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Silt Project, Colorado: Colorado River Storage Project

U.S. Department of Agriculture

SILT PROJECT, COLORADO

COLORADO RIVER STORAGE PROJECT

A Report of reappraisal of direct agricultural benefits and project impacts

U. S. DEPARTMENT OF AGRICULTURE
Salt Lake City, Utah

USDA-SCS PORTLAND OREG. 1959 M-2512

UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF

REAPPRAISAL OF DIRECT AGRICULTURAL BENEFITS

AND PROJECT IMPACTS

SILT PROJECT

COLORADO

COLORADO RIVER STORAGE PROJECT

In Cooperation With
Bureau of Reclamation
United States Department of the Interior

Report Prepared by

USDA Field Advisory Committee and USDA Field Party

Salt Lake City, Utah - August 1961

ACKNOWLEDGMENTS

In preparing this report, full use was made of available field data, published reports, and the combined judgement of agricultural technicians familiar with the project area, its agricultural problems and conditions. The U. S. Bureau of Reclamation furnished the USDA Field Party with preliminary reports, land classification maps and field sheets, information regarding water supply and acreage and location of lands to be included in the project. This information was used to augment field investigations such as soil surveys, economic surveys, engineering surveys, crop yield determinations, and irrigation water investigations made by members of the USDA Field Party, Soil Conservation Service and Economic Research Service.

The U. S. Forest Service, U. S. Bureau of Land Management, and others assisted in the watershed studies. The Forest Service also prepared Chapter III regarding the relationship of the project to national forest lands. Assistance from representatives of the Colorado State University, Colorado Cooperative Extension Service, Colorado Agricultural Experiment Station, State and County Agricultural Stabilization and Conservation Committees, U. S. Farmers Home Administration, Agricultural Research Service, and others was valuable in preparing the report.

The contributions and assistance of these organizations in the preparation of this report are gratefully acknowledged.

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REPORT OF REAPPRAISAL OF DIRECT AGRICULTURAL BENEFITS AND PROJECT IMPACTS SILT PROJECT - COLORADO

SUMMARY

Authority

This report on the Silt participating project, Colorado River Storage Project, has been prepared by the U. S. Department of Agriculture in response to the President's letters of March 19, 1954 to the Secretary of Agriculture and the Secretary of the Interior. In his letters, the President requested that a reappraisal of the direct agricultural benefits, expected to be produced by the participating projects of the Colorado River Storage Project, be made by the Department of Agriculture in cooperation with the Department of the Interior. Following authorization of the Colorado River Storage Project by the Congress on April 11, 1956, an understanding was reached in July 1956 between the Secretary of Agriculture and Secretary of the Interior regarding conduct of a survey to reappraise direct agricultural benefits and to appraise project impacts. The Department of Agriculture survey was made under the authority of Section 6, Public Law 566, 83rd Congress, as amended, which authorizes the Department to cooperate with other Federal, State and local agencies to make investigations and surveys of the watersheds of rivers as a basis for the development of coordinated programs.

Purpose and Scope

The purpose of this report is to present information regarding the soil capabilities for irrigation, the present and future land use and production pattern, the costs associated with on-farm irrigation development, prospective size and type of farm, direct agricultural benefits and probable farm incomes with proposed irrigation development for the Silt project. In addition to the agricultural phases, this report deals with the impacts of the project on the national forests and the relationship of watershed conditions to the project.

This report also is intended to aid the Bureau of Reclamation in developing their Definite Plan Report, and to provide information bearing on the relationship of the project to the regular programs of the Department of Agriculture. It is based on the Silt project plan as outlined by the Bureau of Reclamation and is confined to the proposed project facilities and the project lands to which the Bureau of Reclamation plans to furnish irrigation water.

The assumptions made concerning the level of management and application of practices as a result of project development are not technical recommendations of the Department of Agriculture for the best land and water use on the project. It is assumed that the level of management and application of practices represent the average that will exist during the project evaluation period.

General Description

The Silt project is located in southeastern Garfield County, Colorado. Elevation of project lands varies from 5,500 to 6,300 feet. The climate is semi-arid. Average annual precipitation approximates 11 inches. The average frost-free period varies from 128 to 141 days. Project lands are all privately owned and are located on Harvey and Davie Mesas and in Dry Elk Valley. Agriculture is the basic industry of the project area, with livestock production being the principal type of farming. Mining, railroading and recreation also are a part of the local economy.

Proposed Project Development

The Silt project will furnish supplemental irrigation water for 4,479 acres of land presently irrigated with only a partial water supply and 2,118 acres of non-irrigated land. In addition, 244 acres of Bureau of Reclamation class 4 land and 226 acres of class 6W presently irrigated land will continue to receive their present water supplies.

The project plan proposes the construction of the Rifle Gap Dam and Reservoir on Rifle Creek and the Silt Pumping Plant located on the Colorado River. The reservoir will have an initial capacity of 12,650 acre-feet, including 9,500 acre-feet of active capacity for irrigation and 3,150 acre-feet inactive capacity for sediment, fish and wildlife. In addition to the dam and pumping plant, several canals and laterals, plus interceptor and outlet drains, will also be constructed as part of the project. The existing Harvey Gap Reservoir will continue to deliver water for use on lands on Harvey Mesa. The increase in water supplies provided by the project will be 5,030 acre-feet for presently irrigated lands and 6,700 acre-feet for new lands, a total of 11,730 acre-feet, at the point of diversion.

Evaluation of Direct Agricultural Benefits

Evaluation Areas

For purposes of the analysis, project lands were grouped into eight evaluation areas. The soils, climate and water supply within each evaluation area reflect similar crop adaptations, productivity, land and irrigation development and production costs. Estimates of farm incomes and direct agricultural benefits were developed for each area and for the project as a whole. These areas have been designated as A, B, C, D, E, F, G and H. Lands in evaluation areas A and B are geographically located on Harvey Mesa, lands in C and D are located on Davie Mesa and lands in E, F, G and H in Dry Elk Valley.

Evaluation Area A comprises 2,835 acres of presently irrigated land and 383 acres of new land. Soils are deep, medium to fine textured and have slopes ranging from 0-6 percent. Most of the project soils having saline, alkali and high water table problems are included in this evaluation area.

Evaluation Area B comprises 1,286 acres of presently irrigated land and 176 acres of new land. Soils are similar to those in evaluation area A but slopes are steeper, generally from 6-12 percent. Evaluation area B lands are intermingled with lands of evaluation area A.

With project development, presently irrigated lands in evaluation areas A and B will receive approximately an additional .9 acre-foot of water per acre delivered at the farm headgate. Intermingled non-irrigated new lands will receive 2.7 acre-feet of water delivered at the farm headgate.

Evaluation Area C consists of 657 acres of non-irrigated new lands to be served by the Davie Ditch. Soils are similar to those in evaluation area A on slopes from 0-6 percent. New farm units will be established on these lands.

Evaluation Area D comprises 215 acres of non-irrigated new lands to be served by the Davie Ditch. Soils and slopes are similar to those in evaluation area B. Crop distribution and crop yields will average the same as for evaluation area B.

Lands in evaluation areas C and D are presently non-irrigated. With project development they will receive approximately 2.7 acre-feet of water per acre delivered at the farm headgate.

Evaluation Area E is comprised of 181 acres of presently irrigated land located in Dry Elk Valley. Soils are deep with medium to fine textures, moderate to slow permeability, generally on slopes between 3 and 6 percent. Irrigation water will be delivered by direct diversion from East Rifle Creek.

Evaluation Area F consists of 177 acres of presently irrigated land located in Dry Elk Valley. Soils are similar to those in evaluation area E but slopes are steeper, generally from 6-12 percent.

With project development, lands in evaluation areas E and F will receive approximately an additional 1.9 acre-feet of irrigation water per acre delivered at the farm headgate.

Evaluation Area G comprises 341 acres of non-irrigated new land in Dry Elk Valley. Soils and slopes are similar to evaluation area E.

Evaluation Area H is composed of 346 acres of non-irrigated new land in Dry Elk Valley. Soils are similar to evaluation area E but slopes are steeper, generally from 6-12 percent.

Lands in evaluation areas G and H are presently non-irrigated. With project development they will receive approximately 2.7 acre-feet of water per acre delivered at the farm headgate.

Soils

Basic soils data were obtained from a soil survey of the project area completed by the Soil Conservation Service. Laboratory data on project soils

were furnished by the Agricultural Research Service and the Cooperative Soil Survey Laboratories in Fort Collins, Colorado. Land classification field sheets and laboratory data were obtained from the Bureau of Reclamation.

Evaluation area A comprises 3,218 acres of which 71 percent are in capability class III and 29 percent in capability class II. The 1,462 acres in evaluation area B, 215 acres in evaluation area D, 177 acres in evaluation area F and the 346 acres in evaluation area H are all in capability class IV. Evaluation area C comprises 657 acres of which 62 percent are in capability class II and 38 percent in capability class III. Eighty-eight percent of the 181 acres in evaluation area E are in capability class III and 12 percent in capability class II. Evaluation area G comprises 341 acres of which 84 percent are in capability class III and 16 percent in capability class II.

It is concluded that soils comprising the 6,597 acres of land designated by the Bureau of Reclamation as the Silt Project, which have been interpretively grouped into capability classes II-1,400 acres, III-2,997 acres, and IV-2,200 acres, are suitable for cultivation under irrigation.

Irrigation Supplies and Requirements

Several studies of irrigation requirements have been made in the general vicinity of the Silt project. These data, with additional information supplied by personnel familiar with the area, were used in estimating irrigation water requirements. In the past the water supply has averaged about one-third of requirements in the Dry Elk Valley and about two-thirds of requirements on Harvey Mesa. Estimated water requirement at the farm headgate is 2.86 acre-feet per acre. Weighted future average on-farm irrigation efficiencies are estimated at 53 percent and weighted average net seasonal crop consumptive use at 18.2 inches.

The period 1937-60 was selected as the basis for project water supply studies Project water supplies during a period of years of comparable precipitation and water yield would with project average 2.74 acre-feet per acre of irrigation water at the farm headgate, thus meeting 96 percent of the average water requirements of the project lands.

Land and Irrigation Development

Estimates of development costs for project lands were made by evaluation areas on the basis of the level of management expected on the project and the physical requirements of the soils and site conditions. They are consistent with anticipated irrigation efficiencies and expected crop yields.

Estimated costs include land leveling and the establishment of farm irrigation systems and associated requirements. Estimated on-farm drainage costs for a limited acreage of project lands with water table conditions are also included.

Weighted average development per acre of irrigable land is estimated as follows: evaluation area A, $65.03; evaluation area B, $26.07; evaluation area C, $66.53; evaluation area D, $52.37; evaluation area E, $39.04; evaluation area F, $26.90; evaluation area G, $69.77; evaluation area H, $37.92.

Direct Agricultural Benefits and Potential Farm Incomes

The economic analysis of the proposed Silt irrigation project has two primary objectives: (1) an appraisal of direct agricultural benefits from project development, and (2) an appraisal of prospective farm incomes from representative sizes and types of farms considered most likely with the proposed irrigation development. Both of these analyses contribute to a general appraisal of the prospects for a successful, stable, irrigated agricultural economy. Farm incomes were estimated for five farm types, namely: range beef, grade-A dairy, feeder calves, farm flock of sheep, and cash-crop.

Project lands are expected to be used largely for the production of grain and forage crops. Sale of livestock and livestock products will likely be the predominant sources of agricultural income to project farmers.

The residual approach was used to estimate direct agricultural benefits from irrigation water. The total value of crop and pasture production was allocated to the various factors of production, except water, in accordance with their projected market prices with the residual being credited to the project as a direct benefit. For the 319 acres of project lands which presently have a full water supply from pumping, it is assumed that these lands would have direct agricultural benefits equal to the savings in present pumping costs, minus abandonment losses for present pumping equipment.

Estimates of returns with the project in the analysis are based on weighted averages of anticipated farm types and of sizes of 130 acres in evaluation area A, 135 acres in evaluation areas C and E, 140 acres in evaluation area G, 150 acres in evaluation area B, 155 acres in evaluation areas D and F, and 160 acres in evaluation area H. The annual equivalent value of direct agricultural benefits attributed to the project for the evaluation area lands are estimated at, A-$16.22, B-$7.83, C-$25.68, D-$14.62, E-$14.64, F-$11.92, G-$27.15, and H-$12.45 per acre. Direct agricultural benefits on present pump lands are estimated to be $21.55 per acre. The weighted average for the entire 6,597 acres is $15.85 per acre, or $104,531 annually.

Development of the project will result in a more stable and profitable agricultural economy. For the sizes and types of farms analyzed, estimated farm incomes will vary from $3,903 for a farm-flock sheep farm on evaluation area A lands to $8,606 for a grade-A dairy farm on evaluation area C lands. The general conclusion from this analysis is that the income prospects for fully developed farms of the five types of farms analyzed are adequate to provide a satisfactory level of living and to make some payment for irrigation water.

Relationship of the Silt Project to National Forest Lands

The Silt project features and project lands are all outside the exterior boundary of the White River National Forest. As far as can be foreseen, the project will not impair or affect any existing facility or service on national forest lands.

Relationship of Watershed Conditions to the Silt Project

The watershed area of the Silt project comprises about 175 square miles. It consists of the East, Middle and West Rifle Creek drainages, plus the drainage area of the lands lying south of the Grand Hogback and the west portion of Dry Elk Valley north of Harvey Gap Reservoir. Sixty-three percent of the lands in the watershed are owned by the Federal Government, with the remaining 37 percent being in private and State ownership.

Watershed problems consist largely of: (1) silt and sediment production from the Mancos shale areas above the Rifle Gap Reservoir; (2) denuded watershed lands due to improper grazing practices and loss of protective cover by fire; (3) abandoned beaver dams, which break and contribute sediment to stream flows; and (4) local flood water and sediment damage to irrigation canals and systems following thunderstorms and rapid snow-melt runoff on erosive type soils and steep and sparsely vegetated slopes.

No large flood control structures are recommended. The high and intermediate elevation zones pose no flood problems to the project. Flood control structures will be ineffectual in the lower elevation zones due to steep slopes, raw soils and sparse vegetation. Critical areas do exist and their harmful effects can be lessened by improved management such as fencing, revegetation and restricted grazing. Canal or ditch designs should provide protection for runoff from these lower elevation areas. Individual floods will be small due to short slopes and low rainfall but the cumulative effects of these events creates a need for corrective measures.

Sediment production can be reduced by the application of land treatment measures to watershed lands. Improved watershed conditions will reduce ditch and canal operation and maintenance cost. Establishment of land treatment measures on problem areas will also reduce sediment carried by streams and extend the useful life of the reservoirs.

Needed watershed treatment can be accomplished and would be justified under programs of Federal land administering agencies and by private land owners with assistance normally furnished by Federal and State agencies through Soil Conservation Districts and otherwise.

PROJECT LAND MAP
SILT PROJECT
GARFIELD COUNTY, COLORADO

JUNE 1961

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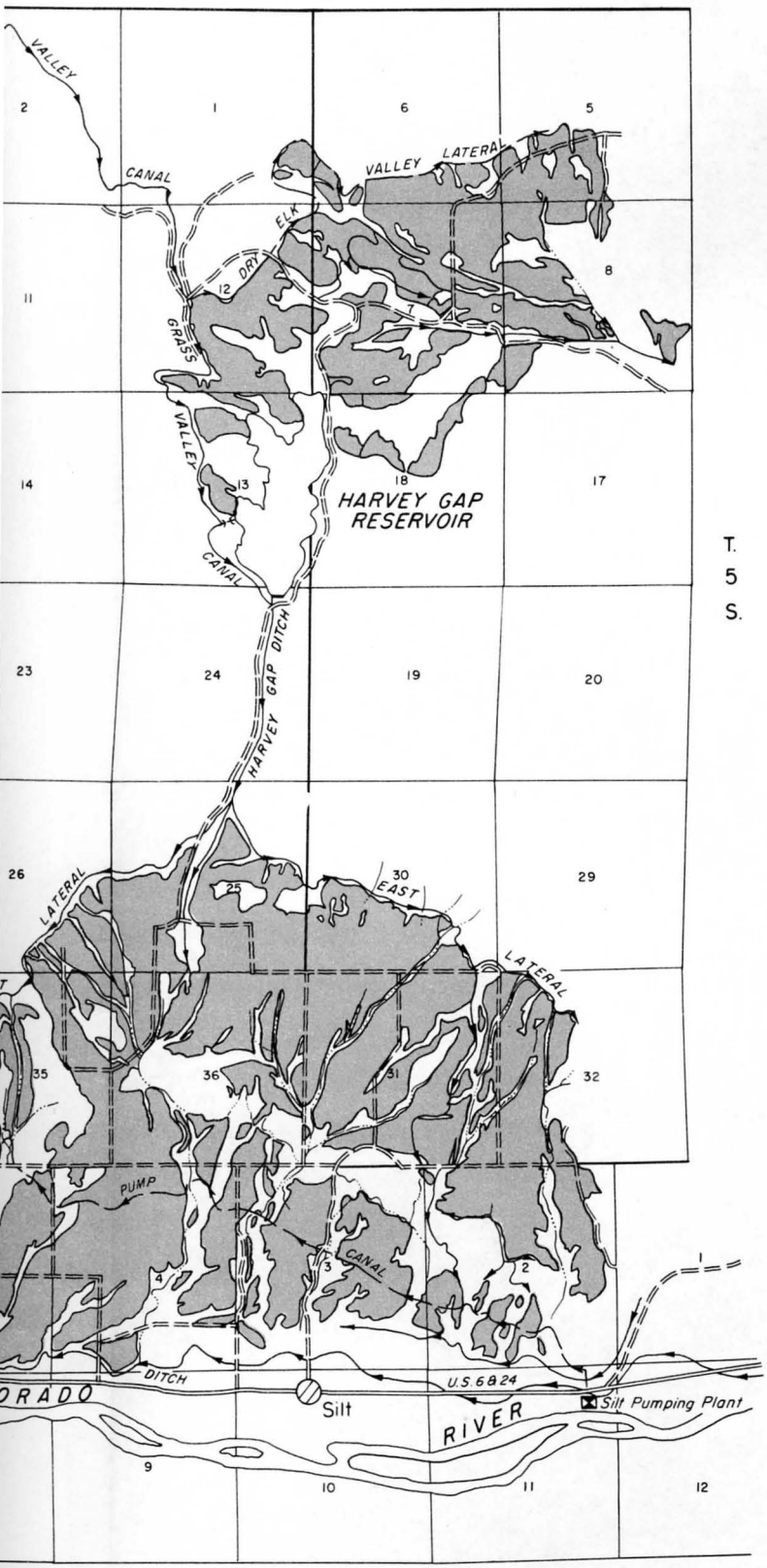
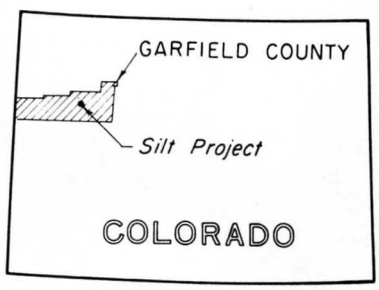
SCALE IN MILES

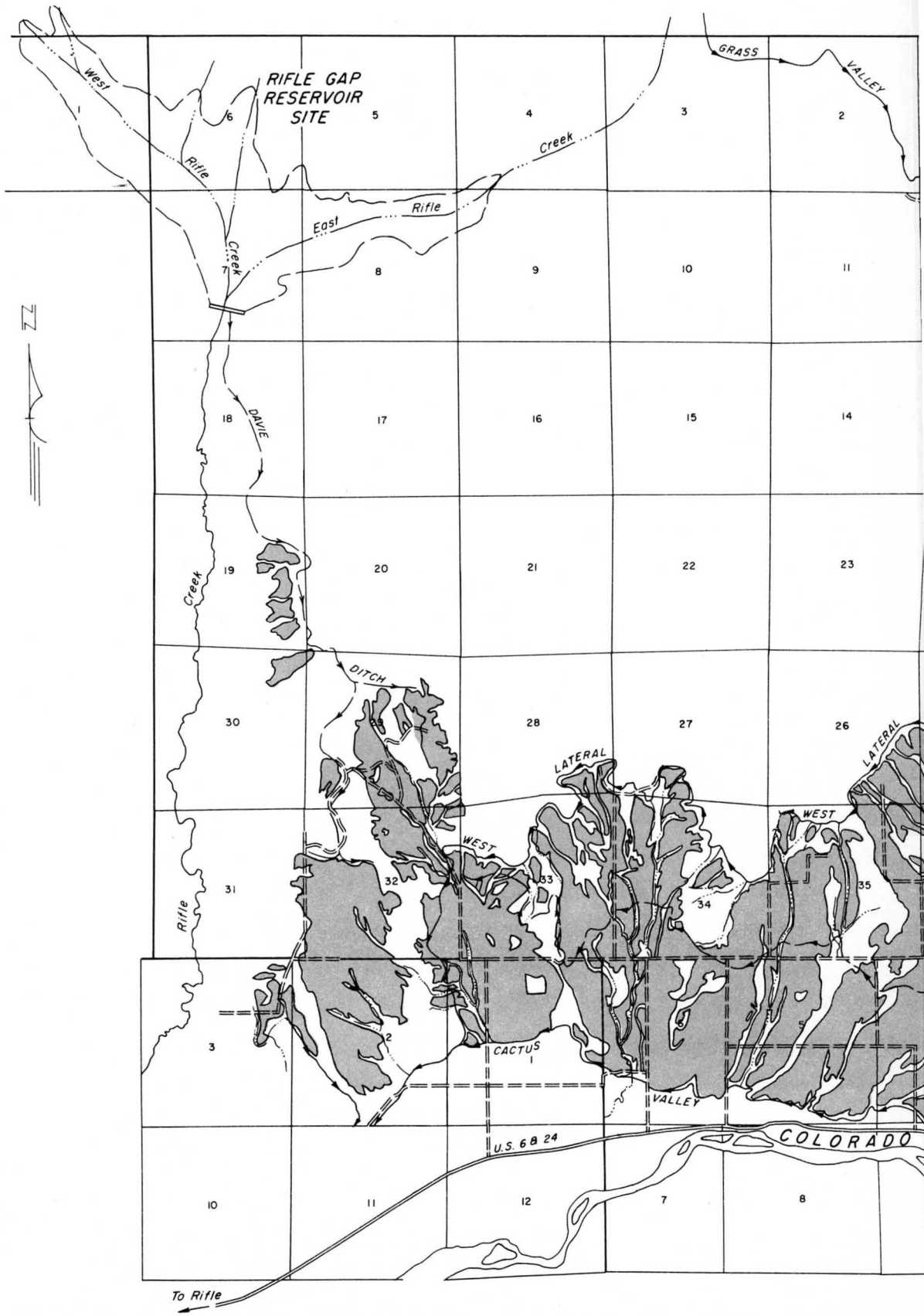


LEGEND

Project Lands



LOCATION MAP


R. 92 W.
RIFLE GAP RESERVOIR SITE
West Rifle Creek
East Rifle Creek
Rifle Creek
GRASS VALLEY
DAVIE
DITCH
LATERAL
LATERAL
WEST
WEST
CACTUS VALLEY
U.S. 6 & 24
COLORADO
To Rifle
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SILT PROJECT

CHAPTER I

GENERAL INFORMATION

Organization

Pursuant to the U. S. Department of Agriculture Memorandum of Understanding between the Soil Conservation Service, Forest Service, and Agricultural Research Service (Economic Research Service) dated February 2, 1956, a USDA Field Advisory Committee, Colorado River Storage Project was established. The committee is composed of a representative from each of these agencies and a member representing the concerned state agricultural colleges. Principal duties of the committee are to maintain appropriate liaison and facilitate coordination of activities by the respective services and the state agricultural colleges in the survey. Field relationships with the Bureau of Reclamation and other interested State and Federal agencies are also a responsibility of the committee.

