoir. Project water would probably be exchanged with water from Ashley Springs. See Figure 10 for details.

Trout Creek Reservoir with Red Cloud Diversion

This plan is a combination of the Trout Creek Reservoir plan and the Red Cloud Diversion. Trout Creek Reservoir would yield a firm municipal supply of 3,200 acre-feet, provide flood protection for Ashley Creek, and would have a total capacity of 25,000 acre-feet. The South Fork Feeder Canal would be used to firm up the 3,200-acre-foot yield.


DAGGETT COUNTY
UINTAH COUNTY
EAST PARK RES.
OAKS PARK RES.
TROUT CR. RES.
North
Fork
Fork
SOUTH FORK FEEDER AQUEDUCT
Ashley
OAKS PARK CANAL
BULLIONVILLE
Big
Little
Reeder
Creek
Brush
Creek
Cow
Hollow
Black
Canyon
Creek
Creek
Brush
Creek
Ashley Spring
STEINAKER RESERVOIR
STEINAKER FEEDER CANAL
Ashley
STEINAKER
44
VERNAL
ASHLEY
ASHLEY SERVICE
ASHLEY CENTRAL
UPPER
CANAL
Brush
N.
1 0 1 2 3 4 5
SCALE OF MILES
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CENTRAL UTAH PROJECT
JENSEN UNIT
TROUT CREEK RESERVOIR ALTERNATIVE
SEPTEMBER, 1975
FIGURE 9

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SOLDIER PARK RESERVOIR ALTERNATIVE
SEPTEMBER, 1975
FIGURE 10

The Red Cloud Aqueduct would divert flows from Big Brush Creek to Ashley Creek at a point just below its confluence with Anderson Creek. The diversion would develop about 3,600 acre-feet of municipal water annually.

Burns Pumping Plant on the Green River would supply irrigation as in the proposed plan, but would pump an average of 7,000 acre-feet annually, and would have a capacity of 90 second-feet. See Figure 11 for details.

Oaks Park Reservoir enlargement

Another alternative considered was the enlargement and use of the existing Oaks Park Reservoir for municipal and industrial purposes. The Oaks Park Reservoir Basin would physically limit the economical size of the enlargement to about 14,000 acre-feet total capacity. Present capacity is 5,750 acre-feet. A combination of this physical limitation and a very limited water supply would reduce the municipal and industrial yield to about 2,500 acre-feet annually. Table 5 shows the most economical size to be about 7,500 acre-feet with a firm yield of 2,040 acre-feet annually. Water supply operation studies indicate it would be necessary to make winter releases from Oaks Park Reservoir to meet the municipal and industrial demand pattern. Winter operation of a reservoir 9,300 feet above sea level would be difficult.

Table 5
Oaks Park Reservoir enlargement

Total capacity (acre-feet)	Municipal and industrial yield (acre-feet)	Annual cost per acre-foot 1/
14,000	2,500	$63
12,000	2,370	59
10,000	2,235	56
9,000	2,170	54
8,000	2,100	52
7,500	2,040	52
7,000	1,920	53
6,500	1,500	63
6,000	500	167
5,750		

1/ Operation, maintenance, and replacement costs were not included. Cost per acre-foot values were allocated on use of facilities method at 5.116 percent for 50 years.

The enlarged reservoir (14,000 acre-feet) would inundate an additional 230 acres of Ashley National Forest land and about 1 mile of Big Brush Creek and two smaller creeks. Although the level of the reservoir

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TROUT CREEK RESERVOIR WITH
RED CLOUD DIV. DAM
DECEMBER 1975
FIGURE 11

would be drawn down annually, some recreational benefits would be anticipated from the enlargement. The annual drawdown would necessitate a put-and-take trout stocking program to maintain the reservoir fishery.

About 2.4 miles of Big Brush Creek directly below the dam site would be adversely affected with no fishery releases from the reservoir. An additional 2.1 miles of Big Brush Creek above the cave and about 12 miles below Brush Creek Springs would be subjected to reduced flow with accompanying losses.

With the additional water developed from the enlarged reservoir, it would be necessary to rehabilitate the Oaks Park Canal in the Grasshopper Flats area where abnormal erosion is occurring. The cost of a combination pipe and chute section to correct the erosion problem and the cost of filling in and seeding the old ditch was included in cost per acre-foot analysis shown in Table 5.

The Burns Pumping Plant would be required for this alternative, however, further study is necessary to determine its capacity. The relationship of the water supply of the upper and lower Brush Creek areas is complicated by the Brush Creek sink area.

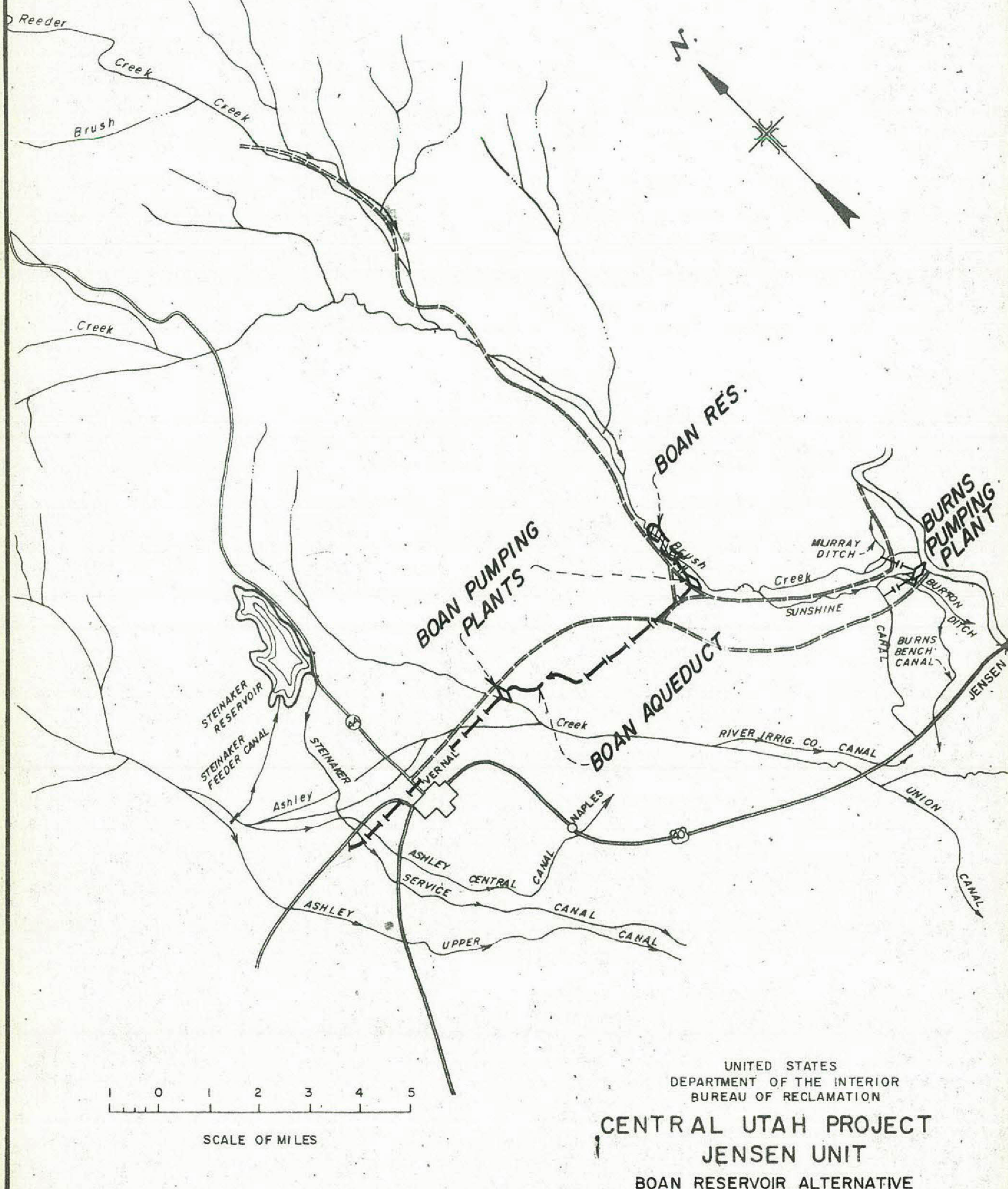
This plan would provide only a fraction of the municipal and industrial water needed for the Jensen Unit and the environmental impacts are more severe than other plans, therefore it is not a reasonable alternative to the Jensen Unit and was not considered further.

Boan Reservoir plan

Another alternative reservoir site is the Boan site, located about 10 miles downstream from the Tyzack site. The Boan Reservoir would inundate about 183 acres of land and 2.3 miles of flowing stream. The plan would require two 20-second-foot-capacity pumping plants and an 11.4-mile aqueduct to convey the water to the Vernal area for municipal and industrial use. The Burns Pumping Plant would remain the same as in the proposed plan. The Boan site is less attractive economically and geologically. In addition, the reservoir would inundate low-grade coal deposits. It would also be ineffective in reducing erosion between the two sites. The Boan site would be comparable to the Tyzack site for fish and wildlife propagation but would be much less scenic and less desirable for recreation use. See Figure 12 for location of facilities.

Brush Creek diversion

This alternative would provide 7,200 acre-feet of municipal and industrial water for the Vernal area. It would also provide 4,600 acre-feet of irrigation water from the Burns Pumping Plant. The plan includes a diversion dam on Big Brush Creek, pumping plant, switchyard, small (5,000-acre-foot) reservoir (East Upper Steinaker Reservoir), treatment plant,



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CENTRAL UTAH PROJECT
JENSEN UNIT
BOAN RESERVOIR ALTERNATIVE
SEPTEMBER, 1975
FIGURE 12

and an 8¼-mile-long aqueduct connecting these features. The maximum pump capacity would be 10 second-feet with an annual capacity of 7,200 acre-feet. Tyzack Reservoir would not be built under this option, therefore the water would be diverted directly out of Big Brush Creek and would be conveyed to the small reservoir, then to the treatment plant, and into Vernal City water tank. The small reservoir would provide additional storage and permit better regulation of the flow through the treatment plant.

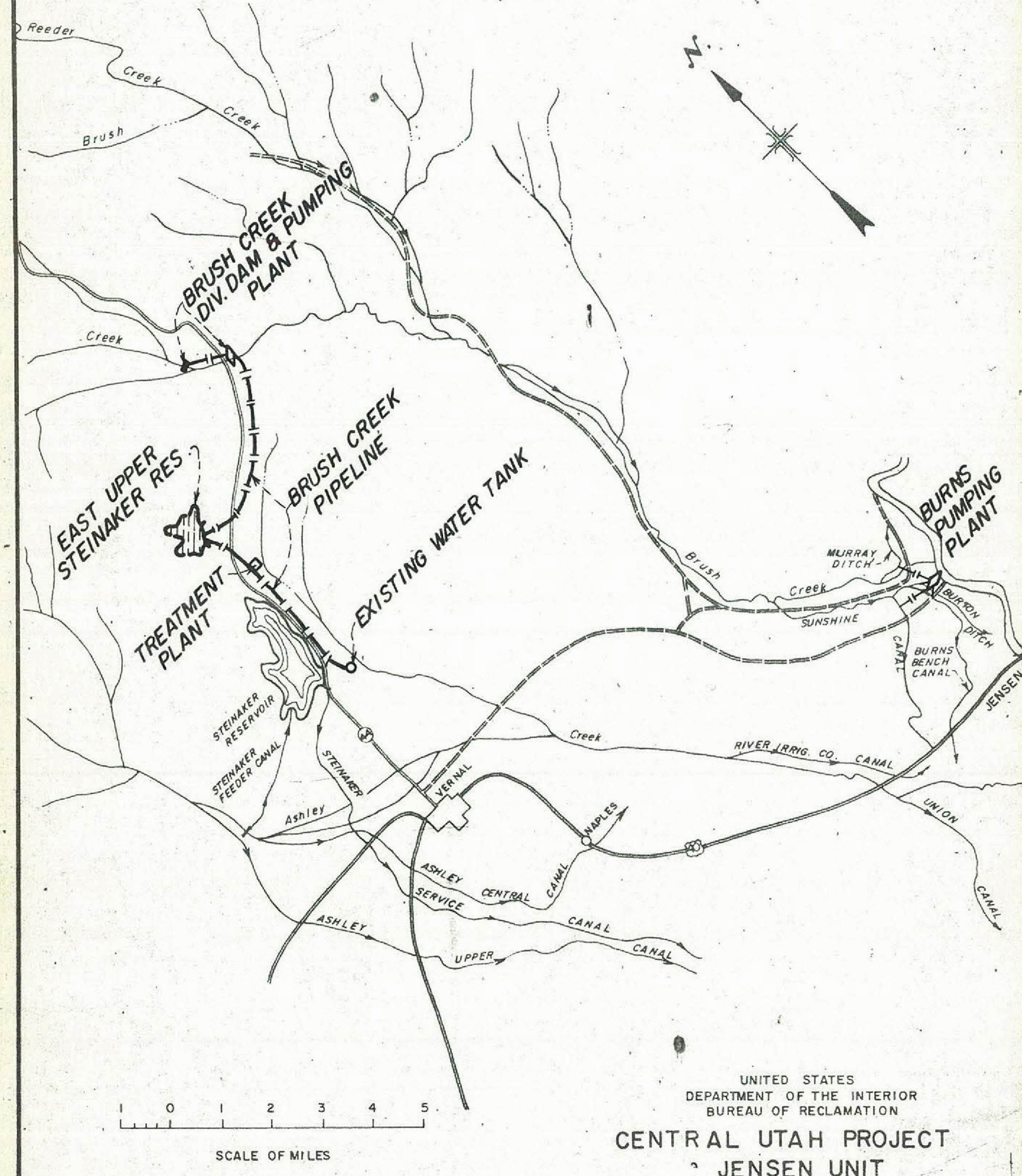
Several different plans were analyzed that would divert water from Big Brush Creek to the Vernal area. It was decided that the plan described above was the most feasible.