A USDA Field Party, working under direction of the USDA Field Advisory Committee and operating within a plan of work dated August 22, 1956, is headquartered at Salt Lake City, Utah. The party is responsible for the collection and analysis of data and the preparation of this report.

Applicable data from previous investigations were utilized in the study.

Description of the Area

Location and Physical Features

The Silt project is located in southeastern Garfield County, Colorado. The project area is bounded by the Colorado River on the south, the White River Plateau on the north, Elk Creek on the east and Rifle Creek on the west. Project lands are located generally in three areas, namely: Harvey Mesa, Dry Elk Valley and Davie Mesa. The town of Silt is located near the southeastern boundary of the project and the town of Rifle is located approximately three miles south and west of the southwestern boundary of the project. Elevation of project lands varies from 5,500 feet above sea level in the Davie and Harvey Mesa area to 6,300 feet above sea level in Dry Elk Valley.

Water for the project will be supplied from Rifle Creek by storage of surplus early season runoff in the proposed Rifle Gap Reservoir or the existing Harvey Gap Reservoir, and by exchange of natural flow water for stored water. Water will also be supplied to project lands from the Silt pumping plant located at Davis Point on the Colorado River. Rifle Creek is formed by its tributaries of East, Middle and West Rifle Creeks, which drain the White River Plateau and Coulter Mesa areas north of the Grand Hogback.

Project lands are all privately owned and are within the boundary of the Bookcliff Soil Conservation District.

From an irrigation agriculture standpoint, the topography of the area is extremely rough. More than half of the area consists of high mesa lands. Secondary mesas and alluvial fans lying below the higher mesas have excessive slopes and are cut by canyons and severely eroded gullies. These lower mesas and alluvial fans, together with the gentler sloping valley bottoms, furnish the greater part of the farming land.

Project soils have developed primarily from loess deposits over shale, sandstone and gravel outwash material. Other soils have developed in alluvium from Wasatch, Mancos and Mesa Verde sandstones and shales and undifferentiated loess and alluvium. They reflect the influence of their parent material and the semi-arid climate under which they were developed. Organic matter content is low; however, soils are generally deep and with additions of nitrogen and phosphorus are highly productive. Soils on Harvey Mesa and Davie Mesa have loam, silt loam, sandy clay loam and clay loam textures. Soils in Dry Elk Valley have clay loam and clay textures. In some areas where drainage is a problem, soils contain large enough accumulations of alkali salts to restrict crop production.

Climate

The climate of the project area is temperate, semi-arid and is suitable for diversified irrigation farming. Relative humidity is low. Average annual precipitation recorded at Rifle (1931-1952) is 10.5 inches.

The average frost-free period for the Harvey Mesa area is estimated at 141 days, with the last killing frost occurring about May 13 and the first killing frost about September 30. The average frost-free period for Dry Elk Valley is estimated at 128 days. The last killing frost occurs about May 23 and the first killing frost about September 27.

History of Settlement

In 1878 two prospectors from Leadville came into Garfield County and reported evidence of carbonate deposits. Settlement in the project area started in 1880 while western Colorado was still inhabited by the Ute Indians. In 1882 Garfield County was formed from part of Summit County and was named after President Garfield. The first fruit orchards were planted in 1888. Most of the early settlers were prospectors and miners who turned to agricultural pursuits after being unsuccessful in mining. First appropriations of water for irrigation were made in 1882 from streams tributary to the Colorado River.

Agricultural Development

Agriculture is the basic industry of the project area. Crop production consists principally of hay and grain, most of which are used locally in the feeding of cattle, sheep, hogs and poultry. Small acreages of sugar beets, potatoes, corn and fruit are also grown. Presently irrigated lands in the project area experience irrigation water shortages after June of each year.

Dairy, range beef and sheep, feeder calf, farm flock of sheep and cash-crop farms comprise the bulk of the existing type of farms. These same types of farms are expected to prevail with project conditions. Adjacent national forest and public domain lands are used from spring, summer and fall grazing by cattle and sheep. Range rights on these lands are fully utilized and no additional grazing permits are available for any new farms developed by the project.

Industrial Development

In addition to agriculture, several other industries contribute to the local economy. Mining is important in Garfield County. Seven workable coal veins, with a combined thickness of 100 feet, are located within a few miles of Rifle. The county has an estimated oil-shale deposit of 500 billion barrels of oil. The U. S. Bureau of Mines developed and operated a pilot oil-shale plant and mine six miles west of Rifle. This plant has now been turned over to the Navy Petroleum Reserves. The Union Oil Company of California is also active in the oil-shale development. They erected and operated, during the period of 1956-58, a three million dollar research extraction plant near Parachute Creek. During 1960 the plant was dismantled and shipped to South America for similar shale research. The Union Carbide Nuclear Company recently completed an eight and one-half million dollar uranium and vanadium mill at Rifle.

Recreation and railroading also provide the area with a substantial source of income.

General

The towns of Rifle and Silt are both located on the main line of the Denver and Rio Grande Western Railroad, which operates between Denver and Salt Lake City, Utah. U. S. Highways 6 and 24 also connecting Denver and Salt Lake City, pass through Rifle and Silt. Colorado State Highway 13 extends north from Rifle to Meeker and Craig.

Census records show Garfield County with a population of 10,560 in 1940, 11,625 in 1950 and 12,017 in 1960. Population of Rifle was 1,373 in 1940, 1,525 in 1950 and 2,135 in 1960.

Proposed Development

The Silt project plan proposes the construction of the Rifle Gap Dam and Reservoir on Rifle Creek, approximately seven miles above the town of Rifle. Surplus early season runoff will be stored in the reservoir. Approximately 80 percent of the water stored in the reservoir will be used to replace natural flow water now used to irrigate some 2,600 acres of land in the lower Rifle Creek Valley. The remainder of the water stored in the reservoir will be used to irrigate new lands on Davie Mesa and upper Cactus Valley. In exchange, natural flow of East Rifle Creek will be diverted above the proposed reservoir and used to irrigate lands in Dry Elk Valley

and Harvey Mesa. The existing Harvey Gap Reservoir will continue to store early season runoff delivered through the Grass Valley Canal from Rifle Creek for use on lands on Harvey Mesa. The Rifle Gap Reservoir will have a capacity of 12,650 acre-feet, including 9,500 acre-feet of active capacity for irrigation and 3,150 acre-feet of inactive capacity for sediment control and fish and wildlife.

Additional irrigation water for project lands will be pumped from the Colorado River by the Silt pumping plant located at Davis Point. This water will be delivered to project lands in the lower Harvey Mesa and lower Antlers and Cactus Valleys by the Silt pump canal. A portion of this area is currently receiving water through eight private pumping systems with lifts from the Cactus Valley Canal. The increase in water supplies provided by the project will be 5,030 acre-feet for presently irrigated lands and 6,700 acre-feet for new lands, a total of 11,730 acre-feet, at the point of diversion.

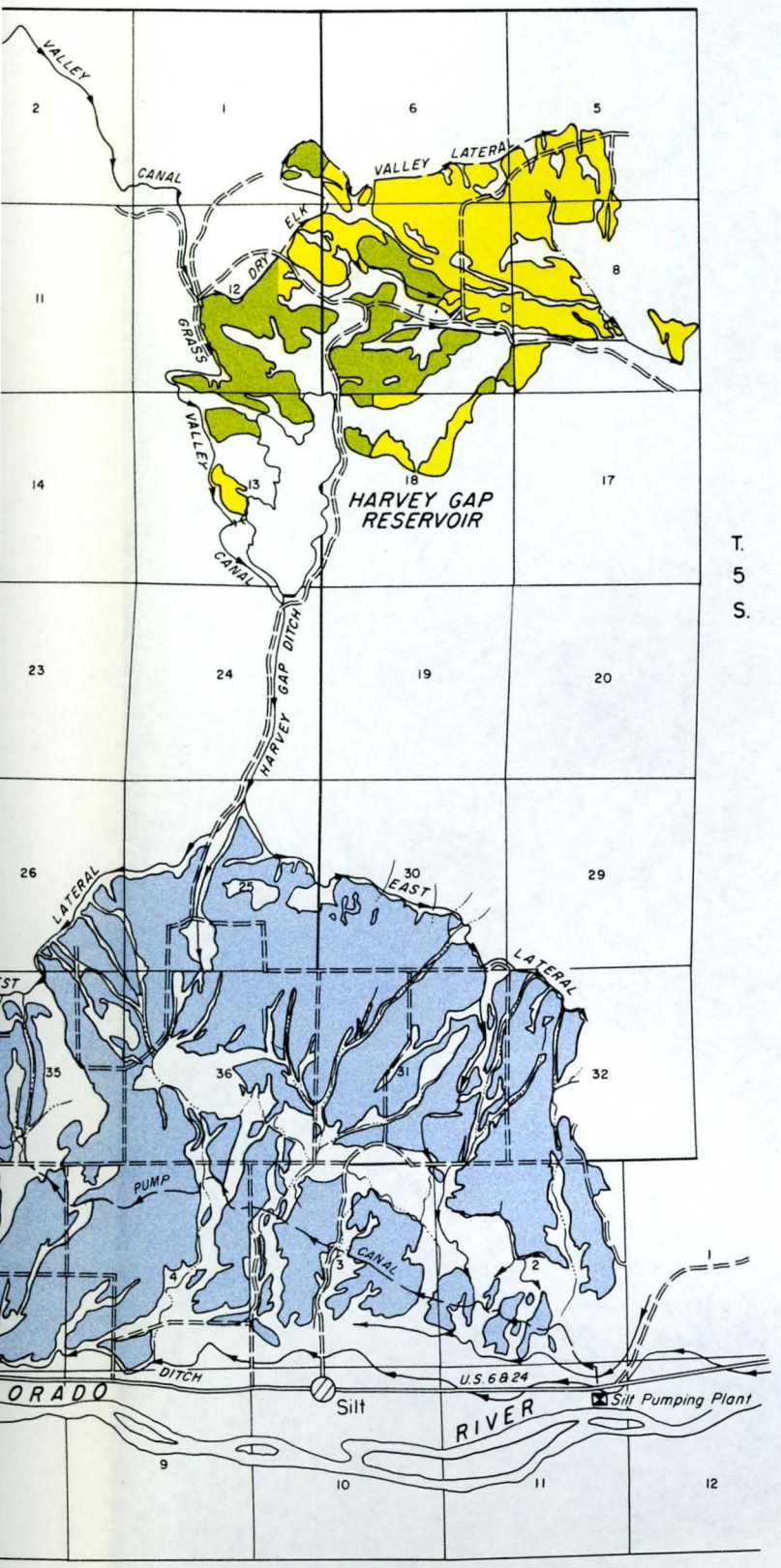
Irrigation water made available by the project will be used to irrigate 4,479 acres of land now irrigated with only a partial water supply and 2,118 acres of land not now irrigated. In addition, 244 acres of Bureau of Reclamation Class 4 land and 226 acres of class 6W presently irrigated land will continue to receive present water supplies. Several miles of interceptor and outlet drains will also be constructed as part of the project. Total acreage of project lands to receive water will be 6,597 acres.

EVALUATION AREA MAP
SILT PROJECT
GARFIELD COUNTY, COLORADO

JUNE 1961

1 0 1 2
SCALE IN MILES

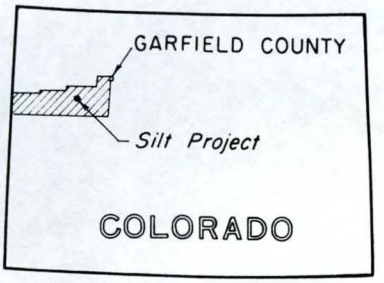
R. 91 W.



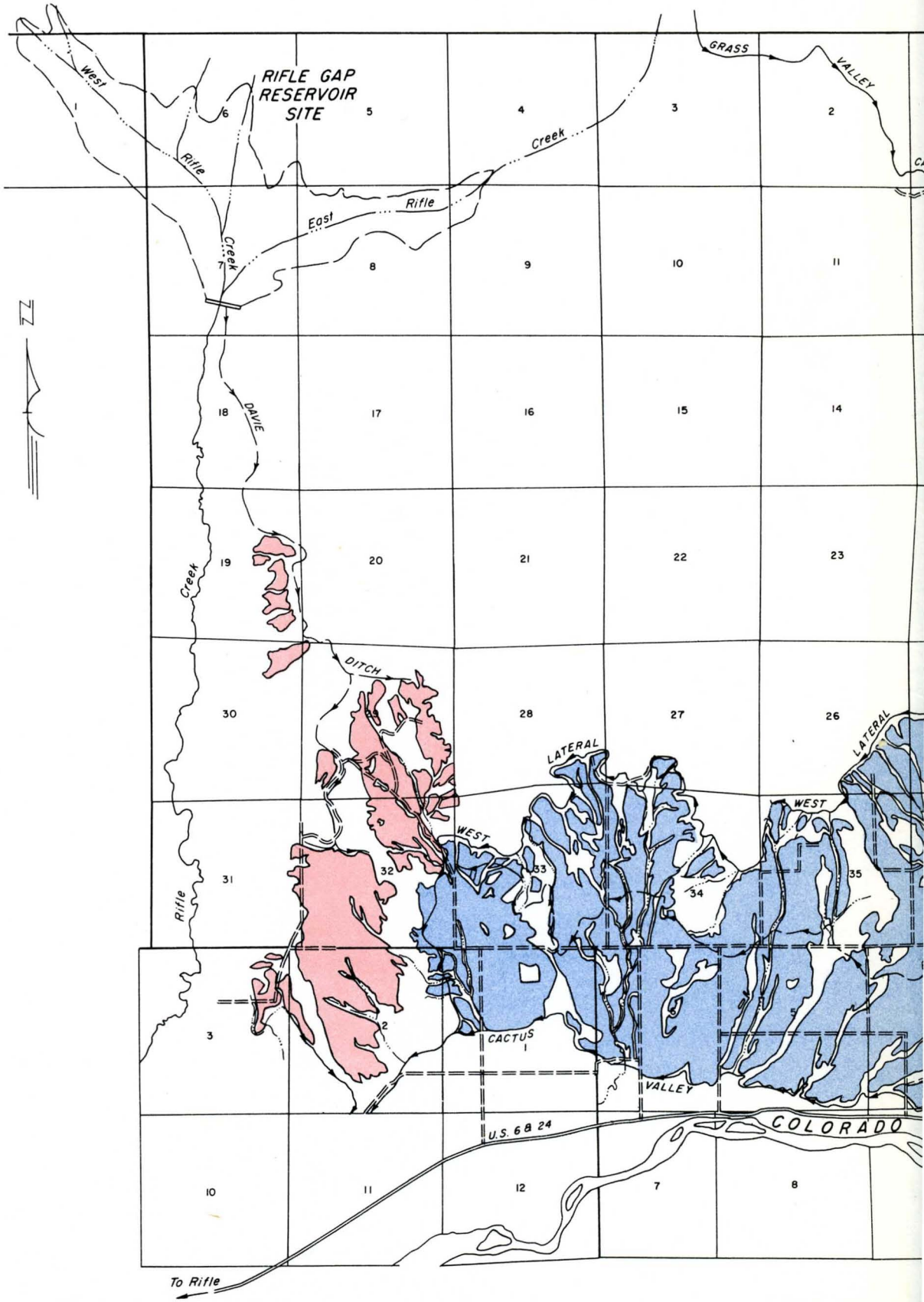
R. 92 W.

LEGEND

- A and B
- C and D
- E and F
- G and H



LOCATION MAP


R. 92 W.
RIFLE GAP RESERVOIR SITE
West Rifle Creek
East Rifle Creek
GRASS VALLEY
DAVIE Creek
Rifle Creek
DITCH
LATERAL
LATERAL
WEST
WEST
CACTUS
VALLEY
U.S. 6 & 24
COLORADO
To Rifle
R. 93 W.

CHAPTER II

EVALUATION OF DIRECT AGRICULTURAL BENEFITS FROM THE SILT PROJECT

The evaluation of direct agricultural benefits for the project is based on the proposed facilities and the project lands to which the Bureau of Reclamation plans to furnish irrigation water. Intervening lands not included in the project are not considered in the report. The assumptions made concerning the level of management and application of practices as a result of project development are not technical recommendations of the Department of Agriculture for the best land and water use on the project. It is assumed that the level of management and application of practices represents the average that will exist during the project evaluation period.

Evaluation Areas - General Description

To facilitate the presentation of basic agricultural data and to assist in the analysis of direct agricultural benefits, project lands were grouped into evaluation areas. Soils, climate, and water supply within each evaluation area reflect similar crop adaptations, productivity, land and irrigation development and production costs.

Eight evaluation areas were established to represent conditions in the project area. These areas have been designated by the letters A, B, C, D, E, F, G and H. The acreage of each is shown in table 1.

Table 1. - Irrigable land acreage by evaluation areas, Silt project

Project Lands	Evaluation Areas								Project Total
	Harvey Mesa		Davie Mesa		Dry Elk Valley				
	A	B	C	D	E	F	G	H	
	Acres								
Presently irrigated lands	2,835	1,286	-	-	181	177	-	-	4,479
Non-irrigated lands	383	176	657	215	-	-	341	346	2,118
Total Acreage	3,218	1,462	657	215	181	177	341	346	6,597

Evaluation areas A and B are located geographically on Harvey Mesa, evaluation areas C and D on Davie Mesa and evaluation areas E, F, G and H in Dry Elk Valley. The areas are described as follows:

Evaluation Area A

Evaluation area A comprises 2,835 acres of presently irrigated land and 383 acres of new land. The new land is intermingled with presently irrigated land and will likely be used to enlarge existing operating units. Evaluation area A lands will receive water either by diversion from East Rifle Creek or by pump from the Colorado River.

The soils are deep, medium to fine textured, generally on slopes from 1 to 6 percent. They have medium water intake rates, moderate to slow permeability in subsoil and substratum and high water holding capacity. Most of the project soils having saline, alkali and high water table problems are included in this evaluation area. Proposed project drainage, supplemented by on-farm drainage, should correct these problems and result in crop yields equal to other lands in the evaluation area.

Lands within this evaluation area can be farmed intensively and will produce high yields. All of the sugar beets now grown in the project area are on these lands and the majority of the expanded acreage of sugar beets with the proposed project is expected to be on these lands.

Effectiveness of the past water supply has been increased by the improved distribution provided by use of the Harvey Gap Reservoir. There are 213 acres included within this evaluation area that have had a full water supply by pumping from Cactus Valley Ditch. Benefits on these lands will be calculated separately from the other lands in this evaluation area. Presently irrigated lands will receive approximately .9 acre-foot per acre of additional irrigation water and new lands will receive approximately 2.7 acre-feet per acre with development of the proposed project. Crop yields have been good but substantial improvement is expected from the additional water.

Evaluation Area B

This evaluation area comprises 1,286 acres of presently irrigated land and 176 acres of new land. The new land is in small scattered tracts intermingled with presently irrigated land, and it is anticipated that the new lands will be added to existing farm units.

Evaluation area B lands are intermingled with lands of evaluation area A. It is very unlikely that a farm unit will have lands of evaluation area B only. Soils are similar to evaluation area A but slopes are steeper, generally from 6 to 12 percent.

A small acreage is affected with water table, salt and alkali. Another small acreage has stones on the surface. Project drainage is not planned for the wet areas, but farm drains may be installed by individual operators. It is not anticipated that drainage or stone removal will be applied to the degree to develop these lands to their maximum productive capacity.

Because of the steep slopes and the degree of development anticipated for these lands, types of crops will be restricted and crop yields will average lower than yields in evaluation area A. Cropping systems will include

alfalfa-grass hay, small grain, and grass legume pastures. With livestock as the principal enterprise, feed crops from these evaluation area B lands can usefully supplement more intensive cropping on evaluation area A lands within farm units.

Water supply has been the same as for evaluation area A and approximately .9 acre-foot per acre of additional water is expected with the proposed project development for presently irrigated lands. Intermingled non-irrigated new lands will receive 2.7 acre-feet of water delivered at the farm headgate. There are 106 acres included within this evaluation area that will be evaluated separately since they now have a full water supply pumped from Cactus Valley Ditch.

Evaluation Area C

This evaluation area consists of 657 acres of new lands to be served by the Davie Ditch. These lands have been farmed previously but are now abandoned. Soils are similar to those in evaluation area A and it is anticipated that they will produce similar crops and yields when irrigated. Water supply will come through Davie Ditch from the Rifle Gap Reservoir. Approximately 2.7 acre-feet of irrigation water per acre will be furnished these lands with project development. New farm units will be established because these lands are physically separated from presently irrigated areas.

Evaluation Area D

Evaluation area D comprises 215 acres of new land intermingled with evaluation area C lands also to be served by Davie Ditch. Irrigation water supply will be the same as evaluation area C. Soils and slopes are similar to evaluation area B. It is anticipated that these lands will have the same limitations in cropping as those in evaluation area B. Crop distribution and yields are projected to average the same as for evaluation area B. New units established on lands of evaluation area D will likely include some lands in evaluation area C.

Evaluation Area E

Evaluation area E is comprised of 181 acres of presently irrigated land located in Dry Elk Valley. Soils in this evaluation area are deep with medium to fine textures, moderate to slow permeability, generally on slopes between 3 and 6 percent. A small acreage of land has a high water table which should be corrected by the proposed project drainage.

Evaluation area E lands will be served by direct diversion of irrigation water in the Grass Valley Canal from East Rifle Creek. Average water supply with project development is anticipated to be the same as for other evaluation areas. The proposed project will supply approximately 1.9 acre-feet per acre additional irrigation water to these lands.

Crop distribution will be similar to evaluation area A and average crop yields will be slightly lower due to the estimated shorter growing season.

Evaluation Area F

Evaluation area F is comprised of 177 acres of presently irrigated land located in Dry Elk Valley, interspersed with lands of evaluation area E. Soils are similar to evaluation area E but slopes are steeper (6 to 12 percent). There is a small acreage of wet land but it is anticipated that the proposed project drainage will correct this condition.

Lands in this evaluation area will also be served by direct diversion into the Grass Valley Canal from East Rifle Creek. The proposed project will supply approximately 1.9 acre-feet per acre additional irrigation water to these lands.

It is anticipated that the same crop distribution will occur on these lands as on lands of evaluation area B. Crop yields are estimated slightly lower than those in evaluation area B. The differences in crop yields will be similar to those between evaluation areas A and E.

Evaluation Area G

This evaluation area comprises 341 acres of new land in Dry Elk Valley. Soils and slopes are similar to evaluation area E. Climate and crop yields with project are the same as for evaluation area E. Water to be furnished by the proposed project is approximately 2.7 acre-feet per acre.

Evaluation Area H

Evaluation area H is comprised of 346 acres of new land in Dry Elk Valley. Soils and slopes are similar to those in evaluation area F. Climate and crop yields with project are the same as evaluation area F. Water supply to be furnished by the proposed project is approximately 2.7 acre-feet per acre.

Soils Inventory

Sources of Data

Soil information used in the reappraisal of the Silt project was obtained from the Soil Conservation Service, Agricultural Research Service and Bureau of Reclamation. A soil survey of the project was completed by the Soil Conservation Service. Laboratory data on project soils were furnished by the Agricultural Research Service and the Cooperative Soil Survey Laboratories in Fort Collins, Colorado. The Bureau of Reclamation supplied land classification field sheets and laboratory data on the chemical and physical properties of project soils. Information on water intake rates of soils was obtained from cylinder infiltrometer tests on selected sites of dominant soils.

General Description of Soils and Soil Problems

More than half the project acreage is comprised of soils that have developed in loess over sandstone shale and gravel outwash material. The remaining acreage is composed of soils which have developed from alluvium or undifferentiated loess and alluvium.

Generally, the soils are deep, medium to fine textured, are high in silt and low in organic matter, have moderate to slow permeability and have a high water-holding capacity. Project soils generally have a moderate capacity to hold nutrients and require additions of nitrogen and phosphorus to obtain good yields of adapted crops. Slopes range from less than 1 to 12 percent, with the majority between 4 and 12 percent. Erosion is slight to moderate.

Although local in nature, salinity, alkali and high water table are problems in all geographic areas of the project where land is presently irrigated. These coexisting problems can be reduced, if not eliminated, by improving on-farm irrigation and improving drainage by providing adequate outlets and keeping outlets free of vegetation to allow a free flow of excess water. The Bureau of Reclamation plans to provide project drainage (digging new outlets and cleaning out natural drainageways) for areas in which there is a concentration of these problems.

With the moderate to high silt content of these soils and slopes from 1 to 12 percent, there is a general problem of soil erosion which can be kept to a minimum with applicable soil and water conservation practices. The fine textured soils require special management or a refinement of soil management practices to prevent puddling and compaction from tillage equipment, which take considerable time to correct.

Factors affecting the capability classification of soils in this project are climate, fine surface texture, degree of salt, alkali, water table, stoniness, and percent slope. The acreage of land capability units within each evaluation area and soil and water relationships are shown in table 2. Project acreage and general soil characteristics for each land capability unit are shown in table 3. These units, tabulated by evaluation areas, allow a general appraisal to be made of each evaluation area and of differences between evaluation areas.

Soils in capability class II have some limitations that reduce the choice of plants or require moderate conservation practices. Soils in capability class III have severe limitations that reduce the choice of plants or require special conservation practices or both. Soils in capability class IV have severe limitations that restrict the choice of plants or require very careful management or both.

Table 2. - Generalized soil-water relationship and acreages of land capability units by evaluation areas, Silt Project

Evaluation Areas	Land Capability Unit	Acres	% Slope	Soil Depth Inches	Water-holding Capacity: Inches per foot of soil	Water-holding Capacity: Total inches for profile	Remarks
A	IIc	48	0-1	60+	2.0	10+	
	IIs	10	0-1	60+	2.0	10+	
	IIe	493	1-3	60+	1.7	8+	
	IIes	6	1-3	60+	2.0	10+	
	IIes1	19	1-3	60+	2.0	10+	
	IIes2	297	1-3	60+	2.0	10+	
	IIe1s1	43	1-3	60+	2.0	10+	
	IIIs1	13	1-3	60+	2.5	12+	
	IIIs2	113	1-3	60+	2.0	10+	
	IIIs3	2	1-3	60+	2.5	12+	
	IIIe	1,883	3-6	60+	2.0	10+	Some soils underlain by gravel between 30 and 48"
	IIIes	38	3-6	60+	2.0	10+	
	IIIes1	9	3-6	60+	2.5	12+	
	IIIes2	188	3-6	60+	2.0	10+	
	IIIes3	56	3-6	60+	2.5	12+	
Total Acres (A)		3,218					
B	IVs2	21	3-6	60+	2.0	8+	Some soil underlain by gravel at 48"
	IVs3	8	3-6	60+	2.5	12+	
	IVs4	103	3-6	60+	1.7	8+	Gravel between 20 and 48"
	IVs5	19	3-6	60+	1.5	3+	Shallow to gravel
	IVe	64	6-12	60+	2.0	9+	Some soils overlying gravel at 30 to 48"
	IVe1	1,000	6-12	48-60+	2.0	10+	Some soils underlain by gravel between 30 and 48" - some with shale at 48"
	IVe2	24	6-12	60+	2.0	10+	
	IVe4	223	6-12	60+	1.7	7+	Much of soil underlain by gravel between 20 and 48"
Total Acres (B)		1,462					
C	IIe	280	1-3	60+	2.0	10+	
	IIes2	127	1-3	60+	2.0	10+	
	IIIe	244	3-6	60+	2.0	10+	Small area of soil underlain by gravel between 20 and 36"
	IIIes2	6	3-6	60+	2.0	8+	Gravel at 48"
Total Acres (C)		657					
D	IVe	101	6-12	60+	2.0	9+	Some soils underlain by gravel between 20 and 48"
	IVe1	69	6-12	60+	2.0	10+	
	IVe4	45	6-12	60+	2.0	10+	
Total Acres (D)		215					
E	IIe	21	1-3	60+	2.0	10+	
	IIIs	10	1-3	60+	2.0	10+	
	IIIe	112	3-6	60+	2.0	10+	
	IIIes1	38	3-6	60+	2.0	10+	
Total Acres (E)		181					
F	IVs	5	1-3	60+	2.5	12+	
	IVs3	27	3-6	60+	2.5	12+	
	IVs4	5	1-3	60+	2.0	10+	Small acreage underlain by shale at depths between 36 and 60"
	IVe1	113	6-12	36-60+	1.7	7+	Much of soils underlain by gravel between 20 and 48"
	IVe2	9	6-12	60+	2.0	10+	
	IVe4	18	6-12	60+	1.7	3+	Gravel at 20" - moderately stony soil
Total Acres (F)		177					
G	IIe	56	1-3	60+	2.0	9+	Some soils underlain by gravel between 36 and 60"
	IIIs	39	1-3	60+	2.0	10+	
	IIIe	179	3-6	60+	2.0	9+	Some soils underlain by gravel between 36 and 60"
	IIIes1	67	3-6	60+	2.5	12+	
Total Acres (G)		341					
H	IVs1	92	3-6	60+	2.5	12+	
	IVe1	175	6-12	60+	1.7	7+ (	These soils are shallow to
	IVe2	38	6-12	60+	2.0	5+)	deep over gravel but all
	IVe4	41	6-12	60+	1.7	3+ (	are deep to underlying rock
Total Acres (H)		346					
TOTAL PROJECT ACRES		6,597					

Table 3. - Generalized soil characteristics by land capability units, Silt Project

Land Capability Unit	Acres	Permeability	Slope Percent	Susceptibility to erosion	Topography	Depth Inches	Underlying Material	Remarks
IIc	48	Slow	0-1	Slight	Smooth to slightly undulating	60+	Sandstone and shale	
IIs	10	Moderate	0-1	Slight	Smooth to slightly undulating	60+	Sandstone and shale	Has a saline and water table problem
IIe	850	Slow to moderate	1-3	Slight	Slightly rolling	48"-gravel 60+"-ss & shale	Gravel, sandstone and shale	
IIes	6	Slow	1-3	Slight	Slightly rolling	60+	Primarily shale interbedded with sandstone	
IIes1	19	Slow	1-3	Slight	Slightly rolling	60+	Primarily shale interbedded with sandstone	
IIes2	424	Moderate to slow	1-3	Slight to moderate	Slightly rolling	60+	Primarily shale interbedded with sandstone	About half the acreage has a saline, alkali and water table problem
IIe1s1	43	Moderate	1-3	Moderate	Slightly rolling	60+	Primarily shale interbedded with sandstone	Small acreage has saline, alkali and water table problems
IIIs	49	Slow	1-3	Slight	Slightly rolling	60+	Primarily sandstone	
IIIs1	13	Slow	1-3	Slight	Slightly rolling	60+	Primarily shale with interbedded sandstone	
IIIs2	113	Moderate to slow	1-3	Slight to moderate	Slightly rolling	60+	Primarily shale with interbedded sandstone	Saline, alkali and water table problems
IIIs3	2	Slow	1-3	Slight	Slightly rolling	60+	Primarily shale with interbedded sandstone	Saline, alkali and water table problems
IIIe	2,418	Moderate to slow	3-6	Slight to moderate	Slightly to moderately rolling	60+	Sandstone, shale and gravel	Small acreage with saline and water table problem. Considerable acreage of soils underlain by gravel at depths of 30-48 inches.
IIIes	38	Moderate to slow	3-6	Slight to moderate	Slightly to moderately rolling	60+	Shale interbedded with sandstone	70% of acreage has saline, alkali and water table problems
IIIes1	114	Slow	3-6	Slight to moderate	Slightly to moderately rolling	60+	Primarily sandstone. some shale	Small acreage with salt, alkali and water table problems
IIIes2	194	Moderate	3-6	Moderate	Slightly to moderately rolling	60+	Primarily shale with interbedded sandstone	50% of acreage has saline, alkali and water table problems
IIIes3	56	Slow	3-6	Slight to moderate	Slightly to moderately rolling	60+	Primarily shale with interbedded sandstone	80% of acreage has saline, alkali and water table problems
IVs	5	Slow	1-3	Slight	Slightly rolling	60+	Sandstone	
IVs1	92	Slow	3-6	Slight to moderate	Slightly to moderately rolling	60+	Sandstone	
IVs2	21	Moderate	3-6	Moderate	Slightly to moderately rolling	60+	Shale interbedded with sandstone	Small acreage of saline, alkali and water table problems
IVs3	35	Slow	3-6	Slight to moderate	Slightly to moderately rolling	60+	Shale and sandstone	Saline, alkali and water table problems
IVs4	108	Slow to moderate	3-6	Slight to moderate	Slightly to moderately rolling	60+	Shale and sandstone	Moderately stony soils
IVs5	19	Rapid	3-6	Slight to moderate	Slightly to moderately rolling	60+	Shallow to gravel, deep to shale	
IVe	165	Moderate to slow	6-12	Moderate	Moderately rolling	60+	Shale, sandstone and gravel	Soil, to gravel, ranges from 20 to 48 inches thick
IVe1	1,357	Slow to moderate	6-12	Moderate	Moderately rolling	60+	Shale, sandstone and gravel	30% of soils underlain by gravel between 20 and 48 inches
IVe2	71	Slow	6-12	Moderate	Moderately rolling	60+	Shale and sandstone	
IVe4	327	Moderate to slow	6-12	Moderate	Moderately rolling	60+	Shale and sandstone	Small acreage with saline, alkali and water table problems. About 60% of acreage moderately stony.
Project total	6,597 acres							

Evaluation Area A - Soils

This area is comprised of deep, medium to fine textured soils on slopes ranging from 0 to 6 percent. They have weakly to strongly developed B horizons with corresponding moderate to slow permeability. About 17 percent of the acreage consists of soils underlain by gravel at depths between 20 and 48 inches. Depth to shale is over 60 inches. Most of the project soils having saline, alkali and high water table problems, are included in this evaluation area. There are 2,302 acres or 71 percent of soils grouped into capability class III and 916 acres or 29 percent grouped into capability class II.

Evaluation Area B - Soils

Soils in this evaluation area are generally deep, predominantly medium textured, have weakly to strongly developed B horizons, moderate to slow permeability, and slopes ranging from 3 to 12 percent. Thirty-five percent of this acreage consists of soils underlain by gravel between 12 and 48 inches. Depth to shale is over 60 inches. A small acreage is affected by salt, alkali, high water table and flooding. This evaluation area includes most of the moderately stony soils on the project. Steep slope is the major soil problem affecting the capability classification. All the soils comprising the 1,462 acres in this evaluation area are grouped into capability class IV.

Evaluation Area C - Soils

Soils of this evaluation area have developed primarily from loess; however, a small acreage has developed from alluvium. They are deep, medium textured soils with weakly to strongly developed B horizons, moderate to slow permeability, and slopes ranging from 1 to 6 percent. A small acreage of soils is underlain by gravel at depths between 30 and 48 inches. Slope as it affects the soil erosion potential is the only significant problem affecting the capability classification of these soils. There are 407 acres or 62 percent of the soils grouped into capability class II and 250 acres or 38 percent grouped into capability class III.

Evaluation Area D - Soils

This evaluation area is comprised of deep, medium textured soils which predominantly have weakly developed B horizons, moderate permeability, and slopes ranging from 6 to 12 percent. A small acreage of soils, representing about 13 percent of this area, is underlain by gravel at depths between 20 and 48 inches. Except for a small acreage that is slightly affected by salt and alkali, the only soil problem is slope as it affects the soil erosion potential. All the soils in this evaluation area (215 acres) are grouped into capability class IV.

Evaluation Area E - Soils

Soils of this evaluation area are deep with medium to fine texture, moderate to slow permeability, and slopes ranging from 1 to 6 percent. There is a small acreage with a high water table problem but slope, as it affects the soil erosion potential, is the significant criterian for capability classification of these soils. There are 160 acres or 88 percent of the soils in capability class III and 21 acres or 12 percent in capability class II.

Evaluation Area F - Soils

This evaluation area is comprised of deep, medium to fine textured soils with moderate to slow permeability. Slopes range from 1 to 12 percent, but the majority of the soils have slopes ranging from 6 to 12 percent. About 50 percent of the acreage is underlain by gravel between 20 and 48 inches. There are a few acres of soil with saline, alkali and water problems. Also, there is a small acreage of moderately stony soils. However, the major problem affecting the capability classification of these soils is moderately steep slopes. All the soils, comprising the 171 acres, in this evaluation area are grouped into capability class IV.

Evaluation Area G - Soils

This evaluation area is comprised of deep, medium to fine textured soils with moderate to slow permeability and slopes ranging from 1 to 6 percent. About 25 percent of the acreage is underlain by gravel at a depth of 48 inches. The major problem significant to the capability classification of soils is slope as it effects the soil erosion potential. There are 285 acres or 84 percent of the soils grouped into capability class III and 56 acres or 16 percent grouped into capability class II.

Evaluation Area H - Soils

Soils comprising this evaluation area are deep with medium to fine texture, moderate to slow permeability, and slopes ranging from 3 to 12 percent. About 40 percent of the acreage is underlain by gravel at depths between 20 and 48 inches. There is a small acreage which is moderately stony, but the soil problems significant to capability classification are fine textures and moderately steep slopes. All the soils in this evaluation area (346 acres) are grouped into capability class IV.

Findings

It is concluded that soils comprising the 6,597 acres of land designated by the Bureau of Reclamation as the Silt Project, which have been interpretively grouped into capability classes II-1,400 acres, III-2,997 acres, and IV-2,200 acres, are suitable for cultivation under irrigation.

Irrigation Requirements and Water Supplies

Sources of Data

Reports on several studies include estimates of irrigation requirements in the general vicinity of the Silt project. Included are the following: (1) Appendix B of the Record of the Upper Colorado River Basin Compact Commission; (2) Consumptive Use of Water in the Irrigated Areas of the Upper Colorado River Basin, by Blaney and Criddle; and (3) Consumptive Use and Irrigation Water Requirements of Crops in Colorado, by Blaney and Criddle. Additional related information is contained in the Water Supply Papers of the U. S. Geological Survey, Climatological Data by the U. S. Weather Bureau, Colorado Heat and Moisture Indexes for Use in Land Capability Classification by the Soil Conservation Service, and other publications. These and other available related reports were carefully reviewed for the purpose of this study. In addition, information was supplied by technicians of the Colorado State University, Colorado Agricultural Experiment Station, Colorado Cooperative Extension Service, Colorado State Engineer, Agricultural Research Service, U. S. Bureau of Reclamation, U. S. Soil Conservation Service, and others familiar with the area.

Water Requirements

Consumptive use requirements for the principal crops in the area were estimated by the Blaney-Criddle procedures (table 4). Long climatological records are available for the town of Rifle, located adjacent to the project area; however, there are material differences in elevation between Rifle and the several parts of the project. Some adjustment of both the temperature and precipitation records at Rifle is necessary, therefore, before they can be considered representative of the project area. There are no data available to guide estimates of the amount of adjustment needed. In addition, considerable variation of elevation occurs within the various parts of the project area. Considering these limitation, a refined and detailed estimate of consumptive use within the project area was not attempted. From inspection of the area and discussions with technicians familiar with the area, it appears that the Davie Mesa-Harvey Mesa area could be reasonably considered as one unit for purposes of estimating the consumptive use requirements, and the Dry Elk Valley as a separate unit.

Estimates of mean temperatures for the two project areas described above were made by application of standard adiabatic lapse rates, 3° per 1,000 feet, for the elevational differences, to the average mean temperature at Rifle as given by the U. S. Weather Bureau, Bulletin W, Supplement 11-5 (1931-1952).

For the purpose of this study, effective precipitation is considered to be 85% of the average precipitation for the ten driest consecutive years (1931-1940). Extension of the precipitation record at Rifle to the project area was difficult in the absence of data on the variability within the area. The Dry Elk Valley presents considerable uncertainty, as it is reputed to be at least partially in an area of "rain shadow" north and east of the Grand Hogback.

Table 4. - Estimate of consumptive use requirements for major crops, Silt project

	Alfalfa	Clover & Grass Pasture	Corn	Small Grain	Sugar Beets
Davie and Harvey Mesas, Evaluation Areas A,B,C and D					
Frost-free Period					
Consumptive use coefficient	.85	.80	.75	.75	.70
Consumptive use factor	28.78	28.78	26.47	20.61	28.78
Consumptive use, Inches	24.46	23.02	19.85	15.45	20.15
Nonfrost-free Period					
Consumptive use coefficient	.70	.65	-	-	-
Consumptive use factor	4.87	4.87	-	-	-
Consumptive use, Inches	3.41	3.16	-	-	-
Total Consumptive Use, Ac. Ins./Acre	27.87	26.18	19.85	15.45	20.15
Effective Seasonal Precipitation, Inches	4.84	4.84	3.40	2.32	4.07
Net Irrigation Requirement, Ac. Ins./Acre	23.03	21.34	16.45	13.13	16.08
Dry Elk Valley, Evaluation Areas E,F,G & H					
Frost-free Period					
Consumptive use coefficient	.85	.80	.75	.75	.70
Consumptive use factor	25.52	25.52	24.47	19.98	25.52
Consumptive use, Inches	21.69	20.41	18.35	14.99	17.86
Nonfrost-free Period					
Consumptive use coefficient	.70	.65	-	-	-
Consumptive use factor	6.76	6.76	-	-	-
Consumptive use, Inches	4.73	4.39	-	-	-
Total Consumptive Use, Ac. Ins./Acre	26.42	24.80	18.35	14.99	17.86
Effective Seasonal Precipitation, Inches	5.50	5.50	3.90	2.74	4.22
Net Irrigation Requirement, Ac. Ins./Acre	20.92	19.30	14.45	12.25	13.64

From an inspection of the area and a consideration of the lapse rates, it was concluded that the effective precipitation of the Davie Mesa-Harvey Mesa area will approximate the average precipitation (ten driest consecutive years) at Rifle, and the corresponding monthly amounts have accordingly been used. For an estimate of precipitation in the Dry Elk Valley, a correlation was developed between the records at Rifle and those at Collbran, the nearest station with similar characteristics and located at near the same elevation as the Dry Elk Valley.

The various irrigation water losses expected within the project at the projected level of land development under project operations were estimated by considering soil characteristics and site locations. Due allowance was made for leaching requirements for salt balance control. Resulting irrigation efficiency estimates were adjusted to reflect an estimated 12 percent reuse of tail water runoff and return flows as is the general practice within the area at present. Total farm irrigation water requirements were estimated by adding on-farm losses to the basic consumptive use estimates weighted by projected crop acreage distribution (table 5).

Table 5. - Irrigation requirements by evaluation areas, Silt project

Evaluation Area	Weighted Average Consumptive Use Requirements, Acre-Inches per Irrigable Acre	Weighted Average Farm Irrigation Efficiency, With Project Percent	Farm Headgate Water Delivery Requirement, Acre Inches per Irrigable Acre
A	18.4	55	33.5
B	18.6	49	38.0
C	18.3	56	32.7
D	18.4	49	37.6
E	17.5	55	31.8
F	17.3	50	34.6
G	16.5	55	30.0
H	16.6	51	32.6

Adequacy of Water Supply

Irrigation water for the Silt project is now supplied by direct diversion of the natural flows of East Rifle Creek, supplemented by releases from the existing Harvey Gap Reservoir. This reservoir is filled during the winter and spring months when stream flows exceed the needs of downstream users. Lands in the Dry Elk Valley are upstream from the Harvey Gap Reservoir and hence receive water only by direct diversions from East Rifle Creek. During the spring snow-melt period, the flow in the creek is usually greatly in excess of the irrigation requirements for all lands which use it, both project and non-project. By early summer, however, the flow diminishes rapidly and is insufficient to meet the irrigation demands. As a result, the Dry Elk Valley lands with their junior water rights are unable to obtain irrigation water subsequent to midsummer, and crop yields are adversely affected. Bureau of Reclamation operations studies indicate that the total historical supply available to the presently cultivated land in Dry Elk Valley has amounted only to about 35 percent of seasonal requirements on an ideal demand basis for a normal rotation cropping pattern.