The diversion dam would be located far enough downstream from Big Brush Creek Gorge so that there would be no damage to the gorge. Excavation for the 8¼-mile-long pipeline would disrupt the landscape, and the pumping plants and discharge lines would create permanent scars and disrupt the landscape. The small reservoir would inundate 143 acres of land. The reservoir would have three small dams, each about 2,000 feet long and 74 feet high at the highest point. The three dams would have 896,000 cubic yards of embankment. See Figure 13 for location of facilities.

Tyzack Reservoir with minimum fishery bypass

The fishery of Big Brush Creek from the reservoir downstream to Little Brush Creek has been designated by Utah Division of Wildlife Resources as Class III (of significant fishery importance), while the lower portion from Little Brush Creek to the Green River is rated Class IV (poor) quality. Since no minimum release from the reservoir was requested by either Fish and Wildlife Service or Utah Division of Wildlife Resources for fishery purposes, all flows below the dam with the proposed plan would result from spills, irrigation releases, and seepages. It is expected that proposed flows below Tyzack Dam would be inadequate to support a trout fishery because of low winter flows. Field studies by the Utah Division of Wildlife Resources and observations by Brigham Young University show that the stream below the dam site has poor quality habitat and presently contains little worthwhile trout fishery.

Although minimum fishery releases from the reservoir were not requested, an alternative with minimum streamflows was studied. Under this alternative the Jensen Unit would be completed as presently proposed, except a minimum flow of 9 second-feet would be released from Tyzack Reservoir. This minimum release would approximate the average daily flow of Big Brush Creek at Tyzack Dam site for the months of September-April for the 1930-66 period. It was concluded that a release of 9 second-feet would be sufficient to maintain stream fishery provided one could be established. It would also be necessary to construct artificial habitat because the existing silty streambed has very few gravels or rocks, needed for food production and specie reproduction. This release would reduce



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CENTRAL UTAH PROJECT
JENSEN UNIT
BRUSH CREEK ALTERNATIVE
SEPTEMBER, 1975
FIGURE 13

the average annual yield of Tyzack Reservoir by 5,100 acre-feet. This would also result in a reduction in size of the Burns Pumping Plant to 86.7 second-feet.

Whether or not a flow of 9 second-feet or less would be adequate to sustain a viable trout fishery would depend upon the extent that the configuration of the stream channel maximizes creation of living spaces for trout during the winter months. This can best be ascertained only after the project is in operation. Assuming under project conditions that the problems of sedimentation, turbidity, and flooding could be solved and adequate habitat is produced, then negotiations could be initiated to provide for a minimum fishery release from Tyzack Reservoir.

Alternatives to the Proposed Plan

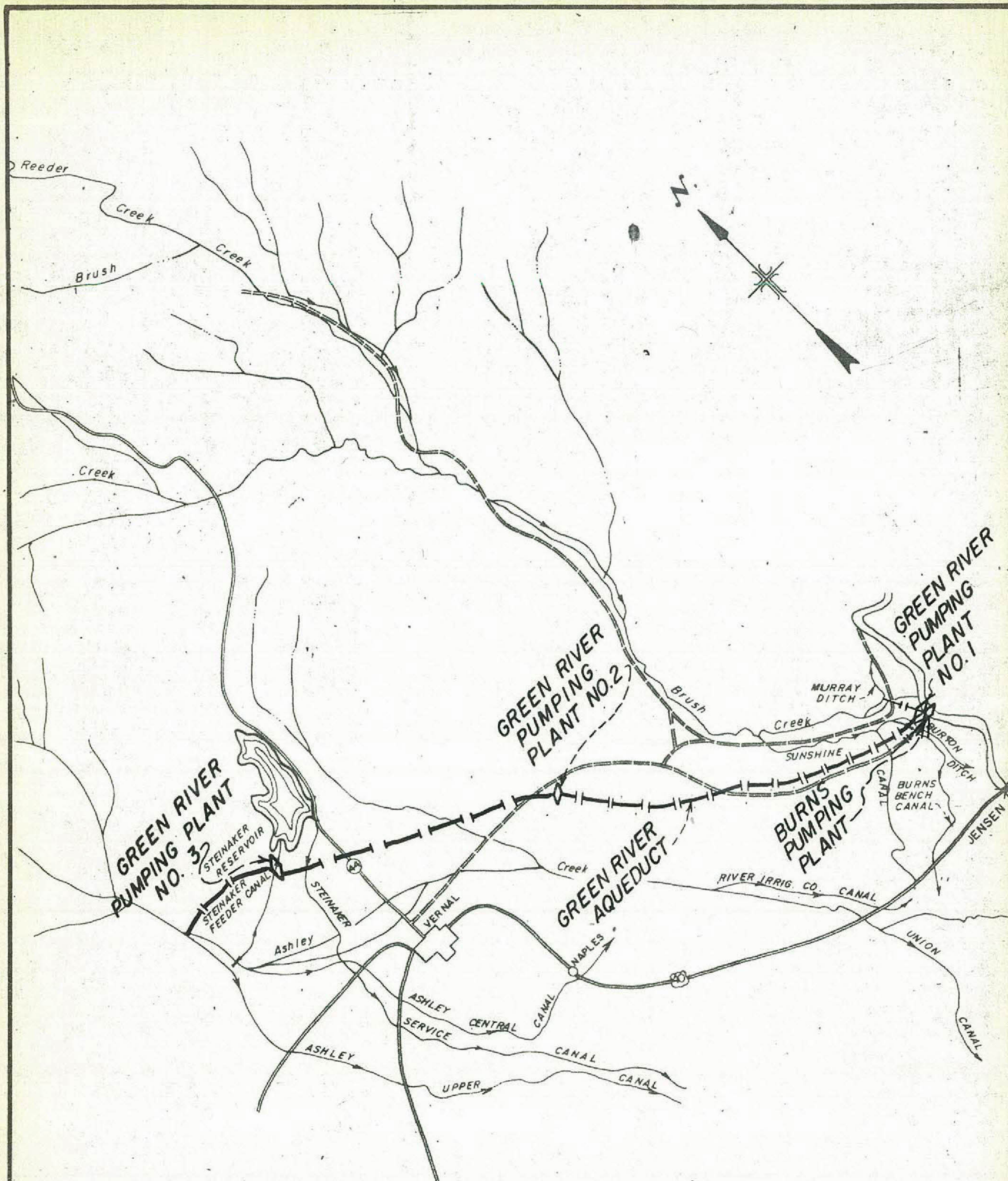
Green River with Burns Pumping Plant

The purpose of this plan is to pump from the Green River 18,000 acre-feet of water for municipal and industrial use and 4,600 acre-feet for irrigation. Tyzack Reservoir would not be built under this alternative. The 46-second-foot-capacity Green River Pumping Plant No. 1 would pump water through the 16.3-mile-long Green River Aqueduct. A second pumping plant would be necessary to pump to Steinaker Reservoir Feeder Canal where a third pumping plant would pump into Ashley Creek above major irrigation diversion as shown in Figure 14. Burns Pumping Plant would be at the same location as the proposed plan but would have a capacity of 90 second-feet rather than 97 second-feet as in the proposed plan.

Increased use of ground water

Ground water in the Jensen Unit area is available from two major systems. The first system exists in the shallow mantle of alluvium (silt, sand, gravel, and cobbles) that overlies a Mancos shale layer up to 5,000 feet thick. Water from this system is highly mineralized and cannot be used for municipal, industrial, or agricultural purposes without treatment. The average yield per well is low (21.5 gallons per minute).

The second system exists in various permeable layers of deep bedrock strata located below the Mancos shale, consisting of Weber, Dakota, Navajo, and Entrada sandstones and the highly fractured and cavernous limestones of the Pennsylvanian and Mississippian Ages. This formation is approximately 1,000 feet thick and underlies the entire Jensen Unit area at depths from 1,000 to 4,000 feet. The water contained in this formation is primarily transmitted and stored in the fracture voids and not in the pore spaces of the sandstone itself. Consequently, the success of a well depends entirely on intercepting sufficient interconnecting fractures that the desired amount of water can be transmitted to the well. In Utah, a 50 percent failure rate is common when drilling is



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CENTRAL UTAH PROJECT
JENSEN UNIT
GREEN RIVER ALTERNATIVE
SEPTEMBER, 1975
FIGURE 14

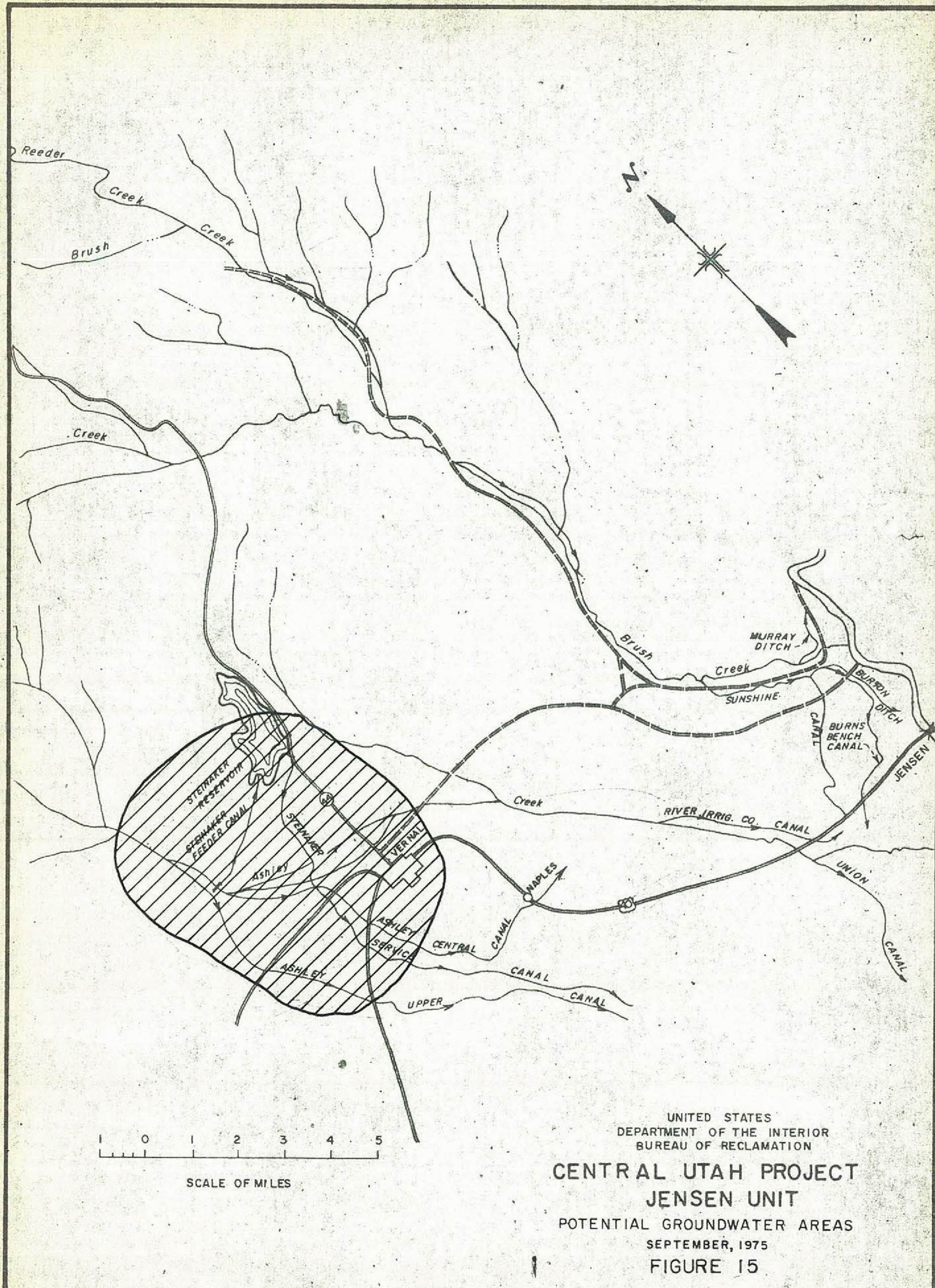
undertaken in this type of formation. Also, water from this system is of poor chemical quality but could be used for agricultural purposes. In general, this water has a fairly strong taste of iron and would require some treatment for municipal and some industrial uses.

Under ideal conditions, a properly developed well penetrating 1,000 to 2,000 feet of Weber sandstone could yield about 4 second-feet. This estimate is based on the yield of similarly fractured rocks in other areas. The extent to which this aquifer could continue to yield water to wells over an extended period of time is not known. The hydrologic properties of this formation have not been investigated in detail. Such an investigation would be necessary before any serious development is undertaken in this formation.

In the Jensen Unit area, 51 deep oil test wells of which 28 were located in the Ashley Oil Field were drilled to an average depth of 3,078 feet and yielded an average of 115 gallons per minute. The higher water producing wells of the Jensen Unit area are located in the northern part of Ashley Valley. Fifteen wells in this area drilled to an average depth of 1,503 feet yielded an average of 229 gallons per minute. The flows of a 2-second-foot well located near Merkley Park in Ashley Canyon are currently being exchanged by the city of Maeser for better quality Ashley Springs water. To develop this source of water to the extent that it could be considered as an alternative to the proposed plan would require the complete development of all existing wells and the construction of several new wells.

Wells drilled at the north end of the Jensen Unit area would have to be drilled 1,000 to 1,500 feet to reach the Weber formation. An additional 1,000 to 2,000 feet would have to be drilled to adequately penetrate it. Drilling such wells would cost at least $28 per foot, or about $84,000 per well. With a 50 percent failure rate, the cost would be about $168,000 for each successful well. These drilling costs would not include the cost of pumping and distribution facilities. The yield of each well would probably vary from ½ to 2 second-feet with an average of 1 second-foot. The average annual costs are shown in Table 3.