Lands on Davie Mesa have previously been subjugated and placed under irrigation. Irrigation water was diverted directly from Rifle Creek near the Rifle Gap Reservoir site. The available water rights were of such low priority, however, that insufficient irrigation water was available and the supply was undependable. Natural precipitation is inadequate for dry farming, hence successful farming is not possible without an adequate supply of irrigation water, and these lands were abandoned.

Lands on Harvey Mesa comprise the greater part of the project, some 4,680 out of the total of 6,597 acres. These lands are supplied by direct diversions during the early part of the irrigation season when the flow of East Rifle Creek is adequate, and by releases of stored water from Harvey Gap Reservoir during the latter part of the season when their natural flow rights are junior to those of downstream users on Rifle Creek. Total seasonal water supplies available to these lands have averaged substantially less than requirements. Most severe shortages have occurred during July and August, and in a number of years the water available during these months has been less than 20 percent of requirements. Bureau of Reclamation operations studies indicate that the average seasonal water supply available to lands under the Harvey Gap Reservoir has been about 69 percent of estimated requirements. There have been few years during which all water requirements have been completely satisfied. In the 24-year study period, only four years had seasonal water supplies greater than 90 percent of ideal requirements, while in 12 years the supply was less than 60 percent of requirements.

In recent years, some 326 acres of land on the lower part of Harvey Mesa, including 7 acres of non-project land, have been irrigated by pumping from the adjacent Cactus Valley Canal, which originates by direct diversion from the Colorado River. These lands have had essentially a full water supply and, accordingly, have been analyzed separately in the economic studies. Under project operations, they would receive their water supply from project sources.

Project plans propose the construction of three principal elements, (1) Rifle Gap Dam and Reservoir on Rifle Creek, (2) Davie Ditch, and (3) Silt pumping plant and canal. In addition, several canals and laterals and interceptor and outlet drains will also be constructed.

The Rifle Gap Reservoir will provide seasonal regulation of the flows of Rifle Creek. Exchange of stored water in the reservoir for natural flow rights held by downstream users will permit the increased diversion of late season flows into the Grass Valley Canal serving Dry Elk Valley and Harvey Mesa and thereby supplement the water supply for those areas.

Water for Dry Elk Valley will be supplied by direct diversion of the unregulated flows of East Rifle Creek through the Grass Valley Canal, in exchange for water stored in Rifle Gap Reservoir. Senior water rights below the Rifle Gap Reservoir will require bypassing natural flows during periods when no storage water is available in the reservoir for exchange. Since there will be no regulation of East Rifle Creek above the diversion point of the Grass Valley Canal, the water supply for the Dry Elk Valley will be affected by such bypasses.

The Rifle Gap Reservoir will provide essentially a full water supply for lands to be served by the Davie Ditch, while also ensuring that the senior rights of water users in the lower Rifle Creek Valley will be satisfied. Davie Ditch will convey water from the Rifle Gap Reservoir to serve the lands on Davie Mesa.

The Silt pumping plant will divert directly from the Colorado River and deliver to the proposed pump canal, which will distribute the water to about 1,804 acres of project lands on Harvey Mesa and a small acreage of interspersed non-project lands with water rights. The water supplied by this pumping plant and canal will supplement direct diversions from East Rifle Creek and gravity releases from Harvey Gap Reservoir. Use of pump water in exchange for gravity flow water in the area below the pump canal will equalize the water supply and minimize water shortages for lands in the Harvey Mesa service area. There are 4,680 acres of project lands, comprising evaluation areas A and B, and 358 acres of interspersed non-project lands with water rights which must be satisfied, a total of 5,038 acres, on Harvey Mesa.

Project operations studies assume that water supplies and project impacts will be equalized in the Harvey Mesa service area. It is fully recognized that farms lying below the Silt pump canal could, if desired, and by payment of the extra pumping costs involved, obtain additional water to an extent that would eliminate their shortages in dry years. Since this supplemental pumpage would be outside of and not a part of regular project operations, neither the additional costs that might be imposed or the possible benefits that might accrue, nor the decreased water supply shortage that would result, have been estimated under the project operations analysis.

In order to assure a dependable water supply for the project lands served by the Silt pumping plant and canal, project plans recommend the reservation of an estimated maximum of 6,600 acre-feet of storage water in Green Mountain Reservoir on the Colorado River.

A comparison of the adequacy of project water supplies by months and evaluation areas is given in table 6.

Table 6. - Average water supply, percent of requirements, by months and evaluation areas, Silt project 1/

Month	Projected Water Supply With Project			Historical Water Supply Without Project 2/	
	Harvey Mesa Evaluation Areas A & B	Davie Mesa Evaluation Areas C & D	Dry Elk Valley Evaluation Areas E,F,G & H	Harvey Mesa Evaluation Areas A & B	Dry Elk Valley Evaluation Areas E,F,G & H
	Percent				
May	100	100	100	100	73
June	100	100	100	98	31
July	100	100	100	56	17
Aug.	90	84	90	35	25
Sept.	73	81	79	43	54
Oct.	100	100	75	100	54

1/ Based on 24-year study period 1937-1960 inclusive.

2/ Davie Mesa, evaluation areas C and D, not irrigated under without-project conditions.

Under project operations, all lands will have a full water supply except in years of unusually deficient water yield. Effective operation of the Silt pumping plant will greatly reduce the effect of local minor water yield deficiencies. Occasional years of extremely deficient water supply, such as have occurred in the past, will result in some water supply shortages for project lands. A comparison of historical water supplies and those that would be available with the project, based on data provided by the Bureau of Reclamation, is given in table 7. Anticipated water shortages are reflected in crop yield estimates of project lands.

Interspersed among the project lands is a limited acreage of non-project land with rights to a proportional share of the present water supply. These lands are generally too steep for effective cultivation or have profile or other limitations which make them undesirable for inclusion within the project. They will continue to receive the normal water supply to which they are legally entitled from appropriate sources of supply, depending upon their location, but the supply will not be supplemented from

Table 7. - Comparison of annual water supply with and without project, by evaluation areas, Silt project 1/

Percent of Water Requirements Available	Percent of Years the "Percent of Water Requirements Available" was Equalled or Exceeded				
	Harvey Mesa Evaluation Areas A & B		Davie Mesa Evaluation Areas C & D	Dry Elk Valley Evaluation Areas E, F, G & H	
	With Project Supply	Without Project Supply	With Project Supply	With Project Supply	Without Project Supply
	Percent				
100	65	2	69	69	-
90	75	17	78	77	-
80	92	36	96	96	0.1
70	99+	45	99+	99+	0.9
60	-	52	-	-	5.0
50	-	90	-	-	17.0
40	-	99	-	-	39.0

1/ Based on 24-year study period 1937-1960 inclusive.

project sources. There are 112 acres of these lands located in the Dry Elk Valley and 358 acres on Harvey Mesa. They produce a limited amount of forage and are owned and managed in conjunction with the project lands with which they are intermingled.

Water from both Rifle Creek and the Colorado River has been analyzed and found suitable for irrigation of project lands.

Findings

Based on estimates of consumptive use requirements and irrigation efficiencies, an average 2.86 acre-feet of water per irrigable acre will be required at the farm headgates to adequately serve the project lands. Reservoir and project operations studies and records of historical flows indicate that the water supplies available from project facilities will be adequate to meet this requirement in all but exceptionally dry years. The average water supply available for delivery to farmers during a period of years comparable to the 1937-1960 study period would be 96 percent of estimated requirements. The project water requirements and water supply are summarized in table 8.

Table 8. - Projected crop distribution and seasonal consumptive use and water requirement estimates by evaluation areas, Silt project

Harvey and Davie Mesas					Dry Elk Valley				
Evaluation area	Crop	Net irrigation requirement: Inches	Projected net crop: Acres	Net water supply required: Acre-feet	Evaluation area	Crop	Net irrigation requirement: Inches	Projected net crop: Acres	Net water supply required: Acre-feet
A	Alfalfa	23.03	1253	2404.7	E	Alfalfa	20.92	107	186.5
	Clover & Grass Pasture	21.34	633	1125.7		Clover & Grass Pasture	19.30	15	24.1
	Corn	16.45	270	370.1		Corn	14.45	24	28.9
	Small Grain	13.13	492	538.3		Small Grain	12.25	24	24.5
	Beets	16.08	375	502.5					
B	Alfalfa	23.03	658	1262.8	F	Alfalfa	20.92	108	188.3
	Clover & Grass Pasture	21.34	326	579.7		Clover & Grass Pasture	19.30	12	19.3
	Small Grain	13.13	390	426.7		Small Grain	12.25	47	48.0
C	Alfalfa	23.03	148	284.0	G	Alfalfa	20.92	123	214.4
	Clover & Grass Pasture	21.34	241	428.6		Clover & Grass Pasture	19.30	72	115.8
	Corn	16.45	77	105.6		Corn	14.45	19	22.9
	Small Grain	13.13	77	84.3		Small Grain	12.25	57	58.2
	Beets	16.08	75	100.5		Beets	13.64	50	56.8
D	Alfalfa	23.03	60	115.1	H	Alfalfa	20.92	88	153.4
	Clover & Grass Pasture	21.34	85	151.2		Clover & Grass Pasture	19.30	144	231.6
	Small Grain	13.13	58	63.5		Small Grain	12.25	93	94.9

	Harvey Mesa Areas A & B	Davie Mesa Areas C & D	Dry Elk Valley Areas E,F,G & H	Project Total
Total crop irrigation requirement, acre-feet	7,210	1,333	1,468	10,011
Estimated on-farm water losses, acre-feet	6,405	1,131	1,315	8,851
Total farm delivery requirement, acre-feet	13,615	2,464	2,783	18,862
Total gross irrigable acreage	4,680	872	1,045	6,597
Farm delivery requirement per irrigable acre, acre-feet	2.91	2.83	2.66	2.86
Proposed project average farm delivery, acre-feet per irrigable acre	2.74	2.71	2.74	2.74
Percent of requirements met by proposed average farm delivery	94	96	100	96

Sources of Data

The soil survey has been generally interpreted in terms of land use and treatment as provided in the Technical Guide of the Bookcliff Soil Conservation District and the Irrigation Guide for Western Colorado Areas Below 7,000 Feet. Land classification surveys of the Bureau of Reclamation furnished supplemental information. Special site investigations, infiltration measurements, and other surveys, and direct inspection of field conditions and review with technicians familiar with the area, have furnished additional basic data. Farm plans and records of land leveling and farm irrigation development work accomplished with the assistance of Soil Conservation Service technicians assigned to the Bookcliff Soil Conservation District, have been used to obtain basic estimates of unit volumes and costs.

Development requirements have been related to the physical characteristics of the various soil mapping units on the project. Projected land development, as influenced by the soil and site characteristics, has been estimated by each capability unit and averaged by evaluation areas. Interspersed lands not included in the project have been excluded from the report. Cost estimates are based on the U. S. Department of Agriculture price projections of September 1957.

Farm Irrigation Development

Irrigation water supplies for the project area have been inadequate for the presently cultivated lands; hence, there has been no significant development of new lands in recent years. However, there has been a limited amount of additional development work accomplished since the original subjugation of the present farms. Most of this has been in connection with the stabilization of the present irrigation and has usually been restricted to: lands with better water rights; situations where specific opportunities existed for improving irrigation efficiencies and the effectiveness of the present water supply; or the improvement of particular problem areas where conditions resulted in unusual difficulty in obtaining satisfactory irrigation. In general, the principal improvements have consisted of adjustment of lengths of run to more nearly fit the requirement of the specific sites affected, the installation of limited drainage facilities, or to the leveling of uneven or undulating fields.

Under present water supply conditions, there has been little economic incentive for development of the land at a rate faster than has occurred. It is expected, therefore, that in the future without the project, conditions would remain little changed from the present and that additional land development would be largely restricted to the correction of specific problems of limited extent. With project development, the increased water supply and resulting better yields and improved economy will provide a basis for increased development. Complete irrigation systems and related development will be required for the projected new lands, and continued improvement in accordance with their site requirements can reasonably be expected for the presently cultivated lands and facilities.

There are only limited areas of soils within the project having stony surfaces or profiles. These are all in capability class IV and limited to pasture and close growing crops. The estimated cost of rock and stone removal and the inherent limitations indicated by the capability classification indicate that these lands would be best restricted to hay and pasture use, for which no clearing would be required. Accordingly, no rock or stone removal has been estimated as an item of land development cost.

There are only limited data on which to base an estimate of the amount of increase in land and irrigation development that can be expected on the presently cultivated lands under the changed conditions assumed with project development. An approach has been made by estimating the requirements in accordance with the actual requirements for various capability units within or near the project area and interpolation of the remaining capability units at appropriate levels. A discounting factor based on estimates by local technicians of the requirements of the area and the cropping patterns and site factors, has been incorporated into the development estimates. Based on this procedure, estimates of average land development associated with project construction have been made and projected to the various evaluation areas. These are summarized in table 9.

Farm Drainage Development

There are considerable areas of wet or potentially wet lands within the project. Project plans include estimates for project drainage installations to provide drainage and drainage outlets for these lands. No on-farm drainage installations are included in the project drainage plans.

Detailed plans and cost estimates for on-farm drainage are not practical until observations are available of the behavior of the affected areas after the installation of the planned project drainage and an analysis of the relative economics of each site in the light of the soil capability and proposed usage. However, tentative estimates have been made of the extent of on-farm drainage installations and of the probable capital and annual costs assumed to result therefrom. The economic benefit studies assume the levels and costs of land, irrigation and drainage development outlined.

Cost estimates for on-farm drainage requirements have been made on the basis of soil types and site characteristics, with due regard to the probability that soils in certain capability units will be most economically used by retaining them in wet pasture condition. Permeability data has been furnished by the Bureau of Reclamation. Drainage requirements for specific areas have been based on the application of the Donnan procedure, and costs have been estimated by the extension of resulting typical unit costs to the areas mapped.

Findings

Estimates of development costs for project lands are based on an analysis of the physical requirements of the soils and site conditions. They are related to projected economic conditions and to the minimum requirements

Table 9. - Summary of land and irrigation development and farm drainage, by evaluation areas, Silt project

Item	Unit	Evaluation Areas							
		A	B	C	D	E	F	G	H
Irrigable land	Acres	3,218	1,462	657	215	181	177	341	346
Dominant slopes	Percent	1-6	6-12	1-3	6-12	3-6	6-12	3-6	6-12
Dominant profile depth	Feet	5	5	5	5	5	5	5	5
Dominant irrigation methods	Predominantly corrugation for close growing crops, furrow for row crops								
Maximum furrow stream size	GPM	12	4	10	2	10	5	10	5
Average farm irrigation efficiency	Percent	55	49	56	49	55	50	55	51
Peak period consumptive use rate	Ins./Day	.20	.20	.20	.20	.20	.20	.20	.20
Average maximum length of runs	Feet	340	225	370	200	340	260	340	240
Average field ditch and lateral required	Ft./Acre	140	201	139	227	136	176	139	198
Weighted average land leveling earthwork required	Cy./Ac.	200	84	176	130	138	101	221	100
Farm irrigation structure, average cost per acre	Dollars	10.85	4.18	26.24	16.55	10.85	4.18	19.11	4.18
Weighted average farm drainage, cost per acre	Dollars	12.16	1.53	-	-	-	-	-	-

for land and water management at the levels expected under project conditions. Weighted average development cost estimates are summarized by evaluation areas in table 10.

Table 10. - Cost of land and irrigation development by evaluation areas, Silt project

Evaluation Area	Cost Per Acre				
	Clearing	Leveling	Farm Irrigation System	Drainage	Total
	Dollars				
A	1.20	36.24	15.43	12.16	65.03
B	0.90	15.05	8.59	1.53	26.07
C	-	31.70	34.83	-	66.53
D	-	23.44	28.93	-	52.37
E	-	24.86	14.18	-	39.04
F	-	18.15	8.75	-	26.90
G	2.63	39.82	27.32	-	69.77
H	4.56	18.00	15.36	-	37.92

Projected Agricultural Economy

Economic analysis of the proposed Silt irrigation project has two primary objectives: (1) An appraisal of direct agricultural benefits from project development; and (2) an appraisal of prospective farm incomes from representative sizes and types of farms considered most likely with proposed irrigation development. Both analyses will contribute to a general appraisal of the prospects for a successful and stable irrigated agricultural economy.

Procedures

An estimate of agricultural benefits and an appraisal of prospective farm incomes were derived by farm-budgeting procedures. Crop-production budgets were used in analyzing agricultural benefits; they were limited to costs and returns of crop and pasture production that would exist with a livestock economy. Farm-income budgets were used in analyzing prospective farm incomes by type of farm. In this analysis, costs and returns were carried through the livestock enterprises. The farm acreages, cropping systems, and crop yields established for appraisal of farm incomes were also used in budgeting for agricultural benefits.

The crop-production budgets consist of three basic elements: (1) The estimated quantity and value of crop and pasture production without and with project after full development of the farms; (2) the quantity and value of economic resources used in achieving the assumed level of production without and with project development (exclusive of water costs); and (3) the delay involved in achieving the increased level of production, which is accounted for by discounting procedures.

Farm-income budgets, representing costs and returns of all the enterprises anticipated for given farm types, used in estimating residual farm incomes. These incomes are available as compensation to farm operators and their families for their labor and management and for payment of water charges. The major elements involved in the analysis were: (1) The quantity of agricultural products produced for sale and their expected market values; (2) the quantity and value of resource inputs expended by project farmers to achieve the level of production anticipated (exclusive of water costs); and (3) allowance for the labor and management of the operator and family equivalent to estimated incomes that would be derived from alternative employment.

Source of Data

Numerous economic studies on irrigation development were relied upon for the economic and physical standards and the procedures used in these analyses. This background information was supplemented by specific information for the Silt project obtained from four major sources: (1) An economic survey of farms in the project area conducted during 1958 in cooperation with the Bureau of Reclamation; (2) material furnished by the Bureau of Reclamation; (3) economic analyses of other projects; 1/ and (4) information furnished by Colorado State University personnel, local representatives of Federal and State agencies, irrigation companies, county officials and businessmen.

1/ Reappraisal by the USDA of Direct Agricultural Benefits for the Vernal Unit, Central Utah Project, and Paonia, Hammond, Smith Fork, Seedskadee, Florida, and Emery County projects, Upper Colorado River Storage Project

Commodity Price Projections

All prices used in estimating farm incomes, direct benefits, and associated costs are based on the September 1957 price projections of the U. S. Department of Agriculture. These projections assume "relatively high employment, a trend toward peace, continued population and economic growth, and a stable general price level."

The long-term projected index of prices received for all farm commodities is 235, base period 1910-14. A comparable index for prices paid, including interest, wages, and taxes is 265.

The price of rotation pasture used in the benefit analysis is derived from the long-term projected price of alfalfa. The computed price is based on the net income derived from alfalfa, adjusted for differences in costs of production and per acre yield of total digestible nutrients. The derived price results in the same net return per acre for alfalfa hay and rotation pasture.

Information obtained during the field survey showed that, historically, prices received locally for specific agricultural commodities marketed have been about the same as the State average prices. Projected prices for livestock and livestock products are based on data collected from the Denver and Grand Junction markets. All prices were adjusted for marketing costs and are net prices to farmers. Projected prices of crops, livestock, livestock products, and selected cost items for the Silt project are shown in table 11.

Farm Sizes

Irrigated acreage was 89 acres per farm on all farms surveyed and 121 acres on full-time farms. The economic survey included a sample of 24 full-time and 20 part-time farms.

Projected farm sizes for both with and without project are based on a family-size-farm concept in which the operator and his family furnish all the labor except during the crop harvesting season. Present sizes, current trends in size of farms, legal limitations of 160 acres of irrigable land per ownership, prospective farm incomes, and other factors were considered in establishing projected farm sizes.

Anticipated Crop Yields

Projected crop yields estimated for evaluation areas, without and with project development, are shown in tables 12 and 13. Production estimates are based on crop yields obtained in comparable areas, estimates by farmers in the project area and agricultural technicians familiar with the area, and other pertinent crop yield data. Yields reflect estimates of average managerial skill for farmers on the project.

Table 11.- Long-term projected prices received and selected prices paid, Silt project

Item	Unit	Price
		Dollars
Prices received 1/		
Alfalfa hay, baled 2/	Ton	20.60
Corn silage 3/	do	7.35
Barley	Bushel	1.05
Sugar beets	Ton	14.40
Straw	do	10.00
Butterfat (whole milk) 4/	Pound butterfat	1.06
Grade A	do	1.16
Grade C	do	.79
Cows (dairy)	Cwt.	12.30
Calves (day old dairy bulls)	Head	10.00
Calves (day old dairy heifers)	do	20.00
Cows (beef)	Cwt.	14.30
Calves (beef steers)	do	21.40
Calves (beef heifers)	do	19.10
Long yearlings (beef steers)	do	19.80
Long yearlings (beef heifers)	do	17.40
Cull ewes	Cwt.	6.30
Lambs	do	21.75
Wool	Pound	.49
Prices paid		
Hired labor	Hour	1.00
Custom rages:		
Baling hay	Ton	5.00
Combining	Acre	5.50
Chopping corn	do	16.00
Thinning beets	do	17.50
Hoeing beets (2 times)	do	13.00
Pulling, topping, and loading beets by machine	Ton	1.50
Hauling beets to dump	do	1.00

1/ Net price received by farmers.
2/ Price in stack after shrinkage.
3/ Based on the price of alfalfa; 2.8 tons of corn silage equivalent to 1 ton of alfalfa.
4/ Weighted average includes 73 percent grade A and 27 grade C at 3.5 test.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Table 12.- Projected crop yields, without project development, by evaluation areas, Silt project

Crop	Unit	Evaluation area A	B	E	F
Alfalfa 1/	Ton	3.0	2.8	1.7	1.5
Rotation pasture 1/	AUM	6.0	5.6	3.4	3.0
Corn silage 1/	Ton	11.5	----	----	----
Barley	Bu.	60.0	55.0	50.0	45.0
Sugar beets 1/	Ton	13.5	----	----	----
Permanent pasture	AUM	3.0	3.0	2.0	2.0

1/ Fertilizer: Annual requirement (available) per unit of yield; alfalfa, 7.5 pounds phosphate per ton; rotation pasture, 3 pounds of phosphate and 6 pounds of nitrogen per AUM; corn silage, 5 pounds nitrogen per ton; sugar beets, 4.5 pounds phosphate and 5.5 pounds nitrogen per ton. Total phosphate required applied at time of seeding, nitrogen applied to pasture once each year.