Well development is strongly opposed by local well owners. Based on the data above, approximately 46 wells would be required to provide the same capacity (46 second-feet) and as much water (18,000 acre-feet) for municipal and industrial use as the proposed Jensen Unit plan. These wells would be located in the potential ground water area north and west of Vernal as shown in Figure 15, and each well would have a pump, a transmission line, and a substation. Because of the high pump lifts, an additional energy source would be required. The method of collection and distribution of the water would have to await determination of the definite yield (proving up) of each well. The ability of this underground source to provide a sustained flow of approximately 46 second-feet has not been proven.



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CENTRAL UTAH PROJECT
JENSEN UNIT
POTENTIAL GROUNDWATER AREAS
SEPTEMBER, 1975
FIGURE 15

Irrigation water would still have to be pumped from the Green River to supply the 4,600 acre-feet of irrigation water for this alternative.

Ratliff Reservoir

Ratliff Dam and Reservoir site is located about 2 miles upstream from the proposed Tyzack Reservoir site. Water would be pumped from the reservoir by the Ratliff Pumping Plant and conveyed approximately 10.9 miles to Ashley Creek by the Ratliff Aqueduct. The pumping plant would have a capacity of 46 second-feet and an operating head of about 275 feet. Burns Pumping Plant would remain the same as in the proposed plan. This plan would serve the same municipal and industrial demands and the same irrigable areas as the proposed plan.

Five dam sites were considered under this alternative. The Ratliff plan would produce benefits comparable to those described in the proposed plan but at a higher cost because of extensive relocation of Highway 44. Figure 16 shows the approximate location of the features and the road relocation. The reservoir would inundate about 403 acres of land and about 1.7 miles of flowing stream. About 3.9 miles of Utah Highway 44 would be built to relocate the existing highway. About 2.8 miles of 138-kilovolt power lines, 3 miles of access road, 1.8 miles of 4" gas pipeline, and 1.8 miles of underground telephone cable would have to be built to relocate existing facilities.

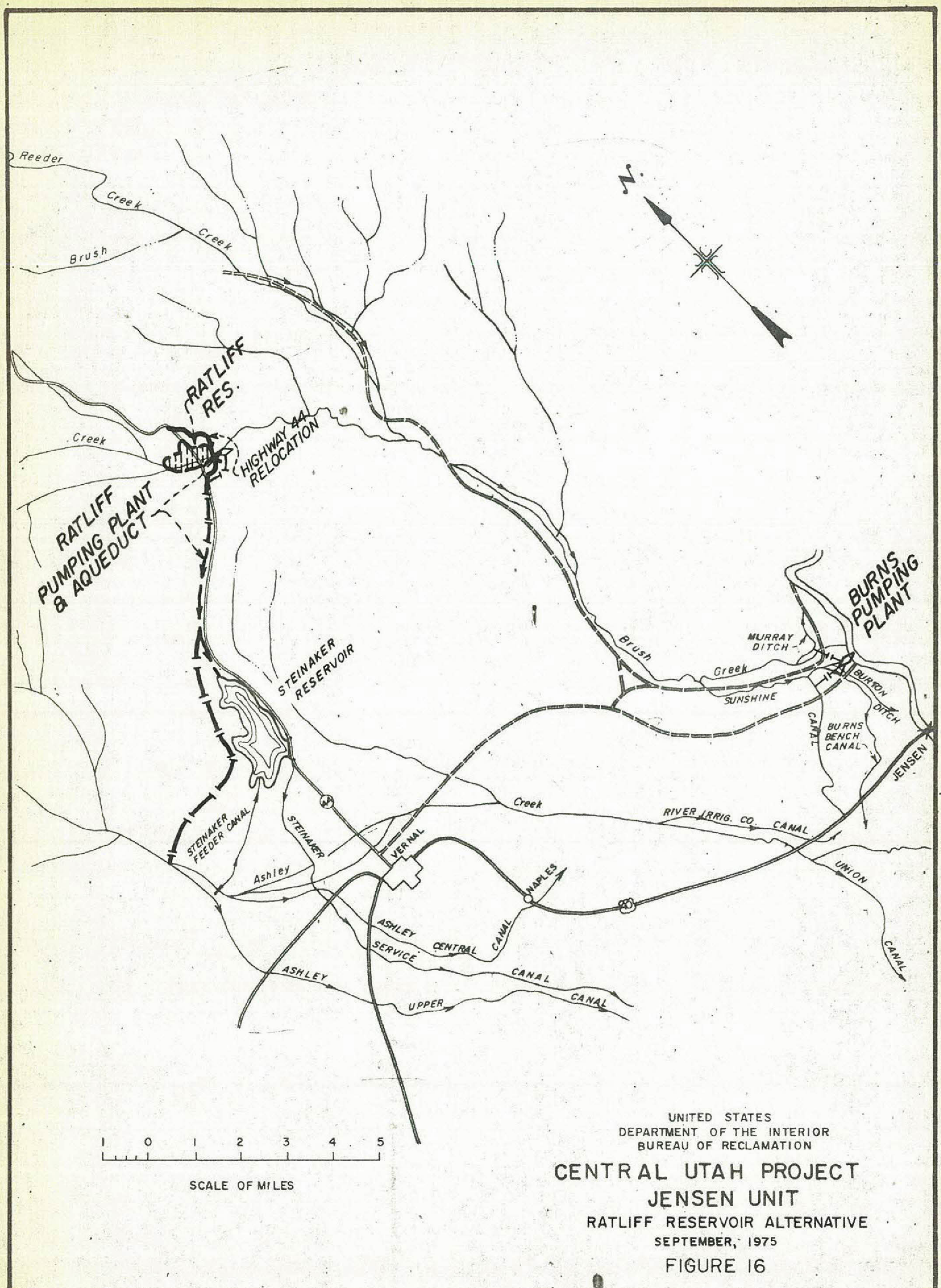
The reservoir might inundate phosphate resources that are minable by strip mining methods. The phosphate-bearing Park City formation is covered by at least 900 feet of younger material at the dam site but is exposed at the upper end of the reservoir. Therefore, this alternative might conflict with future mining operations.

Brush Creek Tunnel

The Brush Creek Tunnel plan would use Ratliff Reservoir, with a 3.1-mile-long gravity tunnel and aqueduct conveying the water to Ashley Creek. This plan would serve the same demands and the same irrigable lands as the proposed plan. With the tunnel, it would not be necessary to build Ratliff Pumping Plant and Aqueduct. The Burns Pumping Plant would also be the same as in the proposed plan. See Figure 17 for location of features.

Buckskin Hills Canal

The Buckskin Hills Canal plan would involve the same municipal and industrial demands as in the proposed plan. Water would be delivered to Ashley Valley from Tyzack Reservoir by the 27.2-mile-long, 46-second-foot Buckskin Hills Canal, instead of the Tyzack Pumping Plant and Tyzack Aqueduct. The Buckskin Hills Pumping Plant would be constructed at the terminus of the canal to deliver water through the 5-mile-long Buckskin Hills



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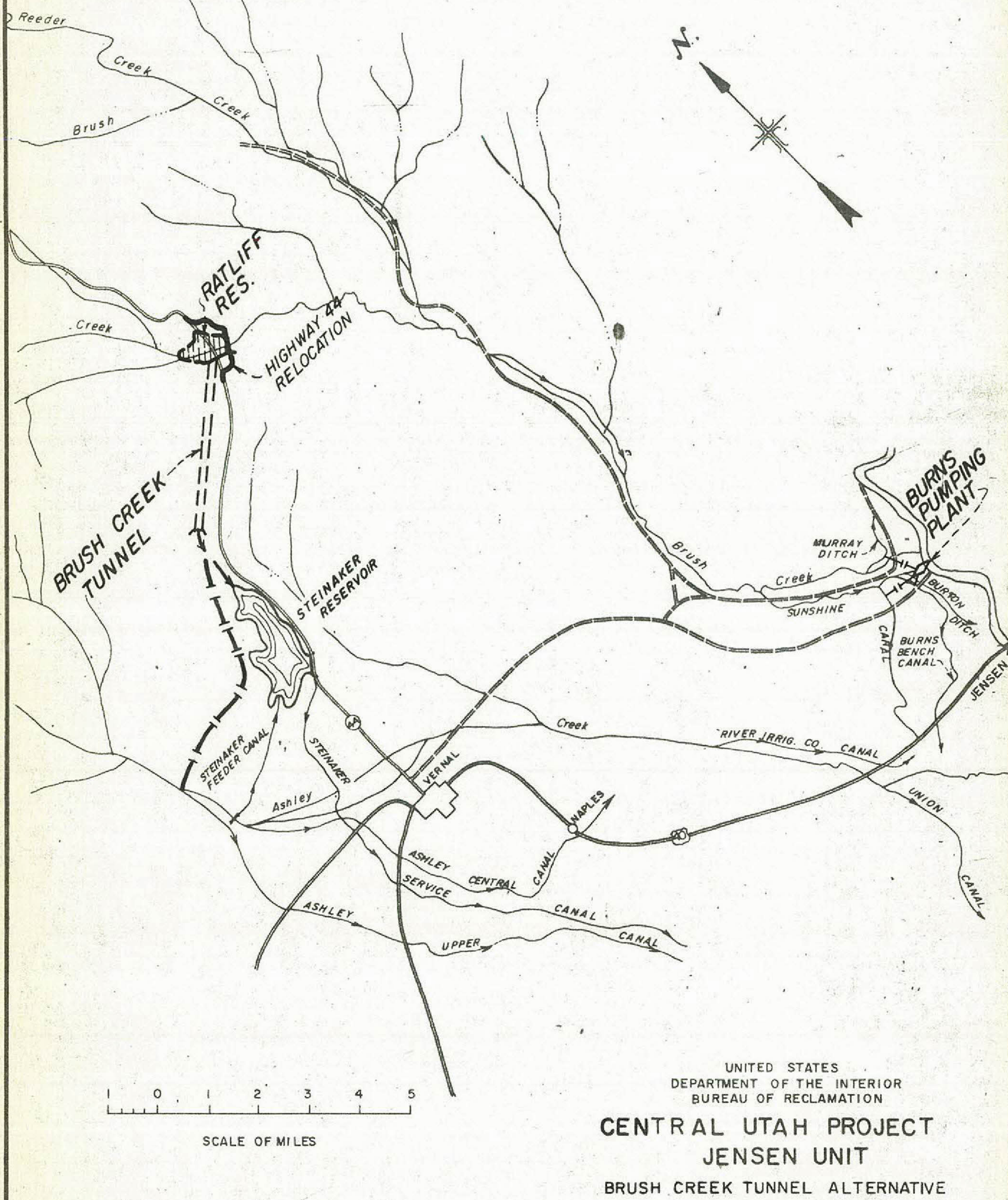
JENSEN UNIT
RATLIFF RESERVOIR ALTERNATIVE
SEPTEMBER, 1975
FIGURE 16



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BRUSH CREEK TUNNEL ALTERNATIVE
SEPTEMBER, 1975
FIGURE 17

Aqueduct. This plan would give the same flexibility for exchange with Ashley Springs as the proposed plan. The Burns Pumping Plant capacity and location would remain the same as in the proposed plan. Figure 18 shows the location of these features.

Another alternative to the plan above was considered. This alternative would serve approximately 3,000 acres of irrigable full service lands located below the Buckskin Hills Canal in lieu of some municipal and industrial use. This plan was not given further consideration because it would require about 11,100 acre-feet to irrigate the 3,000 acres, which would only leave 6,300 acre-feet for municipal and industrial water. In order to meet both the irrigation and municipal and industrial demands, the canal would have to be enlarged from 46 to 84 second-feet. Figure 18 shows the location of these full service lands.

Alternative Features and Operations of the Proposed Plan

Alternative features

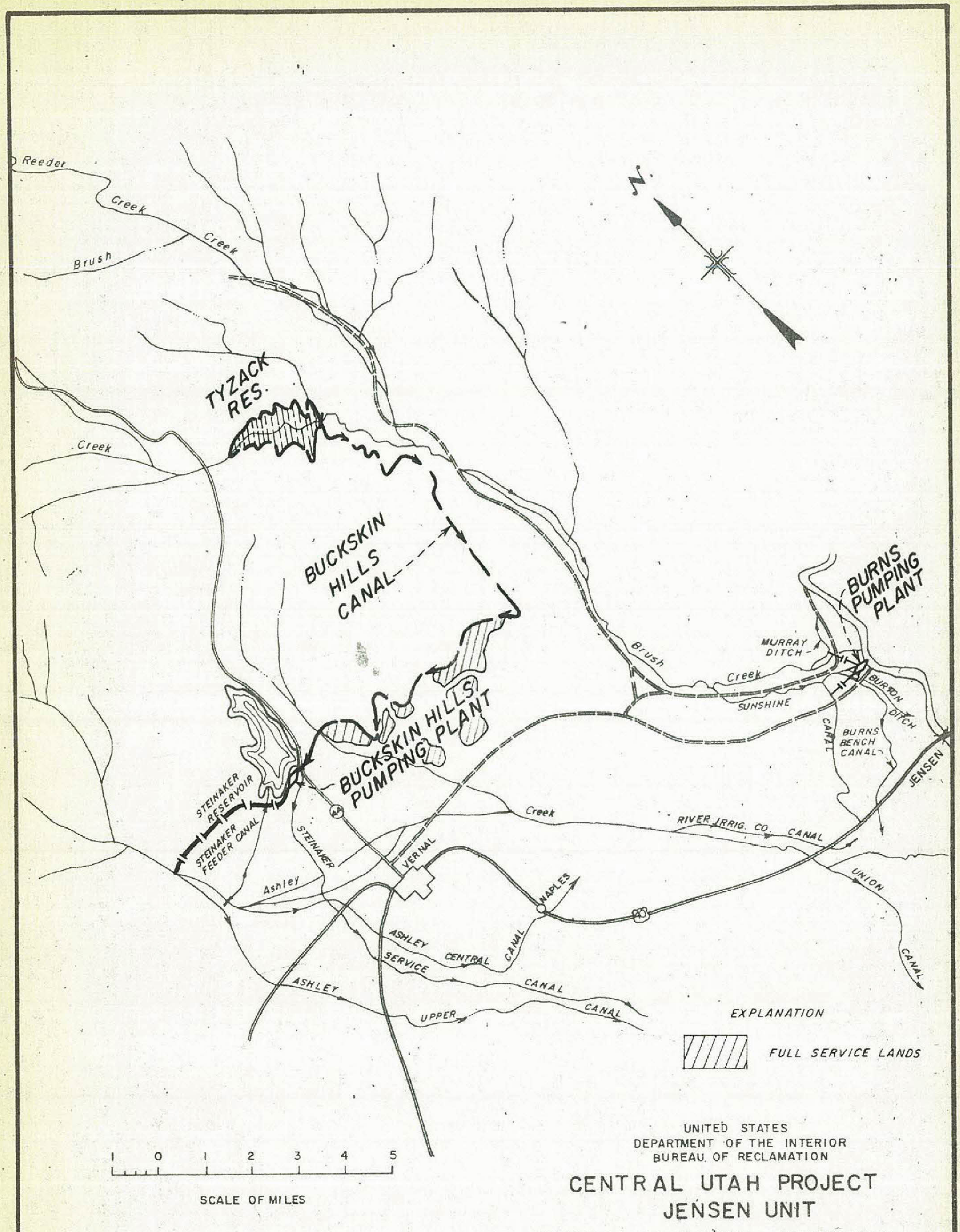
Throughout the planning stage of the Jensen Unit, several dams and reservoirs and conveyance systems were studied. The scale of development was studied to derive the optimum multipurpose unit. The alternative plans discussed in this section differ from the proposed plan primarily in the location of the storage and conveyance facilities.

Alternates to Tyzack Dam Axis

Three alternative dam sites within about 1,000 feet of the presently proposed Tyzack site were studied. These are shown as axes A, B, and C on Figure 19. Initially the uppermost (axis A) was favored. Then, on the basis of additional geological studies made early in 1971, the lowermost axis (axis C) was determined to be superior to the other two. Axis C offers a better foundation, and the accompanying lower water surface elevation would eliminate much of the reservoir blanketing required at the upper site in the area of the dikes. In general, the effects on the environment would be about the same at any of the three sites because of their proximity to each other, but development of the axis C is more favorable geologically. Refinement of the individual structures will continue until the time of construction in order to incorporate the optimum economic and environmental features.

Alternates to Tyzack Aqueduct

Alignment changes for Tyzack Aqueduct and discharge line to reduce the environmental impact have been considered. A short tunnel through a ridge for the discharge line in lieu of an open cut was considered to reduce the visual impact and disturbance to the natural vegetation but the cost would be prohibitive. Refinement in the project plan would continue



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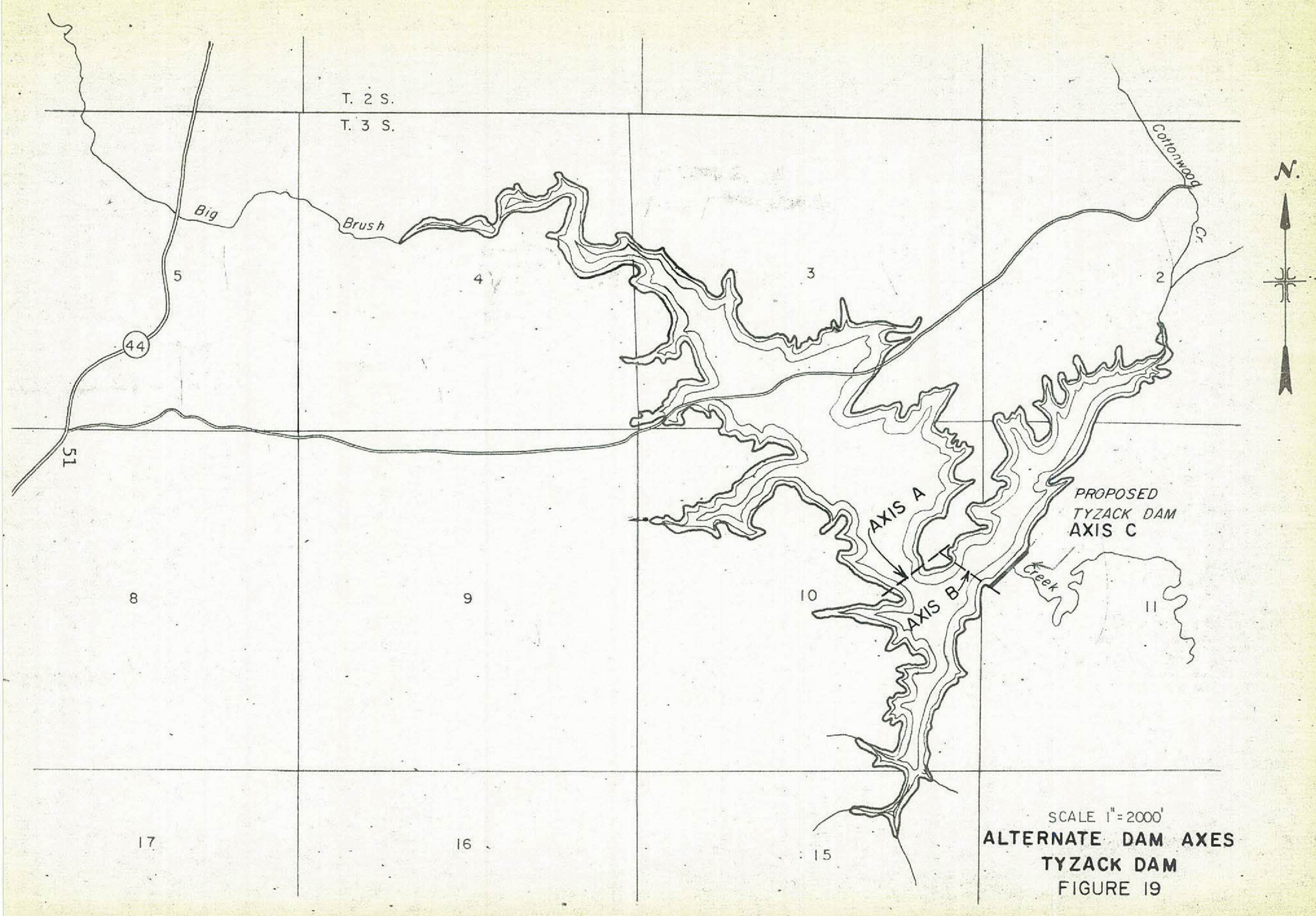
BUCKSKIN HILLS CANAL ALTERNATIVE
SEPTEMBER, 1975
FIGURE 18



SCALE 1" = 2000'

ALTERNATE DAM AXES
TYZACK DAM
FIGURE 19

until the time of construction in order to incorporate optimum economic and environmental elements into all of the project features.

Alternative Locations of the Transmission Lines

Under the proposed plan, the Tyzack and the Burns Pumping Plants would receive power from the Colorado Power Storage Project (CRSP). The proposed plan would tap the Flaming Gorge-Vernal No. 1 Line near Brush Creek. A 138-kilovolt line would extend about 2 miles from the tap to a 5,000-kilovolt-ampere substation at Tyzack Switchyard. Another 138-kilovolt line would extend about 1 mile from a tap on the Vernal-Hayden line near Utah Highway 149 to a 2,500-kilovolt-ampere substation at the Burns Switchyard. Two alternative hookups and transmission line routes were considered.

Alternative one would include an addition to the Vernal substation. Switchyards would be constructed at Tyzack and Burns Pumping Plants with a 5,000-kilovolt-ampere and 2,500-kilovolt-ampere capacity, respectively. An overhead 24.9-kilovolt transmission line would be constructed from the point of connection to the switchyards. The line to Tyzack Plant would be a maximum of 7 miles long.

Alternative two would involve a 7,500-kilovolt-ampere tap of a bus at the existing Vernal Switchyard of the CRSP. Two lines of 24.9 kilovolts would be extended 13 miles to Tyzack Pumping Plant and 7 miles to the Burns Pumping Plant. The capacity of the Tyzack Switchyard would be 5,000 kilovolt-amperes and the Burns Switchyard would be 2,500 kilovolt-amperes.

Environmentally the proposed plan appears superior to alternatives one or two because of the shorter line required. Alternatives one and two appear inferior to the proposed plan because of the new line (new corridor) that would be required from the point of connection to the pumping plants.

Alternative operations

Construction of the proposed plan would not preclude modified operation of the project in the future. Features of the project would be designed to accommodate considerable flexibility in operation. Three possible modified operations are described below that demonstrate this flexibility. It should be noted, however, that a departure from the proposed plan would likely be accompanied by a loss in efficiency of operation and an increase in costs.

Maximum Irrigation

Should the projected municipal and industrial requirements fail to materialize, the reservoir could be operated primarily for irrigation.

The service area could be expanded or the amount of water pumped from the Green River by the Burns Pumping Plant decreased. Pumping to lands located further downstream could be considered.

Maximum Municipal and Industrial Water

If on the other hand municipal and industrial requirements exceed those projected or those that occur in a different area, the Tyzack Reservoir and other project features could be oriented to the additional or differently located requirement. If the new requirement occurs downstream, reservoir storage water might be conveyed in Brush Creek and/or Green River to vicinity of use. Other facilities could be constructed as required to distribute the water supply.

Maximum Recreation and Fish and Wildlife Use

A third operational prerogative would be maximum use for the enhancement of fish and wildlife and recreational potential. Tyzack Reservoir could be stabilized at an optimum level for recreation and reservoir fishery. On the other hand the reservoir could be fluctuated to provide a minimum streamflow below the dam and delivery of water to Stewart Lake Waterfowl Management Area for optimum development and management of that resource.

Under this plan some water would still be required for irrigation or municipal and industrial use to qualify the project under Reclamation laws. The benefits from maximizing fish and wildlife use would have to exceed the costs of the repayment for that portion of water not received by the users under the proposed plan.

Another operational alternative that would maximize the fish and wildlife and recreation potential would be to stabilize Oaks Park an optimum level and provide a minimum fishery release in the 4.5 miles of Brush Creek below the reservoir and above Brush Creek Cave. Water normally released from Oaks Park Reservoir via the Oaks Park Canal into Ashley Creek during the irrigation season would remain in the reservoir and be exchanged with water from Tyzack Aqueduct. This option would be limited by the municipal and industrial demand of Ashley Valley. As long as there is excess capacity in the Tyzack Aqueduct and Pumping Plant during the irrigation season, this exchange could be made. A more detailed study would be needed to determine the amount of water that could be exchanged.

Minimum Flows for Ashley Creek and Rehabilitation of Grasshopper Flats

Ashley Creek from Ashley Springs to the Steinaker Diversion Canal is classified by the State of Utah as a Class III stream section and, therefore, should be protected and improved where feasible. Aquatic habitat sufficient to sustain a fishery varies considerably in any given stream. Natural influences generally compensate natural habitat losses, with the exception of large floods in which the habitat is destroyed for many years. Ashley Creek is an unregulated stream and is subject to frequent flooding, consequently the classification could change. This section will be inventoried and classified by the State of Utah during the summer of 1976. If this study confirms that a fishery does exist and should be protected there are various options to accomplish this.

Historically the annual flow of Ashley Springs helped maintain a minimum flow in Ashley Creek below Ashley Springs, but with present and future development of Ashley Springs as a municipal and industrial source of water for the Ashley Valley area, the streamflow will become severely depleted. Ultimately 22,900 acre-feet of Ashley Springs water will be put into the municipal water system leaving inadequate flows to maintain a fishery in this 7.2-mile section of stream.

About 35 years ago the Forest Service granted permission to divert water from the Oaks Park Reservoir across a sagebrush alluvial flat (Grasshopper Flats) to the Ashley Creek system. During the years an open cut has been eroded by this new stream and an irregular zigzag channel has been cut by the water during the summer use intervals. Continued cutting will prevail as long as water is allowed to move through the channel. On such a high gradient (5 to 15 degrees) a stabilized stream channel would be difficult to anticipate in this short period of time. Various stop-gap measures to control the erosion have been tried over the years, but the condition has not improved.

It should be emphasized that the Jensen Unit is not the cause of these two problems, therefore any options to solve the problem would enhance the fishery of Ashley Creek and the erosion problem of Grasshopper Flats rather than mitigate in terms of the Jensen Unit. The two problems are interconnected and in some cases a solution for one would be a solution for both.

Option one.--This option would be to use the existing Oaks Park Reservoir to deliver water to Ashley Creek via a new 10-second-foot pipeline nearly parallel to the existing Oaks Park Canal which now delivers irrigation water from Oaks Park Reservoir to Ashley Creek. The pipeline would be necessary for winter operations and deliveries. At the beginning of the erosion on Grasshopper Flats, a 60-second-foot pipe would be used through the eroded area and this would replace the existing canal. The eroded area would be smoothed over and reseeded.

The positive impacts of option one would be the rehabilitation of Grasshopper Flats and the enhancement of the fishery in Ashley Creek from where the 60-second-foot pipe enters Ashley Creek to the Highline Canal Diversion by a release of 10 second-feet of water from Oaks Park Reservoir when needed. The negative impacts would be the more severe fluctuation of Oaks Park Reservoir during the winter months. The reservoir would empty and fill twice a year during some years of operation--once to meet the winter fishery demands and once to meet the summer irrigation demands. This option would cost about $3,020,000 indexed at January 1974 prices.

Option two.--This alternative would involve the construction of a water treatment plant near the end of the Tyzack Aqueduct that would allow treatment of about 10 second-feet of Tyzack Reservoir water for municipal and industrial use. This would permit an exchange with Ashley Springs and allow 10 second-feet of water to enter Ashley Creek when needed for a minimum fishery flow between Ashley Springs and Steinaker Diversion Dam.

The Grasshopper Flats would have to be rehabilitated to make option two comparable to option one. The best way to accomplish this would be to construct a 60-second-foot pipe through the eroded part and push in the eroded channel and reseed the area. The U.S. Forest Service feels that piping water through Grasshopper Flats appears to be the best alternative for solving this problem. Sloping the channel banks, rip-rapping the banks, and controlling the flow of water through the ditch have been tried and have not been successful in controlling the erosion.