Table 13.- Projected crop yields, with project development, by evaluation areas, Silt project

Crop	Unit	Evaluation area A	B	C	D	E	F	G	H
Alfalfa 1/	Ton	4.0	3.5	4.0	3.5	3.7	3.2	3.7	3.2
Rotation pasture 1/	AUM	8.0	7.0	8.0	7.0	7.4	6.4	7.4	6.4
Corn silage 1/	Ton	15.0	----	15.0	----	15.0	----	15.0	----
Barley	Bu.	70.0	60.0	70.0	60.0	70.0	60.0	70.0	60.0
Sugar beets 1/	Ton	16.0	----	16.0	----	----	----	16.0	----
Permanent pasture	AUM	3.0	3.0	----	----	2.0	2.0	----	----

1/ Fertilizer: Annual requirement (available) per unit of yield; alfalfa, 7.5 pounds phosphate per ton; rotation pasture, 3 pounds of phosphate and 6 pounds of nitrogen per AUM; corn silage, 5 pounds nitrogen per ton; sugar beets, 4.5 pounds phosphate and 5.5 pounds nitrogen per ton. Total phosphate required applied at time of seeding, nitrogen applied to pasture twice each year.

Anticipated Cropping Systems

Climate, topography, distance to central markets, and opportunities for off-farm employment influence the kinds of crops that are commercially produced in the project area. Present irrigated crops consist of alfalfa and pasture on 74 percent of the cropland; small grains on 19 percent; corn silage on 4.5 percent; and sugar beets and potatoes on 2.5 percent. Development of the project is not expected to affect the kinds of crops produced.

Development of the project is expected to increase the percentage of the project area in rotation pasture, corn silage, and sugar beets and to decrease the percentage in alfalfa and small grains (table 14). On farms that do not grow sugar beets, a 7-year crop rotation is assumed, including 5 years of alfalfa or rotation pasture, and 2 years of grain and corn for silage or if topography was a limiting factor grain was substituted for corn silage in the rotation. A 9-year crop rotation was assumed on farms on which sugar beets were grown. Small grain was used as a nurse crop in the seeding of alfalfa and rotation pasture.

A 9-year crop rotation was assumed on evaluation areas A, C, and G. On evaluation areas B, D, E, F, and H a 7-year rotation was projected. Because of slopes, corn silage and sugar beets were not projected on evaluation areas B, D, F, and H.

Table 14.- Projected cropping pattern, without and with project development, by evaluation areas, Silt project

Crop	Evaluation areas								Project
	A	B	C	D	E	F	G	H	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Without Project									
Alfalfa	1,214	597	-----	-----	122	120	-----	-----	2,053
Rotation pasture	556	260	-----	-----	-----	-----	-----	-----	816
Corn silage	247	-----	-----	-----	-----	-----	-----	-----	247
Barley	469	341	-----	-----	48	47	-----	-----	905
Sugar beets	150	-----	-----	-----	-----	-----	-----	-----	150
Range, nonirrigated	387	176	657	215	-----	-----	341	346	2,122
Farmstead, etc.	195	88	-----	-----	11	10	-----	-----	304
Total	3,218	1,462	657	215	181	177	341	346	6,597
Permanent pasture 1/	255	110	-----	-----	56	54	-----	-----	475
With Project									
Alfalfa	1,253	658	148	60	107	108	123	88	2,545
Rotation pasture	633	326	241	85	15	12	72	144	1,528
Corn silage	270	-----	77	-----	24	-----	19	-----	390
Barley	492	390	77	58	24	47	57	93	1,238
Sugar beets	375	-----	75	-----	-----	-----	50	-----	500
Farmstead, etc.	195	88	39	12	11	10	20	21	396
Total	3,218	1,462	657	215	181	177	341	346	6,597
Permanent pasture 1/	255	110	-----	-----	56	54	-----	-----	475

1/ Nonproject lands projected to receive essentially the same supply of water without and with project development.

Direct Agricultural Benefits

A primary objective of the economic analysis is to estimate direct agricultural benefits. These benefits are defined as the value of crop and pasture production expected with project development over the value anticipated without the project, minus the value of additional farm inputs or associated costs required. The concepts and assumptions on the specific composition and value of nonproject resources or associated costs, as used in this report, are outlined below.

A basic assumption is that the national economy will operate at essentially full employment for the period of analysis. With this general assumption, alternative employment opportunities would be expected in the national economy for resources used in the development and operation of irrigated farms, including the labor and management skills of farm operators. Also, the projected levels of farm prices received and paid are higher than they would be with significant unemployment.

Estimates of direct agricultural benefits are based on crop-production budgets that account for the quantity and value of crop and pasture production expected after full development of project farms, and for the cost that will be incurred on the project lands in achieving the level of production expected. Estimates were made for each evaluation area and for the project area as a whole.

The cropping patterns assumed in the benefit analysis are the same as those used in the analysis of water requirements and prospective farm incomes.

Farms with adequate water supplies will require considerably more labor than farms with partial supplies. The additional operator and family labor required is considered as an economic cost in deriving benefits attributable to the project.

Labor and Management Charges

Labor for crop production on project lands will be required during the summer. Thus, the summer hired wage rate assumed in the analysis ($1.00 per hour) was applied to operator and family labor in evaluating direct agricultural benefits from irrigation water. A management allowance or charge was made for the farm operators also. This amounts to 15 percent of the hired wage rate. Based on these rates and an allocation of 75 percent of the hours to the operator and 25 percent to the family, the hourly rate would be $1.11.

Return to Land and Water

Summaries of the average value of crop production, annual production costs, and return to operator and family labor and management, land and water, without and with project development, are shown by evaluation areas in tables 15 and 16. Net income, cost of operator and family labor and management, and the weighted average increase in net income with project development by evaluation areas are shown in table 17. Deduction of all expenses and allowances except those for land and water leaves a weighted average net return to these resources ranging from $34.71 per acre for evaluation area G to $9.67 per acre for evaluation area B.

Table 15.- Net income from crop production to operator and family labor and management, land, and water, without project development, by evaluation areas, Silt project

Item	Unit	Evaluation areas			
		A	B	E	F
Total land	Acre	130.0	150.0	135.0	155.0
Alfalfa	do	48.8	61.3	91.0	105.0
Rotation pasture	do	22.4	26.7	-----	-----
Corn silage	do	9.9	-----	-----	-----
Barley	do	18.9	35.0	36.0	41.0
Sugar beets	do	6.0	-----	-----	-----
Idle	do	16.0	18.0	-----	-----
Farmstead, etc.	do	8.0	9.0	8.0	9.0
Operator and family labor	Hour	1,158	1,396	1,058	1,236
Investment	Dollar	9,224	8,905	8,776	8,880
Buildings and improvement	do	1,455	1,435	1,386	1,451
Machinery and equipment	do	6,718	6,440	6,440	6,440
Other	do	1,051	1,030	950	989
Value of production	do	7,392	6,898	5,265	5,414
Production expenses 1/	do	4,057	3,439	2,917	3,133
Net crop income 2/	do	3,335	3,459	2,348	2,281
Interest 3/	do	461	445	439	444
Net income 4/	do	2,874	3,014	1,909	1,837

1/ Excluding interest, land and water development, and O&M.
2/ Return to operator and family labor and management, land and irrigation water.
3/ At 5 percent.
4/ Return to operator and family labor and management, land and irrigation water.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Table 16.- Net income from crop production to operator and family labor and management, land, and water, with project development, by evaluation areas, Silt project

Item	Unit	Evaluation area A	B	C	D	E	F	G	H
Total land	Acre	130.0	150.0	135.0	155.0	135.0	155.0	140.0	160.0
Alfalfa	do	50.6	67.5	30.6	43.0	80.0	94.5	48.5	40.5
Rotation pasture	do	25.6	33.5	49.6	61.0	11.0	10.5	28.5	66.5
Corn silage	do	10.9	-----	15.9	-----	18.0	-----	7.5	-----
Barley	do	19.9	40.0	15.9	42.0	18.0	41.0	22.5	43.0
Sugar beets	do	15.0	-----	15.0	-----	-----	-----	25.0	-----
Farmstead, etc.	do	8.0	9.0	8.0	9.0	8.0	9.0	8.0	10.0
Operator and family labor	Hour	1,627	1,862	1,501	1,784	1,729	1,982	1,764	1,777
Investment	Dollar	9,602	9,247	9,415	8,891	10,477	9,622	9,486	8,755
Buildings and improvements	do	1,475	1,435	1,532	1,451	1,557	1,451	1,474	1,467
Machinery and equipment	do	6,718	6,440	6,741	6,440	6,818	6,440	6,783	6,440
Other	do	1,409	1,382	1,142	1,000	2,102	1,731	1,229	848
Value of production	do	11,988	9,430	12,248	9,458	9,890	9,411	13,729	9,070
Production expenses 1/	do	5,446	3,985	5,718	3,993	4,364	4,111	6,437	3,959
Net crop income 2/	do	6,542	5,445	6,530	5,465	5,526	5,300	7,292	5,111
Interest 3/	do	480	463	471	445	524	481	474	438
Net income 4/	do	6,062	4,982	6,059	5,020	5,002	4,819	6,818	4,673

1/ Excluding interest, land and water development, and O&M.
2/ Return to operator and family labor and management, land and irrigation water.
3/ At 5 percent.
4/ Return to operator and family labor and management, land and irrigation water.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Table 17.- Summary: Weighted average increase in net income, with project development, by evaluation areas, Silt project

Item	Net income 1/	Operator & family labor	Cost of operator & family labor 2/	Net income 2/	Weighted farm size	Net income per acre 3/	Increased net income per acre with project
Evaluation area	Dollar	Hours	Dollar	Dollar	Acres	Dollar	Dollar
A (with)	6,062	1,627	1,806	4,256	130	32.74	20.52
A (without)	2,874	1,158	1,285	1,589	130	12.22	-----
B (with)	4,982	1,862	2,067	2,915	150	19.43	9.67
B (without)	3,014	1,396	1,550	1,464	150	9.76	-----
C (with)	6,059	1,501	1,666	4,393	135	32.54	32.54
D (with)	5,020	1,784	1,980	3,040	155	19.61	19.61
E (with)	5,002	1,729	1,919	3,083	135	22.84	17.40
E (without)	1,909	1,058	1,174	735	135	5.44	-----
F (with)	4,819	1,982	2,200	2,619	155	16.90	13.90
F (without)	1,837	1,236	1,372	465	155	3.00	-----
G (with)	6,818	1,764	1,958	4,860	140	34.71	34.71
H (with)	4,673	1,777	1,972	2,701	160	16.88	16.88

1/ Return to operator and family labor and management, land and water.

2/ At $1.15 per hour for operator labor and management and $1.00 per hour for family labor. Weighted average is based on 75 percent of hours by operator and 25 percent of hours by family.

3/ Net return to land and irrigation water.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Land Development Costs

The acreage of each evaluation area, the projected land values and the additional cost of land and farm irrigation systems, and annual cost per acre are shown in table 18. Costs of farm buildings, machinery, fences, domestic water, and maintenance and replacement costs of the farm irrigation system are included as farm expenses in the budgets. The degree of development anticipated on land and farm irrigation systems for each evaluation area was considered in setting up man and machine requirements.

Table 18.- Estimated average annual additional cost per acre of irrigable land for land and land development, with project development, by evaluation areas, Silt project

Item	Unit	Evaluation areas							
		A	B	C	D	E	F	G	H
Land area 1/	Acre	3,005	1,356	657	215	181	177	341	346
Land values									
Irrigated land	Dollar	200.00	190.00	-----	-----	115.00	100.00	-----	-----
Range, improved	do	-----	-----	-----	-----	-----	-----	25.00	25.00
Range, unimproved	do	15.00	15.00	15.00	15.00	-----	-----	15.00	15.00
Weighted average	do	177.98	168.93	15.00	15.00	115.00	100.00	23.36	23.82
Additional land improvement									
Land	Dollar	1.79	1.81	15.00	15.00	-----	-----	23.36	23.82
Land clearing	do	1.20	.90	-----	-----	-----	-----	2.63	4.56
Land leveling	do	36.24	15.05	31.70	23.44	24.86	18.15	39.82	18.00
Farm irrigation system	do	15.43	8.59	34.83	28.93	14.18	8.75	27.32	15.36
Drainage	do	12.16	1.53	-----	-----	-----	-----	-----	-----
Total	do	66.82	27.88	81.53	67.37	39.04	26.90	93.13	61.74
Annual cost									
Land 1/	Dollar	.09	.09	.76	.76	-----	-----	1.18	1.20
Land clearing 2/	do	.06	.05	-----	-----	-----	-----	.13	.23
Land leveling 2/	do	1.83	.76	1.60	1.18	1.25	.91	2.01	.91
Farm irrigation system 3/	do	.85	.47	1.91	1.58	.78	.48	1.50	.84
Drainage 3/	do	.67	.08	-----	-----	-----	-----	-----	-----
Total	do	3.50	1.45	4.27	3.52	2.03	1.39	4.82	3.18

1/ Excludes lands in the present pump area.

2/ Land, land clearing, and land leveling amortized over a 100-year period at 5 percent interest (factor .05038).

3/ Farm irrigation system and drainage amortzed over a 50-year period at 5 percent interest (factor .05478).

Based on price projections by the U. S. Department of Agriculture, September 1957.

Projected additional investment in land, land improvements, and development of farm irrigation systems per irrigable acre, required with project development, for evaluation areas A through H, are $66.82, $27.88, $81.53, $67.37, $39.04, $26.90, $93.13, and $61.74, respectively. At 5 percent the annual amortized cost per acre for the total additional investment required would be $3.50, $1.45, $4.27, $3.52, $2.03, $1.39, $4.82, and $3.18.

Development Period

Benefits from the use of supplemental water would begin to accrue immediately after completion of the project. The 559 acres of nonirrigated land, which are in small, scattered tracts, are projected to be developed in conjunction with land already under irrigation. Development of the 1,559 acres of nonirrigated land, on which new farms are projected to be established is likely to proceed at a slower rate. Several years may elapse before the full level of benefits are attained. The assumption is made for the Silt project that a period of three years will be required before the full level of projected benefits are achieved on the presently irrigated and intermingled new lands, and five years will be required for lands on which new farms are projected. Project benefits are discounted accordingly.

Findings

Increased net income per acre with project development for evaluation areas A through H are $20.52, $9.67, $32.54, $19.61, $17.40, $13.90, $34.71, and $16.88, respectively (table 19). Annual amortized cost of additional land investment and development ranges from $4.82 per acre for evaluation area G to $1.39 for evaluation area F (table 18). Discount factors are based on three-and five-year development periods, an interest rate of 5 percent, and an evaluation period of 100 years.

The present annual equivalent values per acre of direct agricultural benefits for the eight evaluation areas are estimated at $16.22, $7.83, $25.68, $14.62, $14.64, $11.92, $27.15, and $12.45, respectively (table 19). The weighted average annual direct agricultural benefits for the 6,278 acres, except for those lands which presently have a full water supply from pumping, are $15.56 per acre, or $97,657 annually.

It was assumed that project lands which presently have a full water supply from pumping would have benefits equal to the savings in pumping costs minus abandonment losses for pumping equipment. Evaluation area A has 213 acres of pumplands and evaluation area B 106 acres. On the basis of present pumping costs, direct agricultural benefits from the 319 acres of pumplands are estimated at $21.55 per acre annually, or $6,874 for the total acreage.

The weighted average annual direct agricultural benefits are $15.85 per acre or $104,531 for the proposed project.

Table 19.- Summary of estimated annual direct agricultural benefits, by evaluation areas, Silt project

Evaluation area	Land area	Increased net income with project		Amortized cost of additional land investment and development		Direct benefits		Discount factor 1/	Net direct benefits	
	Acres	Per acre	Total	Per acre	Total	Per acre	Total		Per acre	Total
A	2/ 3,005	$20.52	$61,663	$3.50	$10,518	$17.02	$51,145	3/.95271	$16.22	$48,726
B	2/ 1,356	9.67	13,093	1.45	1,966	8.22	11,147	3/.95271	7.83	10,620
C	657	32.54	21,379	4.27	2,805	28.27	18,574	4/.90844	25.68	16,873
D	215	19.61	4,216	3.52	757	16.09	3,459	4/.90844	14.62	3,142
E	181	17.40	3,149	2.03	367	15.37	2,782	3/.95271	14.74	2,650
F	177	13,90	2,460	1,39	246	12.51	2,214	3/.95271	11.92	2,110
G	341	34.71	11,836	4.82	1,644	29.89	10,192	4/.90844	27.15	9,226
H	346	16.88	5,841	3.18	1,100	13.70	4,741	4/.90844	12.45	4,310
Total	6,278	$19.70	$123,657	$3.09	$19,403	$16.61	$104,254		$15.56	$97,657
Present pump-lands 2/	319								$21.55	$6,874
Project total	6,597								$15.85	$104,531

1/ At 5 percent. Present annual equivalent value per $1.00 of benefits accruing during a 100-year period.
2/ Benefits figured separately on 319 acres of land in evaluation areas A and B which presently have a full supply from pumping but will be included in the project. Of the 319 acres, 213 are in evaluation A and 106 in evaluation area B.
3/ Assumes a 3-year development period.
4/ Assumes a 5-year development period.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Prospective Farm Incomes

Estimates of prospective farm incomes were made for several types and sizes of farms with the proposed project development. Farm incomes were estimated for grade A dairy, range beef, feeder calf, farm-flock of sheep, and cash-crop farms.

Budgets were developed for the following farm types and evaluation areas: range beef on evaluation areas A, B, E, and F; grade A dairy on evaluation areas A and C; feeder calves on evaluation areas A, B, and H; farm-flock of sheep on evaluation areas A, B, and G; and cash-crop farms on evaluation areas A and G.

Many kinds of input-output and price information are needed for farm budgets, among them labor requirements, machinery and building needs, land investment, and feed requirements. Published research in similar irrigated areas was relied upon. These data were supplemented by information collected from farmers in the project and nearby areas.

Livestock Enterprises and Production Rates

Sales of livestock and livestock products likely will be the predominant sources of income on the project. Project development probably will effect no basic change in the livestock economy of the area, but will however, result in an increase in feed crops and pasture available for livestock. Because of the increased feed supply, numbers of dairy cows, farm sheep, and feeder calves will be increased. It is anticipated also that development of the project will increase the acreage of sugar beets and the number of cash-crop farms in the area.

A production rate of 325 pounds of butterfat per dairy cow is assumed. Feeder steers are assumed to gain 390 pounds and feeder heifers 375 pounds in 11 months. Farm ewes are assumed to produce a 90-pound grass-fat lamb and 10 pounds of wool each. Beef cows are assumed to produce calves averaging 393 pounds.

Types of Farms

Projected types of farms with project development are based on the future market for each agricultural commodity, existing types of farms on the project, and available Federal grazing permits. Among the farms surveyed, four types predominated--range beef, feeder calf, sheep, and cash-crop. The feeder calf and sheep farms utilized most of the forage and grain crops produced. Cash-crop farms produced primarily grain, sugar beets, and alfalfa for sale.

Brief descriptions of the projected farm types follow:

Range beef - Part of the feed supply is furnished by Federal grazing permits, which limit the number of breeding cows to the equivalent of twelve 134-cow herds. The irrigated land serves as a winter feed base for the breeding herd and summer pasturage for yearlings. Sale of calves and grass-fat long yearlings is the principal source of income.

Development of the project is not expected to result in an increase in the number of beef farms with range permits, or in the number of cows in the breeding herds on these farms.

Grade A dairy - The analysis of dairy enterprises is based on 45 cows per farm. Labor requirements are near maximum for a family-size operation. Seventy-three percent of the milk produced is sold at a grade A price and 27 percent at a grade C price. All milk will be produced under grade A standards and sold to grade A plants.

Feeder calf - Calves are purchased in fall from owners of range herds, wintered and grazed on irrigated pasture the following summer and sold as grass-fat long yearlings in the fall. The size of herd used in the analysis was 150 head.

Farm-flock sheep - Farm flocks consist of 350 mature ewes per farm. sale of grass-fat lambs and wool is the principal source of income.

Cash-crop farms - Alfalfa hay and small grains are produced and sold to ranchers and dairymen on the project and surrounding areas. Sugar beets are also produced on these farms.

Captial Requirements

Projected capital requirements on several farm types on the Silt project are shown in table 20. Capital requirements on beef farms vary from $77,500 to $88,000. Grade A dairy farms require capital ranging from $67,000 to $89,000. Capital needs for feeder calf operations vary from $48,500 to $72,000. Capital needed for sheep farms varies from $45,000 to $68,000. Needs on cash-crop farms range from $36,500 to $55,000. These figures represent the cost of new structures and equipment and assume a farm residence value of $10,000.

Farmers who are presently on the Silt project have most of the capital items needed, with the possible exception of additional land development and expansion of livestock numbers. New farms will require most of the capital items listed except for the investment shown for present land and water supply. New farms will require approximately $20,000 less capital than present farms because of the large investment in present water supply.

Return to Operator and Family Labor and Management

An appraisal of the adequacy of projected farm incomes requires a guide or standard in terms of returns to operator and family labor and management. An average return of $3,100 for essentially full-time family-type farms has been considered an acceptable minimum. This amount is used as a general guide in appraising the adequacy of prospective farm incomes. For farms with greater or less than average operator and family labor inputs, capital requirements, or managerial skills, this return would vary accordingly. The farm dwelling and domestic water supply system are not included as farm expenses or farm receipts in the budget analysis.

Table 20.- Capital investment for illustrative farm types, with project development, by evaluation areas, Silt project

Item	Unit	Range beef	Grade A dairy	Cash crop	Feeder calves	Farm-flock sheep
Evaluation area		A	A	A	B	B
Irrigable land (project)	Acre	130	130	130	150	150
Irrigable permanent pasture (nonproject)	do	15	15	------	11	11
Land and present water supply	Dollar	32,619	32,619	31,494	30,086	30,086
Farm buildings and improvements 1/	do	5,032	14,562	2,283	4,540	7,463
Equipment 1/	do	11,675	18,048	11,245	11,313	11,313
Livestock	do	28,825	13,725	------	12,750	6,420
Total farm	do	78,151	78,954	45,022	58,689	55,282
Residence 2/	do	10,000	10,000	10,000	10,000	10,000
Total needs	do	88,151	88,954	55,022	68,689	65,282

1/ Cost of new structures and equipment.
2/ Value assumed for purposes of approximately total capital requirements.

Based on price projections by the U. S. Department of Agriculture, September 1957.

The $3,100 does not necessarily represent the total income received by the farm family from operation of the farm business. In addition to return for labor and management, the farm family will receive a return on equity owned in the farm business. Return on investment owned by the operator, in addition to returns for labor and management, would be available for family living expenses, including income and social security taxes, savings, and retirement of debt.

Findings

Net incomes for the various sizes and types of farms, from tables 21A, 21B, 21C, and 21D are summarized below:

Evaluation area	Range beef	Grade A dairy	Feeder calves	Farm-flock sheep	Cash crop
A	$4,297	$7,665	$6,199	$3,903	$5,448
B	4,448	------	4,457	3,934	------
C	------	8,606	7,180	------	------
D	------	------	5,412	------	------
E	5,257	------	------	------	------
F	5,010	------	------	------	------
G	------	------	------	6,563	6,512
H	------	------	5,094	4,576	------

Table 21A.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation area A, Silt project

Item	Unit	Evaluation area A				
		Range beef	Grade A dairy	Feeder calves	Farm-flock sheep	Cash crop
Total land	Acre	145.0	145.0	145.0	145.0	130.0
Alfalfa	do	71.5	50.0	21.0	40.0	69.0
Rotation pasture	do	15.5	37.0	48.0	47.0	------
Corn silage	do	17.5	17.5	14.0	17.5	------
Barley	do	17.5	17.5	14.0	17.5	28.0
Sugar beets	do	------	------	25.0	------	25.0
Farmstead, etc.	do	8.0	8.0	8.0	8.0	8.0
Permanent pasture (non-project lands)	do	15.0	15.0	15.0	15.0	------
Productive livestock	Number	134	45	150	350	------
Operator and family labor	Hour	3,217	4,451	2,229	2,595	1,836
Investment	Dollar	73,463	67,497	56,196	52,063	41,076
Land	do	32,619	32,619	32,619	32,619	31,494
Buildings and improvements	do	3,019	8,737	2,776	4,513	1,370
Machinery	do	7,005	10,829	7,166	7,005	6,747
Livestock	do	28,825	13,725	12,750	6,420	------
Other	do	1,995	1,587	885	1,506	1,465
Farm receipts	Dollar	14,932	20,216	16,855	11,984	13,500
Crop sales	do	2,491	2,861	6,746	2,326	13,400
Livestock and products	do	12,341	17,149	10,009	9,558	------
Other	do	100	206	100	100	100
Farm expenses 1/	Dollar	6,962	9,176	7,846	5,478	5,998
Farm income 2/	Dollar	7,970	11,040	9,009	6,506	7,502
Interest on investment 3/	Dollar	3,673	3,375	2,810	2,603	2,054
Adjusted farm income 4/	Dollar	4,297	7,665	6,199	3,903	5,448

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Table 21B.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation areas B and C, Silt project

Item	Unit	Evaluation area B			Evaluation area C	
		Range beef	Feeder calves	Sheep	Grade A dairy	Feeder calves
Total land	Acre	161,0	161.0	161.0	135.0	135.0
Alfalfa	do	82.0	45.0	46.0	48.0	19.0
Rotation pasture	do	19.0	56.0	55.0	43.0	54.0
Corn silage	do	------	------	------	18.0	14.5
Barley	do	40.0	40.0	40.0	18.0	14.5
Sugar beets	do	------	------	------	------	25.0
Farmstead, etc.	do	9.0	9.0	9.0	8.0	8.0
Permanent pasture (non-project lands)	do	11.0	11.0	11.0	------	------
Productive livestock	Number	134	150	350	45	150
Operator and family labor	Hour	3,412	2,535	2,894	4,441	2,209
Investment	Dollar	70,179	53,335	48,854	45,806	34,503
Land	do	30,086	30,086	30,086	11,007	11,007
Buildings and improvements	do	2,934	2,724	4,478	8,683	2,722
Machinery	do	6,788	6,788	6,788	10,829	7,166
Livestock	do	28,825	12,750	6,420	13,725	12,750
Other	do	1,546	987	1,082	1,562	858
Farm receipts	Dollar	14,849	12,756	11,670	20,147	16,891
Crop sales	do	2,408	2,647	2,012	2,792	6,782
Livestock and products	do	12,341	10,009	9,558	17,149	10,009
Other	do	100	100	100	206	100
Farm expenses 1/	Dollar	6,892	5,632	5,293	9,251	7,986
Farm income 2/	Dollar	7,957	7,124	6,377	10,896	8,905
Interest on investment 3/	Dollar	3,509	2,667	2,443	2,290	1,725
Adjusted farm income 4/	Dollar	4,448	4,457	3,934	8,606	7,180

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Table 21C.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation areas D, E, and F, Silt project

Item	Unit	Evaluation area D Feeder calves	Evaluation area E Range beef	Evaluation area F Range beef
Total land	Acre	155.0	179.0	205.0
Alfalfa	do	43.0	80.0	94.5
Rotation pasture	do	61.0	11.0	10.5
Corn silage	do	------	18.0	------
Barley	do	42.0	18.0	41.0
Sugar beets	do	------	------	------
Farmstead, etc.	do	9.0	8.0	9.0
Permanent pasture (non-project lands)	do	------	44.0	50.0
Productive livestock	Number	150	134	134
Operator and family labor	Hour	2,537	3,285	3,458
Investment	Dollar	33,631	64,085	62,586
Land	do	10,442	22,995	22,170
Buildings and improvements	do	2,692	3,208	3,172
Machinery	do	6,788	7,005	6,788
Livestock	do	12,750	28,825	28,825
Other	do	959	2,052	1,631
Farm receipts	Dollar	12,897	15,213	14,909
Crop sales	do	2,788	2,772	2,468
Livestock and products	do	10,009	12,341	12,341
Other	do	100	100	100
Farm expenses 1/	Dollar	5,803	6,752	6,770
Farm income 2/	Dollar	7,094	8,461	8,139
Interest on investment 3/	Dollar	1,682	3,204	3,129
Adjusted farm income 4/	Dollar	5,412	5,257	5,010

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Table 21D.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation areas G and H, Silt project

Item	Unit	Evaluation area G		Evaluation area H	
		Sheep	Cash crop	Feeder calves	Sheep
Total land	Acre	140.0	140.0	160.0	160.0
Alfalfa	do	20.0	77.0	40.0	41.0
Rotation pasture	do	57.0	------	67.0	66.0
Corn silage	do	15.0	------	------	------
Barley	do	15.0	30.0	43.0	43.0
Sugar beets	do	25.0	25.0	------	------
Farmstead, etc.	do	8.0	8.0	10.0	10.0
Permanent pasture (non-project land)	do	------	------	------	------
Productive livestock	Number	350	------	150	350
Operator and family labor	Hour	2,779	1,909	2,525	2,897
Investment	Dollar	32,107	22,778	32,972	28,505
Land	do	13,038	13,038	9,878	9,878
Buildings and improvements	do	4,049	1,403	2,719	4,470
Machinery	do	7,166	6,747	6,788	6,788
Livestock	do	6,420	------	12,750	6,420
Other	do	1,434	1,590	837	949
Farm receipts	Dollar	15,919	13,838	12,967	11,880
Crop sales	do	6,261	13,738	2,858	2,222
Livestock and products	do	9,558	------	10,009	9,558
Other	do	100	100	100	100
Farm expenses 1/	Dollar	7,751	6,187	6,224	5,879
Farm income 2/	Dollar	8,168	7,651	6,743	6,001
Interest on investment 3/	Dollar	1,605	1,139	1,649	1,425
Adjusted farm income 4/	Dollar	6,563	6,512	5,094	4,576

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.

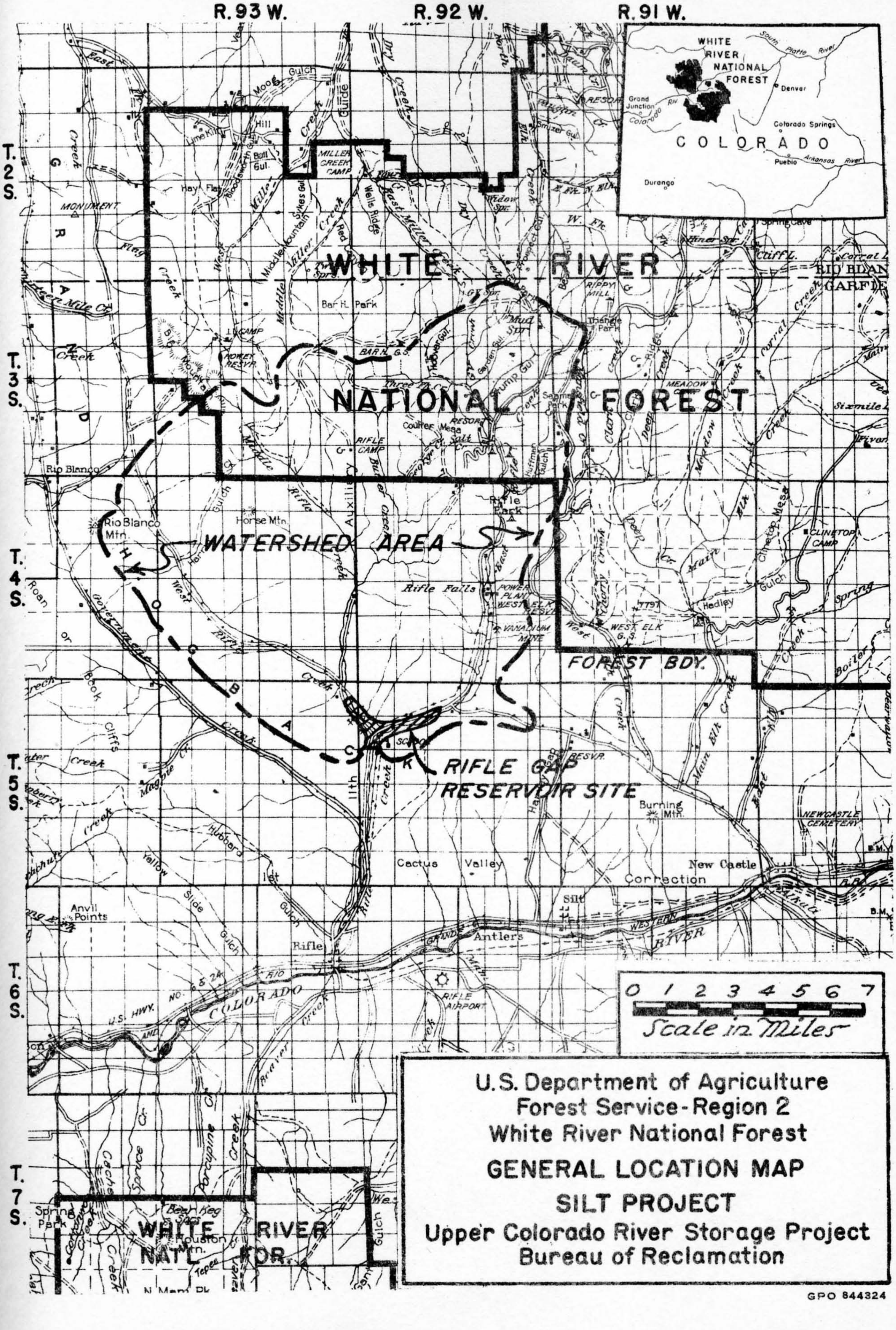
These incomes are available as return to the operator and his family for their management and labor, project irrigation water, and for payment of all operation and maintenance costs. Many farms will have larger or smaller net incomes than those shown here. The conclusion from this analysis is that the income prospects for these fully developed farms would be adequate to provide a reasonably satisfactory level of living and to permit some payment for costs of irrigation water.

Relationship Between Farm-Income and Crop-Production Budgets

Two types of budgets were used in the economic analyses of this project. Farm-income budgets were used in appraising the prospects for a successful, stable agriculture and also as a basis for the crop-production budgets used in estimating direct agricultural benefits. Cropping patterns assumed in the benefit analysis are the same as those used in the analysis of prospective farm incomes; thus they reflect the need for hay, pasture, and other feed crops in livestock enterprises. In the benefit analysis it was assumed that forage crops would be purchased by the livestock enterprises. This assumption also governed estimates of forage prices and cropping patterns.

The estimate of direct agricultural benefits was based on crop-production budgets. The results are shown below by evaluation areas together with benefit estimates based on farm-income budgets. Costs per unit of inputs used in production were the same in the farm-income and crop-production budgets. Distribution of farm types by acreage assumed in both analysis are as follows: (1) With the project--range beef, 26 percent; grade A dairy, 12 percent; feeder calves, 28 percent; farm-flock sheep, 16 percent; and cash crop, 18 percent; (2) Without the project--range beef, 35 percent; grade A dairy, 10 percent; feeder calves, 21 percent; farm-flock sheep, 14 percent; and cash crop, 20 percent. Estimates of net direct agricultural benefits are $15.85 per acre for the crop-production budgets and $16.61 per acre for the farm-income budgets.

Evaluation area	Crop-production budgets	Farm-income budgets
A	$16.22	$17.17
B	7.83	8.27
C	25.68	28.81
D	14.62	15.08
E	14.64	17.17
F	11.92	13.60
G	27.15	25.39
H	12.45	10.28
Pump area	21.55	21.55
Project	15.85	16.61


R. 93 W.
R. 92 W.
R. 91 W.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.
T. 7 S.
WHITE RIVER NATIONAL FOREST
Grand Junction
Denver
Colorado Springs
Pueblo
Durango
COLORADO
WHITE RIVER
NATIONAL FOREST
WATERSHED AREA
FOREST BDY.
RIFLE GAP RESERVOIR SITE
Rio Blanco
Rio Blanco Mtn.
Horse Mtn.
Rifle Falls
Burning Mtn.
Cactus Valley
New Castle
Silt
Antlers
Rifle
Anvil Points
RIFLE AIRPORT
COLORADO
RIVER
U.S. HWY. NO. 6 & 24
WHITE RIVER NAT'L FOR.
0 1 2 3 4 5 6 7
Scale in Miles
U.S. Department of Agriculture
Forest Service-Region 2
White River National Forest
GENERAL LOCATION MAP
SILT PROJECT
Upper Colorado River Storage Project
Bureau of Reclamation

GPO 844324

CHAPTER III

RELATIONSHIP OF THE SILT PARTICIPATING PROJECT TO THE MANAGEMENT, PROTECTION AND USE OF THE WHITE RIVER NATIONAL FOREST AND NONFEDERAL FOREST RESOURCES

Introduction

This section of the report considers the impact of the Silt Participating Project on the White River National Forest and on nonfederal forest and forest-range lands. It is aimed at determining what facilities, resources, and uses will be affected and at evaluating these effects.

Area Concerned

The proposed project features including Rifle Gap Dam and Reservoir, Grass Valley Canal, and Davie Ditch are entirely outside the exterior boundary of the White River National Forest. The proposed reservoir is at a distance of seven to eight miles from the national forest boundary. The watershed area above the dam on Rifle Creek is about 130 square miles of which 35 percent is national forest land, 43 percent public domain, and 22 percent privately owned land. There are no forested lands, either federally or privately owned, within the 300 acre flowage area of the reservoir. See map attached.

Present Status and Current Use

Existing Facilities

Project construction and operation will not affect any existing Forest Service developments, improvements, or services now provided.

Current Management

The national forest area involved within the watershed is under administration and management which is compatible with the proposed project.

Current Use

The watershed is used primarily for growing timber and forage, and for water production, recreation and wildlife habitat.

Annual timber cut, all from national forest lands within the watershed, has averaged approximately 500,000 board feet over the past five years, with a minimum stumpage value of $3,300 per year.

On the national forest, 16 permittees graze 1,150 cattle and horses and 3,100 sheep, for a total of 5,050 animal unit months. Receipts from this use amounted to $2,755 in 1958. Private and public domain lands are also grazed but at different times of the year.

Recreation use on national forest lands within the watershed is moderate; it is estimated the use for hunting, fishing, camping, picnicking and sight-seeing has risen to 7,800 mandays annually. Heavy recreation use occurs on a scenic section of East Rifle Creek between the national forest boundary and the reservoir site. This is the Rifle Mountain Park, an area maintained by the City of Rifle for picnicking, camping, fishing and sight-seeing.

One reservoir, 3 ditches, 15 stockwater ponds, 5 pastures and cabins, one resort, and one summer home are authorized under special use permits on national forest lands within the watershed. These will not be affected by the project.

At present, there are no Forest Service rights-of-way, or withdrawals within the area.

There is very little mining activity, including oil and gas leasing within the area. There are some mining claims, but little or no development work has been done.

Estimated Future Status Without Project Developments

Timber harvest will continue at about the present rate on national forest lands. There will be no significant amount of cutting on nonfederal forest lands.

Adjustments in grazing use on the national forest will be continued to bring stocking and actual use into agreement with carrying capacities and proper use of the range. This action will provide better protection of the project watershed.

The trend of increasing recreation use will continue. An estimate of 35 percent increase in the next five years is conservative.

The forest and forest-range lands in other Federal and private ownerships will continue to be used for grazing, forestry, wildlife, and recreation purposes.

Impacts of Project Construction and Operation on the National Forest (Estimated Future Use With the Project Development)

Construction and operation of this project will have no significant effect upon general administration, management, and protection of the Rifle Ranger District, White River National Forest.

General Administration

The project will not require any change in principles or objectives of administration or management. No changes or additions will be necessary in forest improvements needed for administration or services now provided on the national forest.

Protection

No additional improvements for fire prevention or control will be needed.

Resource Use and Development

The proposed Rifle Gap Reservoir will attract visitors for picnicking, boating, and fishing. Some of this increased recreational use will probably also be extended to national forest lands. However, this increased use is not expected to be heavy and costs of preparing or extending recreational area plans will not be significant.

There will be no conflicts with forest areas such as wilderness, research, or other special areas.

Losses or Benefits to Resource Values

The project will have no effects on forest resource volumes or values.

Impacts on Nonfederal Forest and Forest-Range Lands

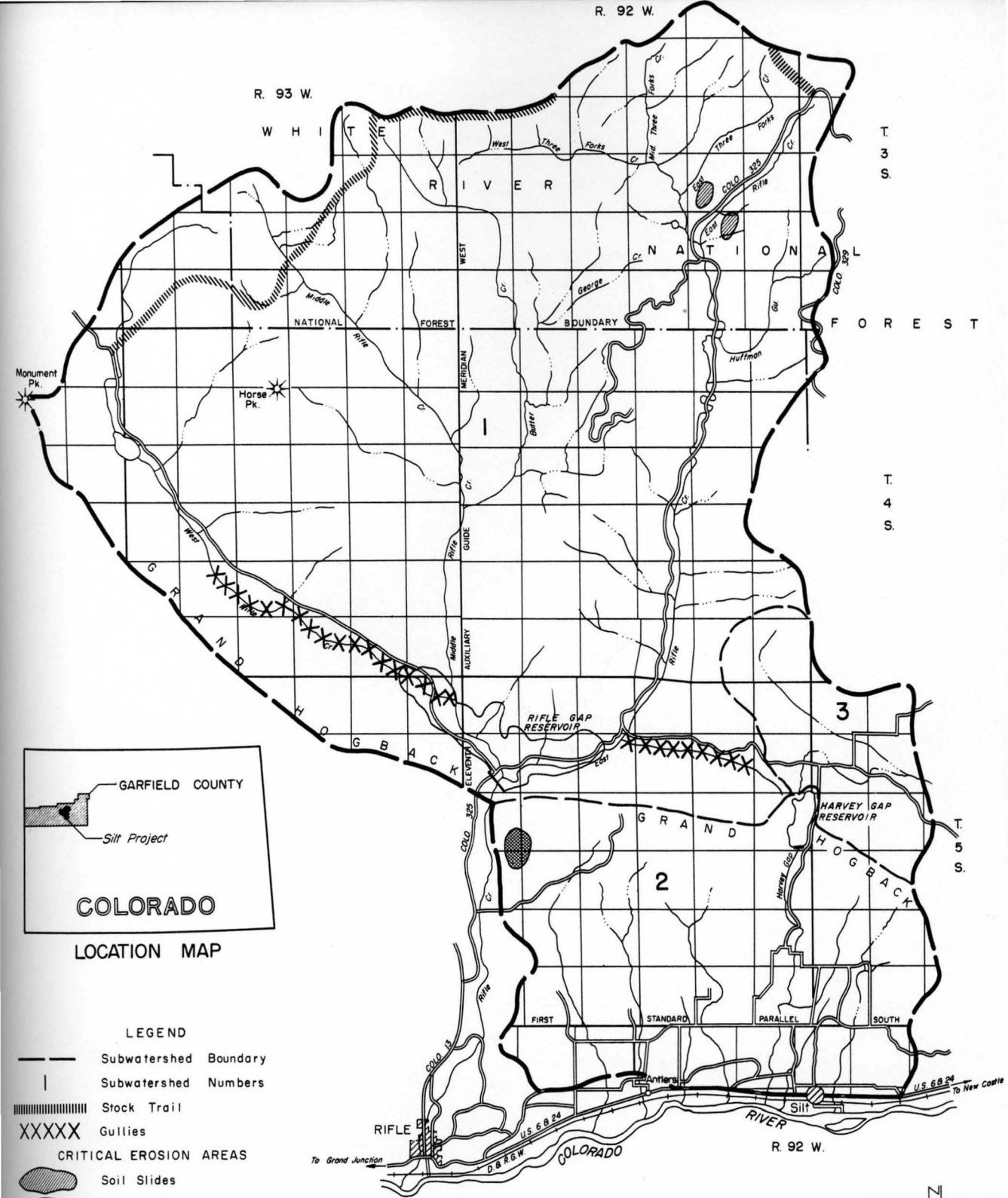
Construction and operation of this project will have no significant effect upon nonfederal forest and forest-range lands. Flooding of the privately owned ranch lands will not affect any grazing permits or grazing use of national forest lands. The forest-based economy will not be affected. Recreational use, including boating and picnicking, will occur on and around the reservoir and will contribute to the local economy.

Summary and Findings

1. The proposed Rifle Gap Dam, Reservoir, Canals, and Ditches are outside the boundary of the White River National Forest.

2. As far as can be foreseen at this time, the project will not impair or affect any existing facility or service on national forest lands.

3. There will be no appreciable losses or gains in resource values now provided by forest and forest-range lands of national forest or nonfederal ownerships.



SILT PROJECT WATERSHED

GARFIELD COUNTY, COLORADO

JUNE 1961

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-3396

7-0-19417-L

CHAPTER IV

RELATIONSHIP OF WATERSHED CONDITIONS TO THE SILT PROJECT

Watershed conditions covered in this report are common to most irrigation projects. They do not materially affect feasibility of the project. However, improvement of watershed conditions will extend the life of the project and reduce operating difficulties and maintenance expenses. These conditions are pointed out here so local, state and federal agencies which deal with watershed lands can orient their programs to the solution of these problems.

Location and Size

The watershed affecting the Silt project is northeast of the town of Rifle in Garfield County, Colorado. The watershed is bounded on the west by the Grand Hogback, on the north by the White River drainage divide, on the east by the ridge between East Rifle Creek and Elk Creek, and on the south by U. S. Highway 6-24 (see map). There are about 10 square miles on the Elk Creek drainage east and north of Harvey Gap Reservoir included because it contains project lands.