The negative impacts of this option would be the construction of a treatment plant near the exit of the Tyzack Aqueduct. The positive impact is that the Oaks Park Reservoir could be stabilized which would improve the fishing and recreation, and the Grasshopper Flats area would be rehabilitated.

The cost of this option would be about $2,100,000 indexed to January 1974 prices.

CHAPTER V

POWER STUDIES

General

The power and pumping data presented in this chapter were prepared in detail to preclude the necessity of a separate project power appendix. Power and pumping are a significant feature of the Jensen Unit but hardly sufficient to justify a separate volume. The data and tables included herein should be sufficient to make a thorough evaluation of the power and pumping requirements of the Jensen Unit.

Power Potential

A study was made of the economic justification and feasibility of power developments at Tyzack Dam and at "on stream" sites on Big Brush Creek. Due to the small amount of water available in Big Brush Creek and the fact that there will be no winter releases from Tyzack Reservoir, power production is not justified.

Project Pumping

It is estimated that a demand for municipal and industrial water will develop in the Vernal area about the same time as completion of Tyzack Reservoir. The demand will be met by a pumping plant at Tyzack Reservoir which can lift 18,000 acre-feet annually into Ashley Creek. Burns Pumping Plant located near the confluence of Brush Creek and Green River would furnish an average of 9,700 acre-feet of water annually to the lands under the Sunshine and Burns Bench Canals and the Murray and Burton Ditches. These canals are presently supplied from Brush Creek. The non-project lands would only receive water equal to their present supply.

In addition, 230 acre-feet annually would be pumped into the Burns Bench Canal and delivered to Stewart Lake for wildlife enhancement. This water would be pumped in the "off-peak" periods so that no added capacity would be required.

The peak annual demand for Tyzack Pumping Plant will vary from year to year between 2,474 and 2,889 kilowatts. Similarly, Burns Pumping Plant will have a peak annual demand ranging from 585 to 1,319 kilowatts. The combined peak demand for the two plants will range between 3,059 and 4,208 kilowatts.

Tyzack Pumping Plant

The Tyzack Pumping Plant will be located near the base of the dam. It will consist of four outdoor centrifugal pumps, two with a rated flow of 8.05 second-feet each and two with a rated flow of 16.1 each. Tyzack Pump will have a maximum head of 587 feet from minimum water surface in the reservoir to the top of a ridge above Steinaker Reservoir. The discharge line will be 62,500 feet long. End-of-month reservoir elevations from the Jensen Unit Project Operation Study of the Water Supply Appendix are shown in Table 6. Tables 7 and 8 show the capacity and energy, respectively, to pump the required water shown in the above operation study. The last two tables are based on meeting the municipal and industrial water demand at the time it occurs. In actual operation, however, it is anticipated that cooperative use of Steinaker Reservoir will allow the operation to be such that a monthly load factor of 100 percent will be possible.

Burns Pumping Plant

The Burns Pumping Plant will be located near the confluence of Brush Creek and Green River. It will pump into four separate discharge lines to serve the existing Sunshine and Burns Bench Canals and the Murray and Burton Ditches. All units are of the outdoor deep-well turbine type.

Sunshine Pumps

These pumps will lift water from Green River to the Sunshine Canal through a 33-inch-diameter conduit, 4,950 feet long. The maximum static head will be 171 feet, and the average static head based on a 4,000-second-foot flow in Green River will be 168 feet. The pumps are as follows.

(1) Two 450-hp., 3-phase, 2,300-volt, 1,200-r.p.m. pump designed for 12 second-feet.

(2) One 250-hp., 3-phase, 2,300-volt, 1,200-r.p.m. pump designed for 6 second-feet.

(3) One 100-hp,. 3-phase, 2,300-volt, 1,800-r.p.m. pump designed for 3 second-feet.

The pumping demands for Sunshine Canal are shown in Table 9. Tables 10 and 11 show the energy and capacity required to supply this demand.

Table 6
Tyzack Pumping Plant
End of Month Reservoir Elevation
Unit-Feet

YEAR	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL	AVE
1930	5608	5608	5608	5608	5607	5605	5604	5603	5602	50453	5606
1931	5608	5608	5608	5605	5600	5596	5592	5588	5585	50390	5599
1932	5589	5588	5605	5608	5608	5606	5604	5602	5599	50409	5601
1933	5601	5600	5603	5608	5606	5602	5599	5595	5592	50406	5601
1934	5594	5595	5596	5591	5586	5581	5577	5573	5569	50262	5585
1935	5573	5572	5578	5602	5600	5597	5594	5590	5586	50292	5588
1936	5588	5588	5593	5590	5586	5583	5580	5577	5573	50258	5584
1937	5575	5575	5601	5607	5607	5605	5603	5601	5598	50372	5597
1938	5600	5600	5608	5608	5608	5606	5604	5605	5607	50446	5605
1939	5608	5608	5608	5606	5603	5598	5595	5593	5589	50408	5601
1940	5591	5593	5603	5600	5596	5591	5587	5583	5580	50324	5592
1941	5581	5579	5601	5608	5607	5605	5603	5606	5608	50398	5600
1942	5608	5608	5608	5608	5608	5607	5605	5602	5600	50454	5606
1943	5602	5606	5608	5608	5606	5602	5605	5596	5593	50426	5603
1944	5595	5594	5608	5608	5608	5607	5605	5603	5601	50429	5603
1945	5604	5603	5608	5608	5606	5603	5601	5598	5596	50427	5603
1946	5598	5600	5600	5598	5595	5591	5587	5583	5580	50332	5592
1947	5584	5585	5608	5608	5608	5607	5606	5604	5603	50413	5601
1948	5604	5603	5608	5608	5607	5605	5603	5601	5598	50437	5604
1949	5600	5601	5608	5608	5606	5604	5604	5604	5602	50442	5605
1950	5605	5608	5608	5608	5608	5606	5604	5602	5599	50448	5605
1951	5602	5601	5608	5608	5606	5603	5600	5597	5594	50419	5602
1952	5595	5598	5608	5608	5607	5606	5603	5600	5598	50423	5603
1953	5603	5602	5605	5608	5607	5604	5600	5597	5594	50420	5602
1954	5596	5598	5603	5601	5598	5594	5590	5587	5583	50350	5594
1955	5584	5582	5586	5586	5583	5578	5573	5568	5563	50203	5578
1956	5566	5566	5578	5577	5573	5566	5560	5554	5547	50087	5565
1957	5550	5546	5556	5589	5590	5589	5586	5582	5579	50167	5574
1958	5581	5579	5598	5608	5606	5602	5599	5595	5592	50360	5596
1959	5593	5591	5596	5599	5596	5592	5588	5584	5580	50319	5591
1960	5580	5580	5580	5580	5576	5570	5564	5558	5552	50140	5571
1961	5554	5550	5557	5556	5550	5540	5528	5528	5528	49891	5543
1962	5534	5552	5593	5608	5607	5603	5600	5598	5595	50290	5588
1963	5596	5594	5596	5595	5590	5584	5580	5575	5571	50281	5587
1964	5572	5569	5581	5590	5586	5582	5578	5573	5568	50199	5578
1965	5569	5567	5581	5608	5608	5607	5604	5603	5603	50350	5594
1966	5608	5608	5608	5607	5604	5600	5597	5594	5590	50416	5602
1967	5592	5591	5601	5608	5608	5606	5604	5602	5599	50411	5601
1968	5601	5600	5607	5608	5608	5607	5604	5603	5600	50438	5604
1969	5602	5603	5608	5608	5607	5604	5602	5599	5596	50429	5603
1970	5598	5596	5608	5608	5608	5606	5603	5601	5598	50426	5603
1971	5600	5598	5606	5608	5607	5606	5604	5602	5599	50430	5603
1972	5603	5603	5608	5608	5606	5603	5600	5598	5595	50424	5603
TOT.	240395	240396	240748	240879	240799	240662	240529	240407	240284	2165099	5595
AVE.	5591	5591	5599	5602	5600	5597	5594	5591	5588	50351	5595

Table 7
Tyzack Pumping Plant
Pumping Capacity Requirements
Unit-Kilowatts

YEAR	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL	YEARS MA
1930	1716	1716	2463	2463	2468	2479	2484	1736	1740	19265	2484
1931	1716	1716	2463	2479	2506	2527	2548	1796	1808	19559	2548
1932	1792	1796	2479	2463	2463	2474	2484	1740	1752	19443	2484
1933	1744	1748	2490	2463	2474	2495	2511	1768	1780	19472	2511
1934	1772	1768	2527	2554	2580	2607	2628	1856	1872	20164	2628
1935	1856	1860	2623	2495	2506	2522	2538	1788	1804	19990	2538
1936	1796	1796	2543	2559	2580	2596	2612	1840	1856	20178	2612
1937	1848	1848	2500	2468	2468	2479	2490	1744	1756	19601	2500
1938	1748	1748	2463	2463	2463	2474	2484	1728	1720	19291	2484
1939	1716	1716	2463	2474	2490	2516	2532	1776	1792	19475	2532
1940	1784	1776	2490	2506	2527	2554	2575	1816	1828	19854	2575
1941	1824	1832	2500	2463	2468	2479	2490	1724	1716	19496	2500
1942	1716	1716	2463	2463	2463	2468	2479	1740	1748	19256	2479
1943	1740	1724	2463	2463	2474	2495	2479	1764	1776	19377	2495
1944	1768	1772	2463	2463	2463	2468	2479	1736	1744	19356	2479
1945	1732	1736	2463	2463	2474	2490	2500	1756	1764	19377	2500
1946	1756	1748	2506	2516	2532	2554	2575	1816	1828	19830	2575
1947	1812	1808	2463	2463	2463	2468	2474	1732	1736	19419	2474
1948	1732	1736	2463	2463	2468	2479	2490	1744	1756	19331	2490
1949	1748	1744	2463	2463	2463	2468	2484	1732	1740	19305	2484
1950	1728	1716	2463	2463	2463	2474	2484	1740	1752	19283	2484
1951	1740	1744	2463	2463	2474	2490	2506	1760	1772	19411	2506
1952	1768	1756	2463	2463	2468	2474	2490	1748	1756	19385	2490
1953	1736	1740	2479	2463	2468	2484	2506	1760	1772	19408	2506
1954	1764	1756	2490	2500	2516	2538	2559	1800	1816	19738	2559
1955	1812	1820	2580	2580	2596	2623	2650	1876	1896	20433	2650
1956	1884	1884	2623	2628	2650	2687	2719	1932	1960	20966	2719
1957	1948	1964	2740	2564	2559	2564	2580	1820	1832	20572	2740
1958	1824	1832	2516	2463	2474	2495	2511	1768	1780	19663	2516
1959	1776	1784	2527	2511	2527	2548	2570	1812	1828	19882	2570
1960	1828	1828	2612	2612	2634	2665	2697	1916	1940	20733	2697
1961	1932	1948	2735	2740	2772	2825	2889	2036	2036	21914	2889
1962	2012	1940	2543	2463	2468	2490	2506	1756	1768	19945	2543
1963	1764	1772	2527	2532	2559	2591	2612	1848	1864	20069	2612
1964	1860	1872	2607	2559	2580	2602	2623	1856	1876	20434	2623
1965	1872	1880	2607	2463	2463	2468	2484	1736	1736	19709	2607
1966	1716	1716	2463	2468	2484	2506	2522	1772	1788	19435	2522
1967	1780	1784	2500	2463	2463	2474	2484	1740	1752	19440	2500
1968	1744	1748	2468	2463	2463	2468	2484	1736	1748	19323	2484
1969	1740	1736	2463	2463	2468	2484	2495	1752	1764	19365	2495
1970	1756	1764	2463	2463	2463	2474	2490	1744	1756	19372	2490
1971	1748	1756	2474	2463	2468	2474	2484	1740	1752	19359	2484
1972	1736	1736	2463	2463	2474	2490	2506	1756	1768	19391	2506
TOT.	76784	76780	108017	107318	107745	108475	109184	76736	77228	848267	
AVE.	1786	1786	2512	2496	2506	2523	2539	1785	1796	19727	

Table 8
Tyzack Pumping Plant
Pumping Capacity Required
Unit-1000 KWH [1/]

YEAR	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL	AVE
1930	1264	843	1232	1362	1364	1370	1373	1279	1282	11370	1263
1931	1264	843	1232	1370	1385	1397	1409	1323	1332	11556	1284
1932	1320	882	1240	1362	1362	1367	1373	1282	1291	11479	1275
1933	1285	859	1245	1362	1367	1379	1388	1303	1311	11499	1278
1934	1306	869	1264	1412	1426	1441	1453	1367	1379	11917	1324
1935	1367	914	1312	1379	1385	1394	1403	1317	1329	11801	1311
1936	1323	882	1272	1415	1426	1435	1444	1356	1367	11921	1325
1937	1362	908	1251	1364	1364	1370	1376	1285	1294	11574	1286
1938	1288	859	1232	1362	1362	1367	1373	1273	1267	11383	1265
1939	1264	843	1232	1367	1376	1391	1400	1308	1320	11503	1278
1940	1314	872	1245	1385	1397	1412	1423	1338	1347	11734	1304
1941	1344	900	1251	1362	1364	1370	1376	1270	1264	11502	1278
1942	1264	843	1232	1362	1362	1364	1370	1282	1288	11367	1263
1943	1282	847	1232	1362	1367	1379	1370	1300	1308	11448	1272
1944	1303	870	1232	1362	1362	1364	1370	1279	1285	11427	1270
1945	1276	853	1232	1362	1367	1376	1382	1294	1300	11442	1271
1946	1294	859	1253	1391	1400	1412	1423	1338	1347	11716	1302
1947	1335	888	1232	1362	1362	1364	1367	1276	1279	11465	1274
1948	1276	853	1232	1362	1364	1370	1376	1285	1294	11412	1268
1949	1288	857	1232	1362	1362	1364	1373	1276	1282	11396	1266
1950	1273	843	1232	1362	1362	1367	1373	1282	1291	11385	1265
1951	1282	857	1232	1362	1367	1376	1385	1297	1306	11463	1274
1952	1303	863	1232	1362	1364	1367	1376	1288	1294	11449	1272
1953	1279	855	1240	1362	1364	1373	1385	1297	1306	11460	1273
1954	1300	863	1245	1382	1391	1403	1415	1326	1338	11662	1296
1955	1335	894	1291	1426	1435	1450	1465	1382	1397	12075	1342
1956	1388	926	1312	1453	1465	1485	1503	1423	1444	12399	1378
1957	1435	965	1371	1418	1415	1418	1426	1341	1350	12137	1349
1958	1344	900	1259	1362	1367	1379	1388	1303	1311	11613	1290
1959	1308	876	1264	1388	1397	1409	1420	1335	1347	11745	1305
1960	1347	898	1307	1444	1456	1473	1491	1412	1429	12257	1362
1961	1423	957	1368	1515	1532	1562	1597	1500	1500	12955	1439
1962	1482	953	1272	1362	1364	1376	1385	1294	1303	11791	1310
1963	1300	870	1264	1400	1415	1432	1444	1362	1373	11860	1318
1964	1370	920	1304	1415	1426	1438	1450	1367	1382	12073	1341
1965	1379	924	1304	1362	1362	1364	1373	1279	1279	11626	1292
1966	1264	843	1232	1364	1373	1385	1394	1306	1317	11479	1275
1967	1311	876	1251	1362	1362	1367	1373	1282	1291	11475	1275
1968	1285	859	1235	1362	1362	1364	1373	1279	1288	11406	1267
1969	1282	853	1232	1362	1364	1373	1379	1291	1300	11436	1271
1970	1294	867	1232	1362	1362	1367	1376	1285	1294	11438	1271
1971	1288	863	1237	1362	1364	1367	1373	1282	1291	11427	1270
1972	1279	853	1232	1362	1367	1376	1385	1294	1303	11451	1272
TOT.	56571	37718	54039	59326	59562	59966	60358	56535	56898	500971	1294
AVE.	1316	877	1257	1380	1385	1395	1404	1315	1323	11650	1294

1/ Based on pumping an average of 18,000 acre-feet annually. By utilizing spills of Steinaker Reservoir it would be possible to reduce pumping to about 15,800 acre-feet annually at a savings of about $5,700 in energy costs.

Table 9
Burns Pumping Plant
Sunshine Canal Pumping Demand
Unit (1000 AF)

Year	April	May	June	July	Aug.	Sept.	Total
1930				1.0	.6		1.6
31			1.0	1.1	.8	.2	3.1
32	.1	.7		.9	.8		2.5
33	.1	.9	.7	1.0	.9	.2	3.8
34		.9	1.0	1.0	.8	.1	3.8
1935	.1	.9	.9	1.0	.8	.1	3.8
36		.9	1.0	1.1	.9		3.9
37		.4	1.1	.9	.8		3.2
38				.8	.8		1.6
39			1.1	1.1	.8		3.0
1940		.9	1.0	1.1	.8	.2	4.0
41	.1	.5		1.0	.9		2.5
42				.8	.6		1.4
43				1.0	.8	.1	1.9
44	.1				.6		.7
1945	.1			.9	.9		1.9
46		.9	1.1	1.1	.8	.2	4.1
47					.4		.4
48	.1			.9	.8		1.8
49				.9	.4		1.3
1950				1.0	.7		1.7
51	1.	.8		1.0	.8	.2	2.9
52				1.0	.6		1.6
53	.1	.9		1.0	.8	.2	3.0
54		.9	1.1	1.0	.8	.1	3.9
1955	.1	.9	1.2	1.0	.8	.2	4.2
56	.1	.9	1.1	1.1	.8	.2	4.2
57	.2	.9	.9	.9	.6		3.5
58	.1	.7	1.1	1.1	.8	.2	4.0
59	.1	.9	1.2	1.0	.8	.2	4.2
1960	.1	.9	1.1	1.1	.8	.2	4.2
61	.2	.9	1.1	1.1	.8	.2	4.3
62		.4		1.0	.8		2.2
63	.2	.9	1.1	1.0	.8	.2	4.2
64	.2	.9	.9	1.1	.8	.2	4.1
1965	.1	.9	1.2	.2	.6		3.0
66			1.1	1.1	.8	.1	3.1
67	.1	.9		.8	.9	.2	2.9
68	.2	.8		1.2	.7	.2	3.1
69				1.2	.9	.1	2.2
1970	.1	.7		1.2	.9		2.9
71	.1	.9		1.0	.8		2.8
72				1.0	.9		1.4
Total	2.8	22.1	22.0	40.7	33.0	3.8	124.4
Avg.	.1	.5	.5	.9	.8	.1	2.9

Table 10
Burns Pumping Plant
Monthly Pumping Energy Requirements for the Sunshine Pump
Unit-1000 KWH

Year	April	May	June	July	Aug.	Sept.	Total
1930				248.3	150.2		398.5
31			248.3	273.1	197.5	50.5	769.4
32	25.3	175.3		222.2	197.5		620.3
33	25.3	222.2	175.3	248.3	222.2	50.5	943.8
34		222.2	248.3	248.3	197.5	26.4	942.7
1935	25.3	222.2	222.2	248.3	197.5	26.4	941.9
36		222.2	248.3	273.1	222.2		965.8
37		101.0	269.3	222.2	197.5		790.0
38				197.5	197.5		395.0
39			269.3	273.1	197.5		739.9
1940		222.2	248.3	273.1	197.5	50.5	991.6
41	25.3	126.3		248.3	222.2		622.1
42				197.5	150.2		347.7
43				248.3	197.5	26.4	472.2
44	25.3				150.2		175.5
1945	25.3			222.2	222.2		469.7
46		222.2	269.3	273.1	197.5	50.5	1012.6
47					101.0		101.0
48	25.3			222.2	197.5		445.0
49				222.2	101.0		323.2
1950				248.3	175.3		423.6
51	25.3	197.5		248.3	197.5	50.5	719.1
52				248.3	150.2		398.5
53	25.3	222.2		248.3	197.5	50.5	743.8
54		222.2	269.3	248.3	197.5	26.4	963.7
1955	25.3	222.2	293.8	248.3	197.5	50.5	1037.6
56	25.3	222.2	269.3	273.1	197.5	50.5	1037.9
57	49.4	222.2	222.2	222.2	150.2		866.2
58	25.3	175.3	269.3	273.1	197.5	50.5	991.0
59	25.3	222.2	293.8	248.3	197.5	50.5	1037.6
1960	25.3	222.2	269.3	273.1	197.5	50.5	1037.9
61	49.4	222.2	269.3	273.1	197.5	50.5	1062.0
62		101.0		248.3	197.5		546.8
63	49.4	222.2	269.3	248.3	197.5	50.5	1037.2
64	49.4	222.2	222.2	273.1	197.5	50.5	1014.9
1965	25.3	222.2	293.8	52.8	150.2		744.3
66			269.3	273.1	197.5	26.4	766.3
67	25.3	222.2		197.5	222.2	50.5	717.7
68	49.4	197.5		293.8	175.3	50.5	766.5
69				293.8	222.2	26.4	542.4
1970	25.3	175.3		293.8	222.2		716.6
71	25.3	222.2		248.3	197.5		693.3
72				248.3	222.2		470.5
Total	702.4	5471.0	5409.5	10085.1	8168.9	966.4	30803.3
Avg.	16.3	127.2	125.8	234.5	190.0	22.5	716.4

Table 11
Burns Pumping Plant
Monthly Capacity Demands for the Sunshine Pump
Unit-Kilowatts

Year	April	May	June	July	Aug.	Sept.	Total	Max Kw
1930				608	369		977	608
31			608	673	488	125	1894	608
32	186	424		552	488		1650	552
33	186	552	424	608	552	125	2447	608
34		552	608	608	488	65	2321	608
1935	186	552	552	608	488	65	2451	608
36		552	608	673	552		2385	673
37		244	673	552	488		1957	673
38				488	488		976	488
39			673	673	488		1834	673
1940		552	608	673	488	125	2446	673
41	186	306		608	552		1652	608
42				488	369		857	488
43				608	488	65	1161	608
44	186				369		555	369
1945	186			552	552		1290	552
46		552	673	673	488	125	2511	673
47					244		244	244
48	186			552	488		1226	552
49				552	244		796	552
1950				608	424		1032	608
51	186	488		608	488	125	1895	608
52				608	369		977	608
53	186	552		608	488	125	1959	608
54		552	673	608	488	65	2386	673
1955	186	552	734	608	488	125	2693	734
56	186	552	673	673	488	125	2697	673
57	369	552	552	552	369		2394	552
58	186	424	673	673	488	125	2569	673
59	186	552	734	608	488	125	2693	734
1960	186	552	673	673	488	125	2697	673
61	369	552	673	673	488	125	2880	673
62		244		608	488		1340	608
63	369	552	673	608	488	125	2815	673
64	369	552	552	673	488	125	2759	673
1965	186	552	734	125	369		1966	734
66			673	673	488	65	1899	673
67	186	552		488	552	125	1903	552
68	369	488		734	424	125	2140	734
69				734	552	65	1351	734
1970	186	424		734	552		1896	734
71	186	552		608	488		1834	608
72				608	552		1160	608
Total	5193	13530	13444	24842	20166	2390	79565	
Max Kw	369	552	734	734	552	125	--	734

Burns Bench Pumps

These pumps will lift water from Green River to the Burns Bench Canal through a 36-inch-diameter conduit, 1,550 feet long. The maximum and average static heads are 83 and 80 feet, respectively. The pumps consist of the following.

(1) Two 250-hp., 3-phase, 2,300-volt, 900-r.p.m. pumps designed for 14.2 second-feet.

(2) One 125-hp., 3-phase, 2,300-volt, 1,200-r.p.m. pump designed for 7.1 second-feet.

(3) One 65-hp., 3-phase, 440-volt, 1,800-r.p.m. pump designed for 3.5 second-feet.

Burns Bench Canal pumping demand is shown in Table 12, with Tables 13 and 14 showing the energy and capacity required to supply this demand.

Murray Pumps

These pumps will lift water from Green River to the Murray Ditch through a 21-inch-diameter conduit, 2,750 feet long. Maximum and average static heads are 59 and 56 feet, respectively. The pump sizes are as follows.

(1) One 100-hp., 3-phase, 440-volt, 1,200-r.p.m. pump designed for 6.8 second-feet.

(2) One 50-hp., 3-phase, 440-volt, 1,800-r.p.m. pump designed for 3.4 second-feet.

(3) One 25-hp., 3-phase, 440-volt, 1,800-r.p.m. pump designed for 1.8 second-feet.

Murray Ditch pumping demand is shown in Table 15. Tables 16 and 17 show the energy and capacity required to supply this demand.

Burton Pumps

These pumps will lift water from Green River to the Burton Ditch through a 24-inch-diameter conduit, 1,350 feet long. Maximum and average static heads are 40 and 37 feet, repectively. The pump sizes are as follows.

(1) One 75-hp., 3-phase, 440-volt, 900-r.p.m. pump designed for 7.6 second-feet.

Table 12
Burns Pumping Plant
Burns Canal Pumping Demand
Unit-1000 AF

Year	Oct.	April	May	June	July	Aug.	Sept.	Total
1930					1.6	1.2		2.8
31		.3	.6	1.3			.2	5.2
32	.1	.3	.9					4.1
33		.3		1.3			.2	5.5
34	.1	.2					.2	5.5
1935	.1	.3					.2	5.6
36	.1	.3					.1	5.5
37		.3	.9	1.3			.1	5.4
38		.3						3.1
39				1.3			.2	4.3
1940		.2	.9	1.3			.2	5.4
41	.1	.3	.9					4.1
42							.1	2.9
43		.1		.3	1.6		.2	3.4
44		.3	.1		1.5			3.1
1945		.3			1.6		.2	3.3
46		.2	.9	1.3	1.6		.2	5.4
47		.2			.5			1.9
48		.3			1.6			3.1
49		.3					.1	3.2
1950		.1					.1	3.0
51		.3	.9				.2	4.2
52		.2					.2	3.2
53		.3	.9				.2	4.2
54		.2		1.3			.2	5.4
1955	.1	.3					.2	5.6
56	.1						.2	5.6
57	.1							5.4
58							.2	5.5
59	.1							5.6
1960	.1							5.6
61	.1	.3		1.3				5.6
62	.1	.1		.8				4.9
63		.3		1.3				5.5
64	.1	.3		1.3			.2	5.6
1965		.3	.9	1.3				5.3
66				1.3			.2	4.3
67		.3	.9					4.2
68	.1	.3	.9					4.3
69		.1						3.1
1970		.3	.9				.2	4.2
71		.3	.9					4.0
72		.3			1.6	1.2	.2	3.3
Total	1.4	10.3	25.0	28.4	67.6	51.6	6.1	190.4
Avg.	0	.2	.6	.7	1.6	1.2	.1	4.4

Table 13
Burns Pumping Plant
Monthly Pumping Energy Requirement for Burns Bench Pump
Unit-1000 KWH