West Rifle, Middle Rifle and East Rifle Creeks are the main streams in the watershed. The watershed is comprised of 112,000 acres, or 175 square miles, and is divided into three subwatersheds as shown in table 22.

Table 22. - Subwatersheds, Silt project

Subwatershed number	Drainages	Square miles
1	Above Rifle Gap Reservoir	130
2	Area including project land and facilities draining south from Grand Hogback or through Harvey Gap Reservoir	35
3	That area in Dry Elk Valley above Harvey Gap Reservoir that drains into Elk Creek	10
Total		175

Watershed Characteristics

Topography and Geology

West Rifle, Middle Rifle and East Rifle Creeks make up the triangular shaped watershed that drains into the reservoir proper. Elevation ranges from about 5,800 feet at the confluence of the creeks, to about 9,200 feet on the northwest and northeast summit lands. A large, gently rolling table land characterizes the upper part. Stream canyons dissect the area, becoming steep and broken at lower elevations. The remainder of the watershed comprises those lands lying south of the Grand Hogback to the Cactus Valley Canal north of Highway 6-24 and the west portion of Dry Elk Valley north of Harvey Gap Reservoir.

Thick beds of Pennsylvanian Age limestone characterize the upper watershed. Sandstones and shales (mostly Permian formations), dominate the eastern and southern portion. Mancos shale outcrops follow West Rifle Creek to the head and make up a sizable area in the southeast corner of the watershed. Dakota and Jurasic sandstone and shale lies above the Mancos and occurs in the same area at slightly higher elevations. The Grand Hogback (Mesa Verde Age), flanks the west side of the watershed and divides the project land between Dry Elk Valley and Harvey Mesa.

Valley floors are generally narrow. Near the reservoir pool area and for short distances up West Rifle and East Rifle Creeks, alluvial bottoms are wide enough to cultivate. The alluvial soils range from loam to clay loam and are derived from reworked sandstone and shale. The Harvey Mesa area consists of wind-lain and alluvial soils overlying Wasatch shales and sandstone. Dry Elk Valley is a small upland valley of reworked loam and clay soil which runs eastward from Harvey Gap Reservoir.

Precipitation and Runoff

Annual precipitation varies from about eleven inches on the project's irrigated lands to nearly thirty inches in the higher mountain areas. Approximately fifty percent of the precipitation is received as snow in the winter. June is the driest month. Some high-intensity rainstorms occur in July, August and September.

Peak streamflows can be expected from snowmelt during April and May, and from high intensity rains in July, August and September.

Vegetative Cover

Vegetative cover for the watershed, by principal type, is shown in table 23.

Table 23. - Vegetative types, watershed area, Silt project

Type	Square miles
Conifer timber	5
Aspen	20
Oakbrush	40
Other mountain brush	20
Sagebrush	20
Grass	23
Pinon juniper	30
Subtotal	158
Naturally barren	4
Cultivated land	13
Total	175

Soils and Erosion

Drainages are characterized by steep slopes with a thin soil cover. Deeper soil is found in the narrow valley bottoms of alluvial deposits and of the upper park areas. The main streams have moderate gradients while the feeder tributaries are steeper. Lands with poor and very poor vegetative conditions are losing soil.

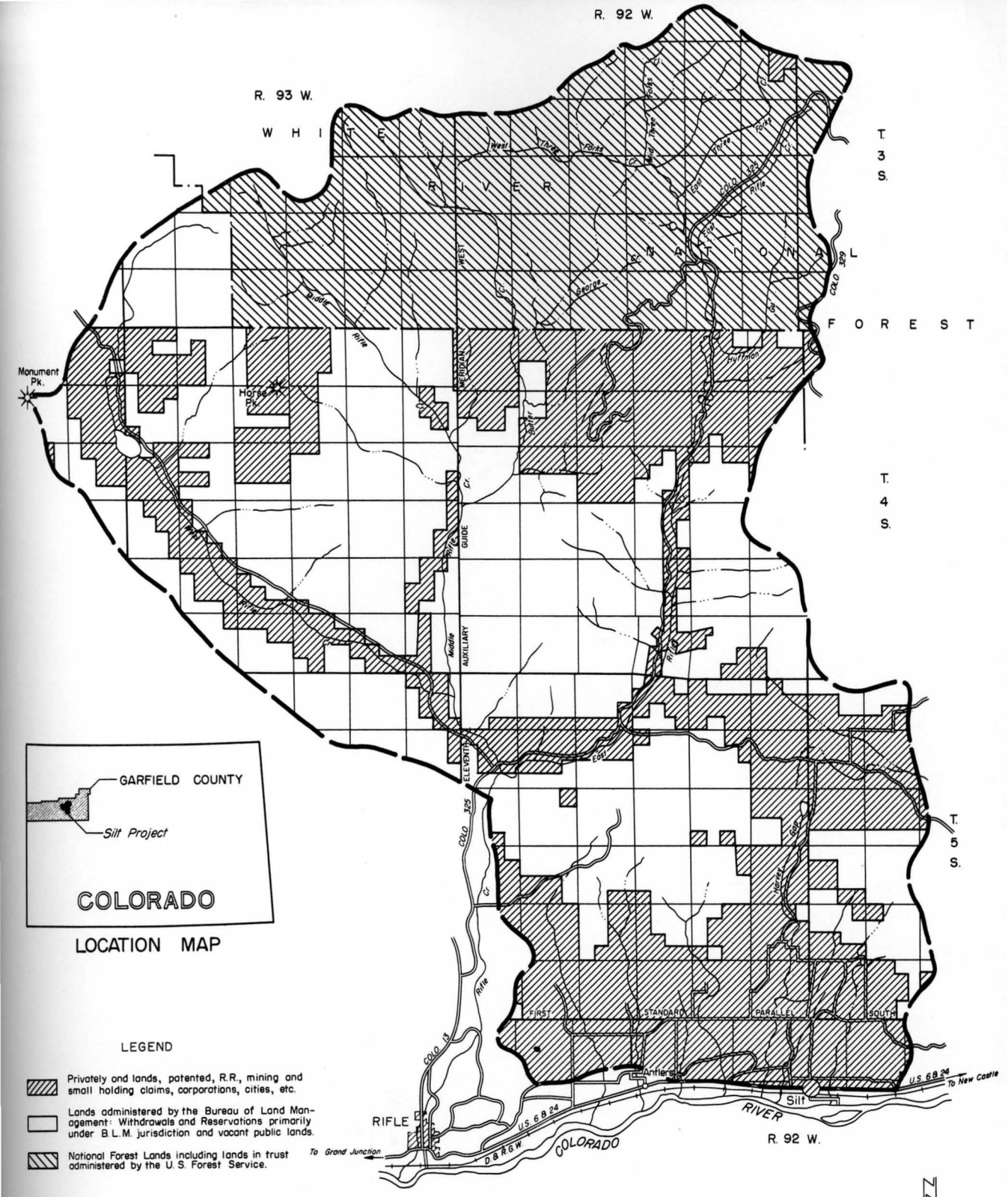
Upper elevation zones have good vegetative cover with practically no erosion except for roads, trails and a stock driveway. In East Rifle Creek and its tributaries, many inactive beaver ponds are deteriorating and releasing the accumulated sediment.

There is an intermediate brush zone type, predominantly oak, which has deep soils, steep slopes, and slight erosion. Most of the lower elevation zones are classified as wild lands having raw, highly erosive soils on steep slopes with a sparse cover of pinon and juniper.

Valley floors above the reservoir site have been deeply gullied. Erosion at the present time is active on all meandering sections of these gullies; however, some sections appear to be in the process of stabilization. Most of these areas are privately owned and the land use is dry and irrigated farming. Improper use and disposal of irrigation water continues to aggravate the problem.

Land Use

A major portion of the upper watershed is federally owned and is used for



LAND STATUS MAP

SILT PROJECT WATERSHED

GARFIELD COUNTY, COLORADO

JUNE 1961

Z-0-19418-1

grazing of sheep, cattle, and big game animals. Timber production, wildlife, and recreation are other uses of this area. Lower elevations are about equally divided between privately owned land and public domain. About one-fourth of the privately owned land is irrigated. A very small percentage of land is being used for dry farming. Nearly three-fourths of the area is used for grazing by domestic livestock and big game animals.

Mining and oil explorations are being conducted within the watershed area. If these explorations lead to development of mineral and oil resources, watershed conditions will be affected.

Land Ownership

Land ownership is shown in table 24.

Table 24. - Land ownership, watershed area, Silt project

Class of ownership	Square miles	Percent of total
Federal land		
Public domain	65	37
National forest land	45	26
Private	65	37
Total	175	100

Watershed Problems

Subwatershed No. 1 (The area above the Rifle Gap Dam Site)

Sediment which may be carried into the reservoir by the major drainages is the most significant problem in this subwatershed.

Contributing factors to the sedimentation problem are: (1) Erosion of the Mancos shale areas, (2) sheet erosion where proper grazing use and distribution are not being practiced, (3) farming practices on lands near the severely gullied areas on the lower drainages, (4) roads, trails, driveways, drainages and recreation use, (5) loss of protective cover by fire, (6) abandoned beaver dams that break and contribute accumulated soil material to the stream.

Subwatersheds No. 2 and 3 (That portion east and south of the Rifle Gap Reservoir including the project irrigated lands)

Significant watershed problems in this area are flood water and sediment

that are carried into the irrigation systems. Factors aggravating these conditions are the erosive types of soils, steep sparsely vegetated slopes, and the occurrence of thunderstorms and rapidly melting snow.

Land Treatment

Land treatment measures that will help to solve these watershed problems are listed in table 25.

Table 25. - Land treatment, Silt project watershed

Treatment	Unit	Estimated Amounts by Land Ownership 1/		
		Private Lands	Bureau of Land Mgt.	National Forest Lands
Proper use of range resource				
A. Domestic livestock	Acres	10,000	10,000	4,000
B. Big game	Acres	28,700	41,600	28,800
Stockwater Development	Number	30	25	10
Gully Control (Erosion control dams)	Number	130	300	
Irrigated Land Practices	Acres	12,900		
Fences for Grazing Control	Miles	10	15	20
Brush and Weed Control	Acres	3,000	1,000	4,000
Range Reseeding	Acres	1,000	750	
Relocation, betterment and maintenance of roads, trails, and stock driveways				
a. Roads	Miles	20	35	30
b. Trails	Miles		10	5
c. Driveways	Miles	3	3	7
Proper beaver management	Mile of Stream			7
Fire Protection	Acres	(All ownerships - total 112,000)		

1/ Estimates prepared by Soil Conservation Service, Bureau of Land Management and Forest Service.

Federal Lands

National Forest Lands

Protection and conservation measures on national forest lands can be accomplished by proper land use and proper management of all resources. The greater amount of protection will be accomplished through proper management of domestic livestock and big game. Grazing adjustments of domestic livestock and big game will be made in accordance with range analysis surveys.

Beaver management plans are in the process of preparation in cooperation with the U. S. Fish and Wildlife Service and the Colorado Game and Fish Department. Upon completion of this plan, an action program will be initiated to bring the population of beaver into balance with the resources and watershed requirements.

The Forest Service is in the process of preparing a multiple use land management plan for the Rifle Ranger District, which includes the watershed area. This plan when completed will provide direction and policy for proper land management within the watershed.

Location of roads, trails and stock driveways within the national forest should be given careful consideration to minimize accelerated erosion.

Public Domain

The greater portion of public domain lands are in the intermediate and lower elevation zones. The lands in the intermediate zone are predominantly used for grazing of livestock by operators of adjoining private lands. The Bureau of Land Management will complete range analysis studies soon. Many small erosion control dams are being planned in gullies in this area.

Lands in the lower elevation zones are wild lands with such highly erosive soil, steep slopes and sparse cover, that very little can be done for improvement. Lands in the project area which are below these wild lands will need to be protected from flooding and deposition. Grazing-use adjustments will be made wherever necessary to provide watershed protection.

Private Land

The Soil Conservation Service, through the Bookcliff Soil Conservation District, has assisted in the planning and installation of conservation treatment in the area. This treatment includes improvement of irrigation systems, land leveling and drainage on irrigated lands within farm and ranch units. Treatment on rangelands has not been extensive. Range practices that have been installed are principally stockwater developments, grass management, and small acreages of range seeding.

Many of the farms or ranches within the area have both irrigated and rangelands within their units. The application of conservation work has been

somewhat limited due to deficient irrigation water and a low financial return from farm and ranch operations. About one-third of the landowners within the area have signed cooperative agreements with the Bookcliff Conservation District. Soil Conservation Service technicians have worked with ditch companies and water users in planning and application of irrigation improvements. Much conservation and improvement work remains to be done. As the economic conditions of the area improve, the conservation activities will accelerate.

Flood Prevention Structural Measures

The high and intermediate elevation zones do not pose any general flood problems to the project. Due to this situation no large flood control structures are required. Wherever critical areas do exist, improved management and use, plus related measures such as fencing, revegetation and small structures, will correct erosion problems.

The lower elevation zone has steep slopes, raw soils and sparse vegetation. Flood prevention structures will be ineffective under these conditions. The amount of flood water will be small due to short slopes and low rainfall.

Canals serving project lands will be affected by runoff from lands in this lower elevation zone. One shale area above a reach of the proposed Davie Ditch is quite critical. Ditch and canal design should provide protection from runoff from these lands.

Irrigation Aspects

Irrigated lands of the project are interspersed between natural drainageways through the project. Most of these drainageways are well channelized and will contain most flood flows. There will be some bank cutting along edges of cultivated fields that will need attention. The installation of efficient farm irrigation systems, improved irrigation water management and proper disposal of waste water will reduce bank cutting where fields are next to deep channels. Some drainageways may require head stabilization and erosion control structures to protect them from cutting. Proper use and disposal of irrigation water may alleviate some of the subsurface drainage problems that exist within the project area. Assistance is available from Federal, State and local agencies to install necessary irrigation improvement, erosion control, and drainage practices.

Findings

Watershed conditions do not pose a flood hazard to the project. They do produce sediment which will be deposited in the project reservoir and will cause canal cleaning problems. The Rifle Gap Reservoir is designed to provide storage for 100 years of sediment accumulation without encroachment on the active irrigation capacity. Any reduction in the sediment will lengthen this period. Most of the sediment comes from problem areas which can be improved by watershed treatment measures. Watershed treatment

can be accomplished under programs of federal land administering agencies and by private landowners with assistance normally furnished by Federal and State agencies through Soil Conservation Districts. There should be greater emphasis by all interested parties on proper land management to improve watershed conditions and reduce the sediment problem.

CHAPTER V

ACTIVITIES OF THE U. S. DEPARTMENT OF AGRICULTURE PARTICULARLY AFFECTED BY THE SILT PROJECT

Introduction

The U. S. Department of Agriculture and the Colorado State University are carrying out a number of agricultural activities in Garfield County, Colorado. With the increased agricultural activity that will accompany the proposed development of the Silt project, these programs will need to be accelerated.

Agricultural Extension Education and Information

The Colorado Cooperative Extension Service maintains an office at Glenwood Springs. The services of a resident Extension Agent, Assistant Extension Agent, Home Demonstration Agent, and the nonresident specialists located on the campus at Fort Collins are available to farmers in the project area.

Additional information and educational services will be required. This is particularly true in connection with any expansion in the dairy and livestock industry. Some additional information and education in connection with better irrigation water management and pasture development will also be needed.

Technical Assistance

The triangular shaped watershed of the Silt project lies within the Bookcliff Soil Conservation District. It includes about 40,000 acres of private lands. The Soil Conservation Service, Glenwood Springs Work Unit, includes the area of the Bookcliff Soil Conservation District. A soil conservationist is resident at Rifle. The unit conservationist at Glenwood Springs furnishes supervision and assistance in soils, engineering, agronomy, woodland and range management. Close working arrangements are maintained with the Forest Service and the Bureau of Land Management.

Additional technical services and on-site assistance from Soil Conservation Service technicians will be required in the planning and application of conservation practices, which will include land leveling, improvement of farm irrigation systems, improved water management, grass management and soil fertility management.

Stream flow forecasts for seasonal flows of Rifle Creek are recognized in the hydrologic study as necessary to the successful management and operation of the Silt project. Installation of two new snow survey courses and a soil moisture station would probably suffice to provide the essential forecast data. Snow-cat or other over-snow transportation would be required to obtain snow course readings. The Soil Conservation Service could provide installation and subsequent operation in accordance

with customary cooperative arrangements between the Service and the Bureau of Reclamation or other interests. Initiation should be at the earliest possible time, since several years operations will be necessary before reliable forecasts can be made.

Farm Credit and Financing

With the completion of the Silt project, it is anticipated that the demand for Farmers Home Administration services will be increased. This demand will largely be for loans of the soil and water conservation and operating types. Some farm-housing type loans will probably also be requested.

Loans will be used for the establishment of conservation measures such as the enlargement and repair of canal and ditch systems, construction of new ditches, land leveling and other related practices.

The above-mentioned farm improvement measures and farm adjustments will, in many cases, require long-term credit that cannot be supplied by local commercial credit sources. Farmers Home Administration credit programs will be called upon to provide this needed assistance.

Cost-Sharing for Conservation Measures

Completion of the Silt project will assure an adequate and stable supply of irrigation water to the farms under the project, with subsequent improvement of both rural and urban economy in the community.

The extension of existing laterals and relocation of others will require extensive reorganization of many farm systems to make efficient and economical use of the water.

The Garfield County Agricultural Stabilization and Conservation Committee, whose office is located at Glenwood Springs, offers cost-sharing for needed soil and water conserving measures through the Agricultural Conservation Program to participating farmers and ranches. Projects requiring cooperative effort on the part of groups of farmers acting as single interests may apply for assistance on such projects through the local ASC Committee.

National Forest Lands

The proposed project features and project lands are all outside the exterior boundary of the White River National Forest. The proposed Rifle Gap Dam and Reservoir will attract visitors to the area and many of these will seek recreational opportunities on adjacent national forest lands.

Restoration, proper management of timber and plant cover, and stabilization of the soil mantle are prime objectives of the White River National Forest. Programs aimed at these objectives are now being carried out and are achieving good results. Construction of the project will add further impetus to early accomplishment of the range improvement, range management, and timber

harvesting aspects of these programs. These activities will aid the general watershed protection objective of reducing floodwater and sediment hazards to project installations and reduce their maintenance.

Research Needs

A comprehensive report covering general research needs for the area of the Colorado River Storage Project will be developed by representatives of the U. S. Department of Agriculture research agencies, state agricultural colleges, and experiment stations. As far as the Silt project is concerned, there appear to be no research needs peculiar to this project that would not be covered in the above-mentioned report.

TECHNICAL SUPPLEMENT

to

A report of reappraisal of direct agricultural benefits and project impacts

Silt Project
Colorado River Storage Project

A Reference of Basic Data, Computation and Assumptions

U. S. Department of Agriculture
Salt Lake City, Utah - July 1961

INTRODUCTION

The material contained in this technical supplement is intended to assist personnel in the Department of Agriculture, Colorado State University, Bureau of Reclamation and others in analyzing the "Report of Reappraisal of Direct Agricultural Benefits and Project Impacts" for the Silt project, State of Colorado, Colorado River Storage Project.

It includes basic field data collected from the project area, together with assumptions, tabulations, worksheets, and other work data used by Field Party personnel in preparing the report.

This material appears in the same general sequence as the report proper and is arranged in the following sections:

1. Soils
2. Engineering
3. Economics

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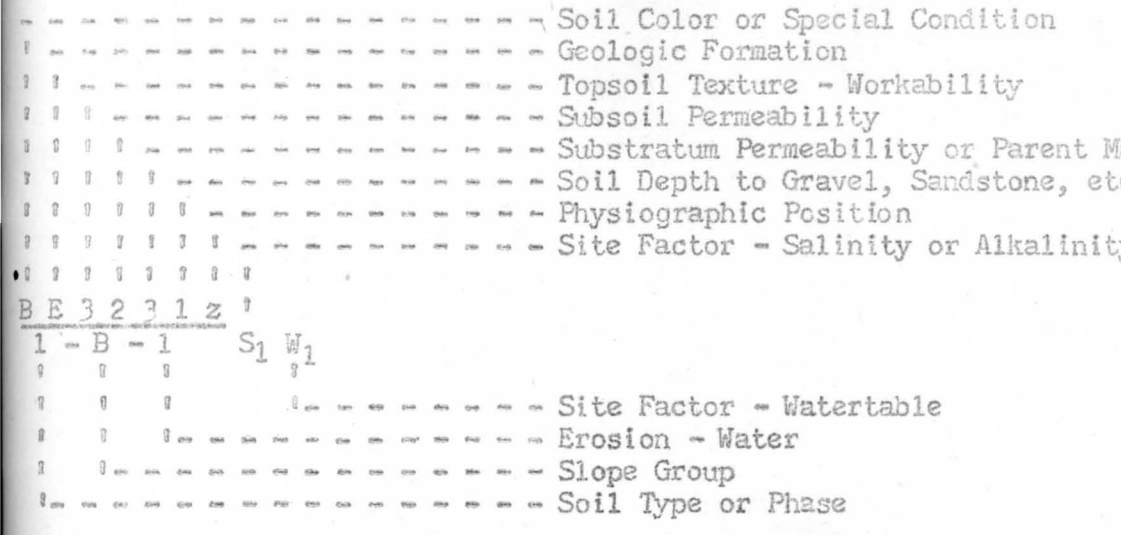
SOILS SECTION

INTERPRETATION OF SOIL SYMBOLS ON SOIL MAPS



Topsoil Texture	Subsoil Permeability	Substratum Permeability	Depth
1-Heavy	1-Very slowly perm.	1-Very slowly permeable	1-Deep-more than 36"
2-Moderately Heavy	2-Slowly permeable	3-Moderately permeable	2-Moderately deep 20-36"
3-Medium	3-Moderately perm.	5-Very rapidly permeable	3-Shallow 10-20"
4-Moderately Light	4-Rapidly permeable		
5-Light	5-Very rapidly perm.		

SOIL COLOR OR SPECIAL CONDITION

B - Brown Soils
C - Dark Brown Soils
F - Gray Wooded Soils
H - Very Dark Brown Soils
P - Very Dark Brown Soils with thick subsoils
S - Soils of Low Organic Matter
W - Swamp Soils gleyed
Z - Alkali Soils
m - Mottled - Used in sub-position following color to indicate mottling due to prolonged irrigation.