Year	Oct.	April	May	June	July	Aug.	Sept.	Total
1930					231.1	144.1		375.2
31		37.2	74.4	156.1			26.4	669.3
32	13.8	37.2	109.9					536.1
33		37.2	109.9	156.1			26.4	704.8
34	13.8	25.5	109.9				26.4	706.9
1935	13.8	37.2	109.9				26.4	718.6
36	13.8	37.2	109.9				13.8	706.0
37		37.2	109.9	156.1			13.8	692.2
38		37.2						412.4
39				156.1			26.4	557.7
1940		25.5	109.9	156.1			26.4	693.1
41	13.8	37.2	109.9					536.1
42							13.8	389.0
43		13.2		38.3	231.1		26.4	453.1
44		37.2	13.8		177.6			372.7
1945		37.2			231.1		26.4	438.8
46		25.5	109.9	156.1	231.1		26.4	693.1
47		25.5			62.0			231.6
48		37.2			231.1			412.4
49		37.2					13.8	426.2
1950		13.2					13.8	402.2
51		37.2	109.9				26.4	548.7
52		25.5					26.4	427.1
53		37.2	109.9				26.4	548.7
54		25.5		156.1			26.4	693.1
1955	13.8	37.2					26.4	718.6
56	13.8	37.2					26.4	718.6
57	13.8	37.2						692.2
58		37.2					26.4	704.8
59	13.8	37.2						718.6
1960	13.8	37.2						718.60
61	13.8	37.2		156.1				718.60
62	13.8	13.2		97.7				636.2
63		37.2		156.1				704.8
64	13.8	37.2		156.1			26.4	718.6
1965		37.2	109.9	156.1				678.4
66				156.1			26.4	557.7
67		37.2	109.9					548.7
68	13.8	37.2	109.9					562.5
69		13.2						414.8
1970		37.2	109.9				26.4	548.7
71		37.2	109.9					522.3
72		37.2			231.1	144.1	26.4	439.1
Total	193.21	1284.6	3055.8	3414.1	9714.7	6196.3	808.20	24666.9
Ave.	5.5	29.9	71.1	79.4	225.9	144.1	18.8	573.7
1/	--	11.6	3.8	--	7.9	6.3	--	603.3
Over all Average	4.5	41.5	74.9	79.4	233.8	150.4	18.8	603.3

1/ Energy required to pump 230 A.F. to Stewart Lake Waterfowl Management Area

Table 14
Burns Pumping Plant
Monthly Capacity Demands for Burns Bench Pumps
Unit-Kilowatts

Year	Oct.	April	May	June	July	Aug.	Sept.	Total	Max. Kw
1930					390	347		737	390
31		178	178	355			75	1523	
32	38	178	242					1195	
33		178		355			75	1587	
34	38	143					75	1590	
1935	38	178					75	1625	
36	38	178					38	1588	
37		178	242	355			38	1550	
38		178						915	
39				355			75	1167	
1940		143	242	355			75	1552	
41	38	178	242					1195	
42							38	775	
43		75		108			75	995	
44		178	38					953	
1945		178					75	990	
46		143	242	355	390		75	1552	390
47		143			143			633	347
48		178			390			915	390
49		178					38	953	
1950		75					38	850	
51		178	242				75	1232	
52		143					75	955	
53		178	242				75	1232	
54		143		355			75	1552	
1955	38	178					75	1625	
56	38						75	1625	
57	38							1550	
58							75	1587	
59	38						75	1625	
1960	38						75	1625	
61	38	178		355			75	1625	
62	38	75		242			75	1409	
63		178		355			75	1587	
64	38	178		355			75	1625	
1965		178	242	355				1512	
66				355			75	1167	
67		178	242				75	1232	
68	38	178	242				75	1270	
69		75					75	887	
1970		178	242				75	1232	
71		178	242					1157	
72		178			390	347	75	990	390
Total	532	6320	6750	7805	16523	14921	2290	55141	
Max kw	38	178	242	355	390	347	75		390

Table 15
Burns Pumping Plant
Murray Ditch Pumping Plant
Unit-1000 AF

Year	April	May	June	July	Aug.	Sept.	Total
1930				.4	.3		.7
31	.1	.2	.3			.1	1.4
32							1.1
33			.3				1.4
34							1.4
1935							1.4
36							1.4
37		.2	.3				1.4
38	.1						.9
39			.3				1.1
1940	.1	.2	.3			.1	1.4
41	.1	.2					1.0
42						.1	.8
43	.1		.3			.1	1.2
44		.2					1.0
1945						.1	.9
46		.2	.3			.1	1.4
47							.8
48						.1	.9
49							.9
1950							.9
51		.2					1.1
52							.9
53		.2					1.1
54			.3				1.4
1955							1.4
56							1.4
57							1.4
58							1.4
59							1.4
1960							1.4
61							1.4
62							1.4
63							1.4
64						.1	1.4
1965	.1	.2					1.3
66			.3			.1	1.1
67	.1	.2					1.1
68		.2					1.1
69							.9
1970		.2				.1	1.1
71		.2					1.0
72	.1			.4	.3	.1	.9
Total	3.9	5.8	6.9	17.2	12.9	3.7	50.4
Average	0.1	.1	.2	.4	.3	.1	1.2

Table 16
Burns Pumping Plant
Monthly Pumping Energy Requirements for Murray Pumps
Unit-1000 KWH

Year	April	May	June	July	Aug.	Sept.	Total
1930				37.2	28.8		66.0
31	9.6	19.2	28.8	↓	↓	10.1	133.7
32	↓	↓		↓	↓	↓	104.9
33	↓	↓	28.8	↓	↓	↓	133.7
34	↓	↓	↓	↓	↓	↓	133.7
1935	↓	↓	↓	↓	↓	↓	133.7
36	↓	↓	↓	↓	↓	↓	133.7
37	↓	19.2	28.8	↓	↓	↓	133.7
38	9.6			↓	↓	↓	85.7
39			28.8	↓	↓	↓	104.9
1940	9.6	19.2	28.8	↓	↓	10.1	133.7
41	9.6	19.2		↓	↓		94.8
42				↓	↓	10.1	76.1
43	9.6		28.8	↓	↓	10.1	114.5
44	↓	19.2		↓	↓		94.8
1945	↓			↓	↓	10.1	85.7
46	↓	19.2	28.8	↓	↓	10.1	133.7
47	↓			↓	↓		75.6
48	↓			↓	↓	10.1	85.7
49	↓			↓	↓	↓	85.7
1950	↓			↓	↓	↓	85.7
51	↓	19.2		↓	↓	↓	104.9
52	↓			↓	↓	↓	85.7
53	↓	19.2	28.8	↓	↓	↓	133.7
54	↓	↓	↓	↓	↓	↓	133.7
1955	↓	↓	↓	↓	↓	↓	133.7
56	↓	↓	↓	↓	↓	↓	133.7
57	↓	↓	↓	↓	↓	↓	133.7
58	↓	↓	↓	↓	↓	↓	133.7
59	↓	↓	↓	↓	↓	↓	133.7
1960	↓	↓	↓	↓	↓	↓	133.7
61	↓	↓	↓	↓	↓	↓	133.7
62	↓	↓	↓	↓	↓	↓	133.7
63	↓	↓	↓	↓	↓	↓	133.7
64	↓	↓	↓	↓	↓	10.1	133.7
1965	9.6	19.2	↓	↓	↓		123.6
66			28.8	↓	↓	10.1	104.9
67	9.6	19.2		↓	↓	↓	104.9
68	↓	19.2		↓	↓	↓	104.9
69	↓			↓	↓	↓	85.7
1970	↓	19.2		↓	↓	10.1	104.9
71	↓	19.2		↓	↓		94.8
72	9.6			37.2	28.8	10.1	85.7
Total	374.4	556.8	691.2	1599.6	1238.4	373.7	4834.1
Avg.	8.7	13.0	16.1	37.2	28.8	8.7	112.4

Table 17
Burns Pumping Plant
Capacity Demand for Murray Pumps
Unit-Kilowatts

Year	April	May	June	July	Aug.	Sept.	Total	Max. Kw.
1930			102	111	80		293	111
31	66	66				41	364	
32			102				466	
33							466	
34							466	
1935							466	
36							466	
37		66	102				466	
38	66						298	
39			102				334	
1940	66	66	102			41	466	
41	66	66					323	
42						41	232	
43	66		102			41	400	
44		66					323	
1945						41	298	
46		66	102			41	466	
47							257	
48						41	298	
49							298	
1950							298	
51		66					364	
52							298	
53		66					364	
54			102				466	
1955							466	
56							466	
57							466	
58							466	
59							466	
1960							466	
61							466	
62							466	
63							466	
64						41	466	
1965	66	66					425	
66			102			41	334	
67	66	66					323	
68		66					323	
69							257	
1970		66				41	364	
71		66					323	
72	66			111	80	41	298	111
Total	2574	1914	2448	4773	3440	1394	16543	
Max. Kw.	66	66	102	111	80	41	--	111

(2) One 40-hp., 3-phase, 440-volt, 1,200-r.p.m. pump designed for 3.8 second-feet.

(3) One 20-hp., 3-phase, 440-volt, 1,800-r.p.m. pump designed for 2 second-feet.

Table 18 shows the pumping demand for Burton Ditch with Tables 19 and 20 showing the energy and capacity required to supply this demand. The total energy and capacity demands for Burns Pumping Plant and for the Jensen Unit are shown in Tables 21 through 24.

Power Source and Rates

Power for the Tyzack and Burns Pumping Plants will be supplied from the CRSP system. The Flaming Gorge-Vernal No. 1 Line would be tapped near Brush Creek and a 138-kilovolt line would extend about 2 miles from the tap to a 5,000-kilovolt-ampere substation at Tyzack Switchyard. Another 138-kilovolt line would extend about 1 mile from a tap on the Vernal-Hayden line near Utah Highway 149 to a 2,500-kilovolt-ampere substation at the Burns Switchyard.

The monthly cost of power for pumping was assumed to be the same as CRSP Rate Schedule UC-F1 of 3 mills per kilowatt-hour and $1.32 per kilowatt for the maximum 30-minute integrated demand but without a charge for a contract rate of delivery. In addition to the above costs, 1 mill per kilowatt-hour was added for power wheeling charges.

Table 18
Burns Pumping Plant
Burton Ditch Pumping Demand
Unit-1000 AF

Year	April	May	June	July	Aug.	Sept	Total
1930				.4	.3		.7
31	.1	.2	.4			.1	1.5
32							1.1
33			.4				1.5
34							1.5
1935							1.5
36							1.5
37		.2	.4				1.5
38	.1						.9
39			.4				1.2
1940	.1	.2	.4			.1	1.5
41	.1	.2					1.0
42						.1	.8
43	.1		.4				1.3
44		.2					1.1
1945							.9
46		.2	.4			.1	1.5
47							.8
48						.1	.9
49							.9
1950							.9
51		.2	.1				1.2
52							.9
53		.2					1.1
54			.4				1.5
1955							
56							
57							
58							
59							
1960							
61							
62							
63							
64						.1	1.5
1965	.1	.2					1.4
66			.4			.1	1.2
67	.1	.2					1.1
68		.2					1.1
69							.9
1970		.2				.1	1.1
71		.2					1.0
72	.1			.4	.3	.1	.9
Total	3.9	5.8	9.3	17.2	12.9	3.8	52.9
Avg.	.1	.1	.2	.4	.3	.1	1.2

Table 19
Burns Pumping Plant
Monthly Pumping Energy Requirements for the Burton Pumps
Unit-1000 KWH

Year	April	May	June	July	Aug.	Sept.	Total
1930				26.0	19.3		45.3
31	6.7	13.3	26.0			7.0	98.3
32							72.3
33			26.0				98.3
34							98.3
1935							98.3
36							98.3
37		13.3	26.0				98.3
38	6.7						59.0
39			26.0				78.3
1940	6.7	13.3	26.0			7.0	98.3
41	6.7	13.3					65.3
42						7.0	52.3
43	6.7		26.0				85.0
44		13.3					72.3
1945							59.0
46		13.3	26.0			7.0	98.3
47							52.0
48						7.0	59.0
49							59.0
1950							59.0
51		13.3	7.0				79.3
52							59.0
53		13.3					72.3
54			26.0				98.3
1955							98.3
56							98.3
57							98.3
58							98.3
59							98.3
1960							98.3
61							98.3
62							98.3
63							98.3
64						7.0	98.3
1965	6.7	13.3					91.3
66			26.0			7.0	78.3
67	6.7	13.3					72.3
68		13.3					72.3
69							59.0
1970		13.3				7.0	72.3
71		13.3					65.3
72	6.7			26.0	19.3	7.0	59.0
Total	261.3	385.7	605.0	1118.0	829.9	266.0	3465.9
Avg.	6.1	9.0	14.1	26.0	19.3	6.2	80.6

Table 20
Burns Pumping Plant
Monthly Capacity Demands for the Burton Pumps
Unit-Kilowatts

Year	April	May	June	July	Aug.	Sept.	Total	Max.Kw
1930				84	62		146	84
31	40	40	84	↓	↓	21	331	↓
32	↓	↓		↓	↓	↓	247	↓
33	↓	↓	84	↓	↓	↓	331	↓
34	↓	↓	↓	↓	↓	↓	331	↓
1935	↓	↓	↓	↓	↓	↓	331	↓
36	↓	↓	↓	↓	↓	↓	331	↓
37	↓	40	84	↓	↓	↓	331	↓
38	40			↓	↓	↓	207	↓
39			84	↓	↓	↓	251	↓
1940	40	40	84	↓	↓	21	331	↓
41	40	40		↓	↓		226	↓
42				↓	↓	21	167	↓
43	40		84	↓	↓	↓	291	↓
44	↓	40		↓	↓	↓	247	↓
1945	↓			↓	↓	↓	207	↓
46	↓	40	84	↓	↓	21	331	↓
47	↓			↓	↓		186	↓
48	↓			↓	↓	21	207	↓
49	↓			↓	↓	↓	207	↓
1950	↓			↓	↓	↓	207	↓
51	↓	40	21	↓	↓	↓	268	↓
52	↓			↓	↓	↓	207	↓
53	↓	40		↓	↓	↓	247	↓
54	↓	↓	84	↓	↓	↓	331	↓
1955	↓	↓	↓	↓	↓	↓	331	↓
56	↓	↓	↓	↓	↓	↓	331	↓
57	↓	↓	↓	↓	↓	↓	331	↓
58	↓	↓	↓	↓	↓	↓	331	↓
59	↓	↓	↓	↓	↓	↓	331	↓
1960	↓	↓	↓	↓	↓	↓	331	↓
61	↓	↓	↓	↓	↓	↓	331	↓
62	↓	↓	↓	↓	↓	↓	331	↓
63	↓	↓	↓	↓	↓	↓	331	↓
64	↓	↓	↓	↓	↓	21	331	↓
1965	40	40	↓	↓	↓		310	↓
66			↓	↓	↓	21	251	↓
67	40	40	84	↓	↓	↓	331	↓
68	↓	40		↓	↓	↓	247	↓
69	↓			↓	↓	↓	207	↓
1970	↓	40		↓	↓	21	247	↓
71	↓	40		↓	↓		226	↓
72	40			84	62	21	207	84
Total	1560	1160	2037	3612	2666	798	11833	
Max Kw	40	40	84	84	62	21		84

Table 21
Burns Pumping Plant
Total Monthly Pumping Energy Requirements
Unit-1000 KWH

Year	Oct.	April	May	June	July	Aug.	Sept.	Total
1930					542.6	342.4		885.0
31		53.5	106.9	459.2	567.2	389.7	94.0	1670.7
32	13.8	78.8	317.7		516.5	389.7	17.1	1333.6
33		78.8	364.6	386.2	542.6	414.4	94.0	1880.6
34	13.8	41.8	364.6	459.2	542.6	389.7	69.9	1881.6
1935	13.8	78.8	364.6	433.1	542.6	389.7	69.9	1892.5
36	13.8	53.5	364.6	459.2	567.4	414.4	30.9	1903.8
37		53.5	243.4	480.2	516.5	389.7	30.9	1714.2
38		53.5			491.8	389.7	17.1	952.1
39				480.2	567.4	389.7	43.5	1480.8
1940		41.8	364.6	459.2	567.4	389.7	94.0	1916.7
41	13.8	78.8	268.7		542.6	414.4		1318.3
42					491.8	342.4	30.9	865.1
43		29.5		93.1	542.6	389.7	69.9	1124.8
44		78.8	46.3		240.8	342.4	7.0	715.3
1945		78.8			516.5	414.4	43.5	1053.2
46		41.8	364.6	480.2	567.4	389.7	94.0	1937.7
47		41.8			125.2	293.2		460.2
48		78.8			516.5	389.7	17.1	1002.1
49		53.5			516.5	293.2	30.9	894.1
1950		29.5			542.6	367.5	30.9	970.5
51		78.8	339.9	7.0	542.6	389.7	94.0	1452.0
52		41.8			542.6	342.4	43.5	970.3
53		78.8	364.6	28.8	542.6	389.7	94.0	1498.5
54		41.8	364.6	480.2	542.6	389.7	69.9	1888.8
1955	13.8	78.8	364.6	504.7	542.6	389.7	94.0	1988.2
56	13.8	78.8	364.6	480.2	567.4	389.7	94.0	1988.5
57	13.8	102.9	364.6	433.1	516.5	342.4	17.1	1790.4
58		78.8	317.7	480.2	567.4	389.7	94.0	1927.8
59	13.8	78.8	364.6	504.7	542.6	389.7	94.0	1988.2
1960	13.8	78.8	364.6	480.2	567.4	389.7	94.0	1988.5
61	13.8	102.9	364.6	480.2	567.4	389.7	94.0	2012.6
62	13.8	29.5	243.4	152.5	542.6	389.7	43.5	1415.0
63		102.9	364.6	480.2	542.6	389.7	94.0	1974.0
64	13.8	102.9	364.6	433.1	567.4	389.7	94.0	1965.5
1965		78.8	364.6	504.7	347.1	342.4		1637.6
66				480.2	567.4	389.7	59.8	1497.1
67		78.8	364.6		491.8	414.4	83.9	1433.5
68	13.8	102.9	339.9		588.1	367.5	83.9	1496.1
69		29.5	317.7		588.1	414.4	59.8	1091.8
1970		78.8	364.6		588.1	414.4	33.4	1432.4
71		78.8			542.6	389.7		1375.7
72		53.5			542.6	414.4	33.4	1043.9
1/		11.6	3.8			7.9	6.3	29.6
Total	193.2	2634.3	9472.8	10,119.8	22,517.4	16,441.4	2360.0	63734.3
Avg.	4.5	61.3	220.3	235.3	523.7	382.4	54.9	1482.4

1/ Energy required to pump 230 AF annually to Stewart Lake Waterfowl Management Area

Table 22
Burns Pumping Plant
Total Monthly Capacity Requirements
Unit-Kilowatts

Year	Oct.	April	May	June	July	Aug.	Sept.	Total	Year's Max. Kw
1930				102	1193	858		2153	1193
31		284	284	1047	1258	977	262	4112	1258
32	38	470	772	102	1137	977	21	3517	1137
33		470	900	965	1193	1041	262	4831	1193
34	38	249	900	1149	1193	977	202	4708	1193
1935	38	470	900	1093	1193	977	202	4873	1193
36	38	284	900	1149	1258	1041	100	4770	1258
37		284	592	1214	1137	977	100	4304	1214
38		284			1073	977	62	2396	1073
39				1214	1258	977	137	3586	1258
1940		249	900	1149	1258	977	262	4795	1258
41	38	470	654		1193	1041		3396	1193
42					1073	858	100	2031	1073
43		181		294	1193	977	202	2847	1193
44		470	144		585	858	21	2078	585
1945		470			1137	1041	137	2785	1137
46		249	900	1214	1258	977	262	4860	1258
47		249			338	733		1320	733
48		470			1137	977	62	2646	1135
49		284			1137	733	100	2254	1137
1950		181			1193	913	100	2387	1193
51		470	836	21	1193	977	262	3759	1193
52		249			1193	858	137	2437	1193
53		470	900		1193	977	262	3802	1193
54		249	900	1214	1193	977	202	4735	1193
1955	38	470	900	1275	1193	977	262	5115	1193
56	38	470	900	1214	1258	977	262	5119	1258
57	38	653	900	1093	1137	858	62	4741	1137
58		470	772	1214	1258	977	262	4953	1258
59	38	470	900	1275	1193	977	262	5115	1193
1960	38	470	900	1214	1258	977	262	5119	1258
61	38	653	900	1214	1258	977	262	5302	1258
62	38	181	592	428	1193	977	137	3546	1193
63		653	900	1214	1193	977	262	5199	1214
64	38	653	900	1093	1258	977	262	5181	1258
1965		470	900	1275	710	858		4213	1275
66				1214	1258	977	161	3610	1258
67		470	900	84	1073	1041	221	3789	1073
68	38	653	836		1319	913	221	3980	1319
69		181			1319	1041	161	2702	1319
1970		470	772		1319	1041	96	3698	1319
71		470	900		1193	977		3540	1193
72		284			1193	1041	96	2614	1193
Total	532	15647	23354	25734	49750	41193	6708	162918	--
Max Kw	38	653	900	1275	1319	1041	262	--	1319

Table 23
Burns and Tyzack Pumping Plants
Total Energy Required for Pumping
Unit-1000 KWH

Year	Oct.	Nov.	March	April	May	June	July	Aug.	Sept.	Total
1930	1279	1282	1264	843	1232	1362	1907	1712	1373	12254
31	1323	1332	1264	897	1339	1829	1952	1787	1503	13226
32	1296	1291	1320	961	1558	1362	1879	1757	1390	12814
33	1303	1311	1285	938	1610	1748	1910	1793	1482	13380
34	1381	1379	1306	911	1629	1871	1969	1831	1523	13800
1935	1331	1329	1367	993	1677	1812	1928	1784	1473	13694
36	1370	1367	1323	936	1637	1874	1993	1849	1475	13824
37	1285	1294	1362	962	1494	1844	1881	1760	1407	13289
38	1273	1267	1288	913	1232	1362	1854	1757	1390	12336
39	1308	1320	1264	843	1232	1847	1943	1781	1444	12982
1940	1338	1347	1314	914	1610	1844	1964	1802	1517	13650
41	1284	1264	1344	979	1520	1362	1907	1784	1376	12820
42	1282	1288	1264	843	1232	1362	1854	1706	1401	12232
43	1300	1308	1282	877	1232	1455	1910	1769	1440	12573
44	1279	1285	1303	949	1278	1362	1603	1706	1377	12142
1945	1294	1300	1276	932	1232	1362	1884	1790	1426	12496
46	1338	1347	1294	901	1618	1871	1967	1802	1517	13655
47	1276	1279	1335	930	1232	1362	1487	1657	1367	11925
48	1285	1294	1276	932	1232	1362	1881	1760	1393	12415
49	1276	1282	1288	911	1232	1362	1879	1657	1404	12291
1950	1282	1291	1273	873	1232	1362	1905	1735	1404	12357
51	1297	1306	1282	936	1572	1369	1910	1766	1479	12917
52	1288	1294	1303	905	1232	1362	1907	1709	1420	12420
53	1297	1306	1279	934	1605	1391	1907	1763	1479	12961
54	1326	1338	1300	905	1610	1862	1934	1793	1485	13553
1955	1396	1397	1335	973	1656	1931	1978	1840	1559	14065
56	1437	1444	1388	1005	1677	1933	2032	1875	1597	14388
57	1355	1350	1435	1068	1736	1851	1932	1760	1443	13930
58	1303	1311	1344	979	1577	1842	1934	1769	1482	13541
59	1349	1347	1308	955	1629	1893	1940	1799	1514	13734
1960	1426	1429	1347	977	1672	1924	2023	1863	1585	14246
61	1514	1500	1423	1060	1733	1995	2099	1952	1691	14967
62	1308	1303	1482	983	1515	1515	1907	1766	1429	13208
63	1362	1373	1300	973	1629	1880	1958	1822	1538	13835
64	1381	1382	1370	1023	1669	1848	1993	1828	1544	14038
1965	1279	1279	1379	1003	1669	1867	1709	1706	1373	13264
66	1306	1317	1264	843	1232	1844	1940	1775	1454	12975
67	1282	1291	1311	955	1616	1362	1854	1781	1457	12909
68	1293	1288	1285	962	1575	1362	1950	1732	1457	12904
69	1291	1300	1282	883	1550	1362	1952	1787	1439	12846
1970	1285	1294	1294	946	1597	1362	1950	1781	1409	12918
71	1282	1291	1288	942	1237	1362	1907	1757	1373	12439
72	1294	1303	1279	907	1232	1362	1910	1790	1418	12495
1/				12	4			8	6	30
Total	56734	56900	56570	40367	63514	69456	82083	76401	62713	564738
Avg.	1319	1323	1316	939	1477	1615	1909	1777	1458	13133

1/ Energy required to pump 230 A.F. annually into Stewart Lake Waterfowl Management Area.

Table 24
Burns and Tyzack Pumping Plants
Total Capacity Required for Pumping
Unit-Kilowatts

Year	Oct.	Nov.	March	April	May	June	July	Aug.	Sept.	Year's Max. Kw
1930	1736	1740	1716	1716	2463	2565	3661	3337	2484	3661
31	1796	1808	1716	2000	2747	3526	3764	3504	2810	3764
32	1740	1790	1792	2266	3251	2565	3600	3451	2505	3600
33	1768	1780	1744	2218	3390	3428	3667	3536	2773	3667
34	1856	1910	1772	2017	3427	3703	3773	3584	2830	3773
1935	1788	1842	1856	2330	3523	3588	3699	3499	2740	3699
36	1840	1894	1796	2080	3443	3708	3838	3637	2712	3838
37	1744	1756	1848	2132	3092	3682	3605	3456	2590	3682
38	1728	1720	1748	2032	2463	2463	3536	3457	2546	3536
39	1776	1792	1716	1716	2463	3688	3748	3493	2669	3748
1940	1816	1828	1784	2025	3390	3655	3785	3531	2837	3785
41	1724	1754	1824	2302	1354	2463	3661	3520	2490	3661
42	1740	1748	1716	1716	2463	2463	3536	3326	2579	3536
43	1764	1776	1740	1905	2463	2757	3667	3472	2681	3667
44	1736	1744	1768	2242	2607	2463	3048	3326	2500	3326
1945	1756	1764	1732	2206	2463	2463	3611	3531	2637	3611
46	1816	1828	1756	1997	3406	3730	3790	3531	2837	3790
47	1732	1736	1812	2057	2463	2463	2801	3201	2474	3201
48	1744	1756	1732	2206	2463	2463	3605	3456	2552	3605
49	1732	1740	1748	2028	2463	2463	3600	2601	2584	3600
1950	1740	1752	1728	1897	2463	2463	3656	3387	2584	3656
51	1760	1772	1740	2214	3299	2484	3667	3467	2768	3667
52	1748	1756	1768	2005	2463	2463	3661	3332	2627	3661
53	1760	1772	1736	2210	3379	2463	3661	3461	2768	3661
54	1800	1816	1764	2005	3390	3714	3709	3515	2761	3714
1955	1876	1934	1812	2290	3480	3855	3789	3600	2912	3855
56	1932	1998	1884	2354	3523	3842	3908	3664	2981	3908
57	1820	1870	1948	2617	3640	3657	3696	3422	2642	3696
58	1768	1780	1824	2302	3288	3677	3732	3472	2773	3732
59	1812	1866	1776	2254	3427	3786	3720	2525	2832	3786
1960	1916	1978	1828	2298	3512	3826	3892	3642	2959	3892
61	2036	2074	1932	2601	3635	3954	4030	3802	3151	4030
62	1756	1806	2012	2121	3135	2891	3661	3467	2643	3661
63	1848	1864	1764	2425	3427	3746	3752	3568	2874	3752
64	1856	1914	1860	2525	3507	3652	3838	3579	2885	3838
1965	1736	1736	1872	2350	3507	3738	3173	3326	2484	3738
66	1772	1788	1716	1716	2463	3682	3742	3483	2683	3742
67	1740	1752	1780	2254	3400	2547	3536	3515	2705	3536
68	1736	1786	1744	2401	3304	2463	3782	3381	2705	3782
69	1752	1764	1740	1917	2463	2463	3787	3525	2656	3787
1970	1744	1756	1756	2234	3235	2463	3782	3515	2586	3782
71	1740	1752	1748	2226	3374	2463	3661	3451	2484	3661
72	1756	1768	1736	2020	2463	2463	3667	3531	2602	3667
Total	76736	77760	76784	92427	131374	133054	157497	148073	115895	--
Max.Kw	2036	2074	1860	2617	3640	3954	4030	3664	3151	4030