GEOLOGIC FORMATIONS

A - Acid igneous undifferentiated
B - Basic igneous undifferentiated
C - Mancos shale
U - Fort Union undifferentiated
V - Lance undifferentiated
D - Loess undifferentiated
E - Wasatch shale and sandstone undifferentiated
G - Gypsum beds
F - Green River undifferentiated
I - Iles undifferentiated
J - Jurasic undifferentiated
K - Dakota Sandstone
L - Lewis Shale
M - Mesa Verde undifferentiated
N - Permian and Pennsylvanian undifferentiated
O - Mixed undifferentiated
P - Browns Park
Q - Mississippian undifferentiated
W - Williams Fork undifferentiated
T - Peat
R - Arkosic

PARENT MATERIALS

A - Acid igneous
B - Basic igneous
C - Light textured shale
D - Loess
E - Heavy textured shale
F - Limestone
G - Gypsum
H - Cobble or stones in medium textured materials
J - Gravel in light textured materials
K - Cobble cemented in lime
L - Soft limy materials
M - Hard sandstone
N - Soft sandstone
P - Clean sand
R - Arkosic
T - Peat
Z - Use where soils are alkali and color needs to be shown

PHYSIOGRAPHIC POSITION

z - Bottomland x - Swales and depressed areas y - Footslope

SLOPE

Group	% Irrig.	% Dryland	% Range
A-Nearly level	0-1	0-1	0-1
B-Gently sloping	1-3	1-3	1-3
C-Sloping to gently rolling	3-6	3-6	3-6
D-Rolling	6-12	6-12	6-12
E-Steep hilly	12-25	12-25	12-25
F-Very steep	25-65	25-65	25-65
G-Very steep	65+	65+	65+

EROSION

*1-Slight-Topsoil intact or over six inches thick if cultivated
2-Moderate-Topsoil and subsoil intermixed-cultivated land only
3-Severe-Topsoil plus subsoil very thin or absent-cultivated land only
3W-Severe-Topsoil plus subsoil very thin or absent-rangeland only -recent deposition
W-Geologic-Use on barren geologic materials only-Class VIII
- Wind Accumulations (label as needed)
- Gullies Over 2' Deep - Active
- Streambank Cutting
- Eroding Ditch

*Erosion severity based on thickness of topsoil or topsoil plus subsoil remaining.

*-Miscellaneous Land Types-

Rg - Severely gullied land - Class VI
Rgw- Raw gullied areas - Class VIII
Rv - Riverwash - Class VIII
Rx - 60% of surface covered with loose rock fragments, stones, or cobbles - Class VIII

*Used in place of soil survey symbol

SPECIAL FACTORS

	Salinity	Alkalinity	Watertable	Overflow	Stones	Cobble
Slight effect	S_1	A_1	W_1	F_1	x_1	$(x)_1$
Moderate effect	S_3	A_2	W_3			
Severe effect	S_4	A_3	W_4	F_3	x_2	$(x)_2$

SILT PROJECT
SOILS BY EVALUATION AREAS

Evaluation Area "A" (Harvey Mesa)

Soil	Slope	Special Factors	L.C.U.	Acres
BC2221	C	A1W1	IIIes1	7
2221	C	A1W3	IIIes1	2
3331	C		IIIe	10
BD3231	B		IIe	440
32H1	B		IIe	20
3331	B		IIe	7
3331	B	A1W3	IIe	16
3231	C		IIIe	715
3231	C	W1	IIIe	4
3231	C	A1W3	IIIe	10
32C1	C		IIIe	191
32H1	C		IIIe	221
32H2	C		IIIe	2
3331	C		IIIe	136
BE2221	B	A1W1	IIIs1	13
3231	B		IIes1	19
3231	B	A1W1	IIes	6
3231	C		IIIes	13
3331	B		IIe1s1	36
3331	B	A1W3	IIe1s1	7
3331	C	A1W1	IIIes	15
3331	C	A1W3	IIIes	10
BM3231	C		IIIe	35
32H1	C		IIIe	114
32H2	C		IIIe	175
33H3	C		IIIe	35
BN3231	C		IIIe	9
BO3231	A		IIc	48
3231	C		IIIe	75
3231	C	A1W3	IIIe	9
32H1	C		IIIe	28
32H2	C		IIIe	12
3331	A	A3W4	IIs	10
3331	C		IIIe	17
3331	C	A1W1	IIIe	8
CD3231	C		IIIe	77
CO3331	B		IIe	10
ZE2221	B	A3W4	IIIs3	2
2221	C		IIIes3	10
2221	C	W1	IIIes3	14
2221	C	A1W1	IIIes3	24
2221	C	A1W3	IIIes3	8
3231	B	A3W3	IIIs2	3
3331	B		IIes2	95
3331	B	A1W1	IIes2	202
3331	B	A1W3	IIIes2	21
3331	B	A3W3	IIIs2	80
3331	B	A3W4	IIIs2	30
3331	C		IIIes2	80
3331	C	A1W1	IIIes2	76
3331	C	A1W3	IIIes2	6
33H1	C		IIIes2	5
	Total Acres			3,209

Evaluation Area "B" (Harvey Mesa)

Soil	Slope	Special Factors	L.C.U.	Acres
BC22H2	D		IVe2	4
BD3231	D		IVe1	298
32H1	D		IVe1	49
3331	D		IVe1	531
33H1	D		IVe1	29
33H2	D		IVe1	16
33H3	D	X1	IVeh	16
BE2221	D		IVe2	2
2231	D		IVe2	18
3231	D		IVe	20
3331	D		IVe	20
33H1	D		IVe	19
33H3	D		IVe	5
BM32C1	D		IVe1	19
32H2	C	X1	IVsh	55
33H3	C	X1	IVsh	48
33H3	D		IVe1	4
33H3	D	X1	IVeh	132
3H	C		IVs5	3
BO3231	D		IVe1	15
32H1	D		IVe1	13
33H1	D		IVe1	20
33H1	D	A1	IVe1	6
33H3	D	X1	IVeh	24
3H	C		IVs5	16
ZD3231	D		IVeh	13
3331	D	A1W1	IVeh	9
ZE2221	C	A3W4	IVs3	8
3331	C	A3W4	IVs2	7
33H1	C	F1	IVs2	14
3331	D		IVeh	7
33H1	D		IVeh	22
	Total Acres			1,462

Evaluation Area "C" (Davie Mesa)

Soil	Slope	Special Factors	L.C.U.	Acres
BD3231	B		IIe	280
3231	C		IIIe	216
32H2	C		IIIe	17
3331	C		IIIe	11
ZE3331	B		IIes2	127
33H1	C		IIIes2	6
	Total Acres			657

Evaluation Area "D" (Davie Mesa)

Soil	Slope	Special Factors	L.C.U.	Acres
BD3231	D		IVe1	10
3331	D		IVe1	54
33H2	D		IVe1	5
BE3331	D		IVe	77
33H1	D		IVe	4
BO33H3	D		IVe	20
ZE3331	D	A1	IVeh	45
	Total Acres			215

Evaluation Area "E" (Dry Elk Valley Irrigated)

Soil	Slope	Special Factors	L.C.U.	Acres
BC2221	C		IIIes1	38
BD3231	C		IIIe	37
3331	C		IIIe	12
BN3231	C		IIIe	12
BO2221	B		IIIs	10
CD3231	C		IIIe	16
CO3331	B		IIe	21
3331	C		IIIe	7
3331	C	W2	IIIe	14
WA3331	C	W4	IIIe	14
	Total Acres			181

Evaluation Area "F" (Dry Elk Valley Irrigated)

Soil	Slope	Special Factors	L.C.U.	Acres
BD3331	D		IVe1	12
33C1	D		IVe1	15
33K2	D	X1	IVeh	6
BJ2221	D		IVe2	3
BN3331	D		IVe1	3
BO2121	B		IVs	5
2221	D		IVe2	6
32H1	D		IVe1	24
32H2	D		IVe1	30
32H3	D	X1	IVeh	12
33H1	D		IVe1	11
CD3231	D		IVe1	18
CO2221	C	A3W4	IVs3	27
3331	B	X1	IVsh	5
	Total Acres			177

Evaluation Area "G" (Dry Elk Valley New Land)

Soil	Slope	Special Factors	L.C.U.	Acres
BC2221	C		IIIes1	67
BD3231	C		IIIe	97
32H1	C		IIIe	57
BO2221	B		IIIs	39
32H1	B		IIe	20
32H1	C		IIIe	17
CD3231	C		IIIe	8
CO3231	B		IIe	36
	Total Acres			341

Evaluation Area "H" (Dry Elk Valley New Land)

Soil	Slope	Special Factors	L.C.U.	Acres
BC2121	C		IVs1	92
22H2	D		IVe2	28
22H2	D	X1	IVe2	10
BD3231	D		IVe1	102
32H1	D		IVe1	32
32H2	D		IVe1	21
32H3	D		IVeh	6
33H1	D		IVe1	11
33K3	D		IVeh	35
BO3331	D		IVe1	9
	Total Acres			346

PROJECT TOTAL 6,597 ACRES

BC 2121 The BC 2121 mapping unit is characterized by weak to moderately developed soils occurring on gently sloping topography in upland valley areas. Elevation varies from 5500 to 6500 feet, with rainfall of about 12 to 15 inches. Soil of this unit is developed on heavy reworked materials derived from the Mancos formation.

In some cases, sandstone strata give rise to a stony condition in the soil profile.

Soil Profile:

A_1	0 - 2"	Very dark grayish-brown (10YR 3.5/2 moist and crushed) clay loam with weak coarse platy structure that breaks into weak medium crumb; hard when dry, moderately firm when moist; slightly calcareous with an abrupt smooth boundary.
AB	2 -11"	Gray brown that changes to very dark grayish-brown when crushed (10YR 5/2 moist) heavy clay loam; moderate medium prismatic structure that breaks into weak fine angular blocky aggregate that is hard when dry, moderately firm when moist; slightly calcareous, with nearly continuous clay skins; clear smooth boundary.
B_2	20-30"	Dark grayish brown (10YR 4/2 moist and crushed) light clay; weak medium prismatic that breaks into fine subangular blocky; very hard when dry, very firm when moist; slightly calcareous with a pH of 8.4; nearly continous clay skin; gradual smooth boundary.
B_{3ca}	30-52"	Dark grayish-brown (10YR 4/2 moist) heavy clay; hard when dry, moderately firm when moist; violently calcareous; visible lime in cracks and voids; pH of 8.5; thin patchy clay skin; gradual smooth boundary.
C_{ca}	52-70"	Dark grayish-brown (10YR 4/2 moist and crushed) clay with weak fine angular blocky structure; hard when dry, firm when moist; violently calcareous; visible lime, pH 8.5; thin patchy clay skins; gradual smooth boundary.
C	70+	Dark brown to brown (10YR 4/3 moist and crushed) clay; massive; hard when dry; calcareous; no visible lime; no clay skins.

Range in Characteristics

Soil development in this mapping unit varies from weak to moderate with hue 10YR to hue 2.5YR range. Texture ranges from light clay loams to clay in the surface, and from clay loam to clay in the subsoil. Top soils are

thin, often being less than 4 inches and sometimes as thin as 2 inches; clay skins are found almost to the surface. The parent materials show a high pH and probably contain sodium salts. The upper part of the profile has a pH of less than 8.3 and shows no slick spots. The developed soil shows no sign of black alkali. Closely related to and often included within this mapping unit are the following taxonomic units: BC 22H1, BC 22H2, BC 2111, BC 2221, BC 21H1, BC 21H2.

Topography

Gently sloping to moderately sloping upland valley and side slopes.

Drainage

Surface drainage is slow to moderately slow; internal drainage is very slow due to heavy texture of the solum.

Vegetation

In its native state, vegetation consists of sagebrush and native grasses, especially western wheatgrass. As observed in this area, very little greasewood occurs on this mapping unit.

Use

To date, very little irrigation water has been available for this type. Where limited irrigation has been used, fair yields of alfalfa and small grain have been grown. No evidence of seep or alkali has been noticed.

Distribution

This soil is found wherever exposures of Mancos shale occur in a 12 to 20 inch precipitation zone.

Location

This soil was described $\frac{1}{4}$ mile S of NE corner of Sec. 7, T5S, R91W, Garfield County.

BC 2221 Mapping unit BC 2221 is characterized by slightly to moderately developed soils on foot slope alluvium derived from reworked Mancos shale. It occurs in a 12-15" precipitation zone, at an elevation of 6000 feet. It generally occurs on moderately to steeply sloping topography that lies adjacent to shallow exposures of Mancos shale. Soil horizons are moderately to slightly defined with nearly continuous clay skins in the subsoil and visible lime accumulation in the B_{3ca} zone.

Soil Profile

A_p	0 - 2"	Dark brown to brown (10YR 3.5/2 - 4/3 crushed, moist) heavy clay loam with weak coarse platy structure that breaks into weak fine crumb; firm when moist; slightly calcareous with thin patchy clay skins; boundary is clear and smooth.
AB	2 - 7"	Very dark gray brown to dark gray brown (10YR 3.5/2 crushed, moist) heavy clay loam with weak coarse prismatic structure that breaks into weak medium angular blocky; firm when moist; slightly calcareous; thin patchy clay skins; clear smooth boundary.
B_{21}	7 -12"	Dark brown to brown (10YR 3/3.5 - 4/3 crushed, moist) very heavy clay loam; has moderate coarse prismatic structure that breaks into moderate subangular blocky aggregate; firm when moist; strongly calcareous, pH8.2; nearly continuous clay skins; clear smooth boundary.
B_{22}	12-20"	Dark grayish brown to brown (10YR 3.5/3 crushes to 4/2.5 moist) heavy clay loam; moderate medium subangular blocky; firm when moist; strongly calcareous; continuous clay skins; clear smooth boundary.
B_{23}	20-33"	Dark brown to brown (10YR 4/2 that crushes to 4/3 moist) clay loam, weak medium prismatic structure that breaks into weak fine subangular blocky; firm when moist; strongly calcareous; nearly continuous clay skins; gradual smooth boundary.
B_{3ca}	33-45"	Very dark grayish brown to dark brown (10YR 3/4 crushes to 3/3 moist) clay loam with weak fine angular blocky structure; firm when moist; violently calcareous; visible lime; gradual smooth boundary.
C	45-60"	Dark brown to brown (10YR 4/3 that crushes to 4.5/3 moist) loam friable when moist; violently calcareous, pH 8.4; lime is visible in splotches and streaks.

Range in Characteristics

Due to the foot slope position, a wide variation in degree of soil development exists. The soil horizons are very weak and immature at the top of the

slopes and moderately mature at the foot of slope. Depth also varies for the same reason. Lighter textures are often found near the top of the slope with heavier textures at the bottom of the slope. In some cases, sandstone rock fragments are intermixed with the soil. Taxonomic units that may occur in this mapping unit other than the one herein described are 2111, 22H1, 2121 and in some cases BC 3331 may be included. Color ranges from hue 10YR to hue 2.5Y.

Topography

Topography ranges from moderately steep to steep foot slopes that lie adjacent to mountain exposures of Mancos shale and associated members of Mesa Verde formation.

Drainage

Internal drainage is generally slow due to heavy texture. Surface runoff is rapid because of steep topography. Under irrigation, wet spots often develop, especially at the lower end of the slope.

Vegetation

Vegetation in this native state consists of sagebrush and western wheatgrass.

Use

Where irrigation water is available, this mapping unit is devoted to the production of hay and small grain. The land is very productive under irrigation.

Distribution

This soil occurs wherever exposure of Mancos shale occurs. Total acreage is small but bodies are widely scattered.

Location

Harvey Gap area - 600 feet N., ½ Mi. W., SW Corner, Sec. 7, T7S, R91W.

BD 32H1 This mapping unit is characterized by moderately developed zonal soil developing on loess in the Brown soil zone of Western Colorado. It has been deposited on broad gently sloping mesas and bench land adjacent to major stream systems. Soil horizons are moderately well defined with top soil that varies from 3 to 6 inches in thickness and subsoils that are approximately the same thickness. A very definite lime enrichment zone is characteristic of this type, occurring somewhere between 15 and 24 inches. Also characteristic of this type is a very definite layer of outwash materials which underlie the mantle of loess, somewhere between 2 and 5 feet. Also included within this mapping unit are the following types: BD 32H2, BD33H2, BD33H1 and BD 3231. The above soils occur in association depending on the depth of the loess mantle and the steepness of the slope. The weakly developed soils follow the slopes near drainage ways and the deeper better developed soils occur on the more gently sloping mesa areas. The parent loess from these types has very definite textural characteristics. The percent of very fine sand and coarse silt is high, making up 60 to 70 percent of the total soil texture. Quantity of clay varies from 15 to 25 percent in the unweathered loess. This mapping unit resembles the correlated mellenthin soil of the Brown zone in Southwestern Colorado, except for the presence of outwash materials in the substratum.

Soil Profile:

A_1	0 - 3"	Dark-reddish (5YR 3/3 moist and crushed) light clay loam; weak platy structure that breaks down to weak fine crumb; moderately friable when moist; non calcareous; thin patchy clear skins; clear smooth boundary.
B_{21}	3 - 7"	Dark reddish-brown to reddish-brown (5YR 3.5/4 moist and crushed) heavy loam with moderate medium subangular blocky structure that breaks into weak fine subangular blocky peds; hard when dry, moderately firm when moist; non calcareous; nearly continuous clay skin; clear smooth boundary.
B_{22}	7 - 11"	Dark reddish-brown (5YR 3.5/3 moist and crushed) heavy loam with moderate medium subangular blocky structure that crushes into weak fine subangular peds; hard when dry, moderately friable when moist; non calcareous; nearly continuous to continuous clay skins; gradual boundary.
B_{3ca}	11-15"	Dark brown to brown (7.5YR 4.5/4 moist and crushed) clay loam with weak fine angular blocky to subangular blocky structure; hard when dry, moderately friable when moist; strongly calcareous with 8.4 pH; thin patchy clay skins; gradual boundary.
C_{ca}	15-29"	Brown (7.5YR 5/4 moist and crushed) loam; moderate medium subangular blocky structure that breaks into weak fine subangular blocky aggregates; dry when hard, moderately

firm when moist; violently calcareous; very definite splotches and streaks of lime; thin patchy clay skins; gradual smooth boundary with an occasional lime coated sandstone fragment; this is the lime zone that accompanies the above solum.

C 29-36" Dark brown to brown (7.5YR 4.5/4 moist and crushed) light clay loam; massive; hard when dry, firm when moist; violently calcareous; definite streaks of lime; gradual smooth boundary.

D 36-60" Pale brown (10YR 6.5/3 crushed and moist) light clay loam; massive; slightly hard when dry, moderately friable when moist; violently calcareous with a pH of 8.4 and carries from 15 to 30 percent outwash sandstone and cobble fragments.

Range in Characteristics

This mapping symbol BD 32H1 covers a wide range of closely related taxinomic units that differ in color from 5YR to 7.5YR; in texture from very fine sandy loam loess to heavy silt loam loess. Soil development varies from slightly to moderately developed top soils and subsoils. The lime zone ranges between 10 and 24 inches. Clay skins are generally thin and patchy, but may be nearly continuous in the better developed types. The mantle of loess over outwash materials varies from 2 to 5 feet. In some cases, outwash gravels have been brought up through the profile by rodent activity and may occur in the profile or on the surface. Soil development in this mapping unit ranges from weak to moderate, depending upon steepness and direction of slope. Soils on southwest facing slopes are generally thin over outwash and show much less development than correspondong types on south and east facing slopes.

Topography

Gently to moderately sloping upland mesas.

Drainage

Surface runoff is slow to moderately rapid, depending on slope. Internal drainage is moderate.

Vegetation

Native vegetation consists of sagebrush and native grasses that grow in a climatic zone of 12 inch precipitation.

Use

Where irrigation water is available, a large portion of this type is utilized for the production of small grain and hay, with some corn, potatoes and sugar beets grown.

Distribution

This type is not as extensive as type BD 3231 but occurs in connection with it around the upper edges of the loess covered uplands.

Location

300 feet North, 70 feet East of the northwest coreer of the SE$\frac{1}{4}$ Sec. 26, T5S, R92W.

BD 3231 Mapping unit is characterized by moderately developed zonal soils developing on loess in the Brown soil zone of Western Colorado. It has been deposited on broad, gently to moderately sloping mesa and bench lands adjacent to major stream systems. Soil horizons are moderately well defined with top soils that vary from 4 to 6 inches in thickness and subsoils that are approximately the same thickness. A very definite lime enrichment zone is characteristic of this type occurring somewhere between 15 and 24 inches.

BD 3331, which occurs on steeper slopes and has less soil development, is associated with this type. Also, BD 32H1 is similar in all respects except the mantle of loess lies over cobbly or stony outwash materials. The parent loess from which these types are derived has very definite textural characteristics. The percentage of very fine sand and coarse silt is high, making up 60 to 70 percent of the total soil mixture. Quantity of clay varies from 15 to 25 percent in the unweathered loess.

This soil type resembles the correlated Mellenthin soil of the Brown soil zone in Southwestern Colorado.

Soil Profile:

A_p	0 - 3"	Dark brown to brown (7.5YR 3.5/3 moist) loam; weak fine granular structure; slightly hard when dry, moderately friable when moist; slightly calcareous with patchy clay skins and a clear boundary.
B_2	3 -11"	Dark reddish-brown to reddish-brown (5YR 3.5/3 moist) light clay loam; weak coarse prismatic structure that breaks into weak medium subangular blocky peds; hard when dry, moderately friable when moist; slightly calcareous, thin patchy clay skins and a clear wavy boundary.
B_{2ca}	11-21"	Brown to light brown (7.5YR 5.5/4 moist) silt loam, moderate fine angular blocky to subangular blocky structure; hard when dry, moderately friable when moist; violently calcareous with weak nearly continuous clay skins and diffuse boundary; the lime is feasible between peds and in old root channels.
C_{ca}	21-26"	Pinkish gray to light brown crushed (7.5YR 6/3 moist) light loam; weak, coarse, subangular blocky structure; slightly hard when dry, moderately friable when moist; violently calcareous; no clay skins and a clear smooth boundary.
C_{ca2}	26-39"	Dark reddish-brown to reddish-brown (5YR 3.5/4 moist) light loam; weak, coarse subangular blocky structure; slightly hard when dry, moderately friable when moist; violently calcareous, with clear wavy boundary.

C_{1b}	39-66"	Light olive brown (2.5Y 5/4 moist and crushed) heavy loam; massive; slightly hard when dry, very friable when moist; violently calcareous with visible lime and gypsum in voids and seams.
	66" +	Is same as layer above except lime and gypsum are well disseminated.

Range in Characteristics

This mapping symbol BD 3231 covers a wide range of closely related taxinomic units that differ in color from 5YR to 7.5YR, in texture from very fine sandy loam loess to heavy silt loam loess. Soil development varies from slightly to moderately developed top soils and subsoils. The lime zone ranges between 10 and 24 inches. Clay skins are generally thin and patchy, but may be nearly continuous in the better developed types.

A very pronounced characteristic of this group of soils is the different colored crotovinas that occur in the lower horizons.

BD 32H1, a closely related type, has very similar soil development in all respects except it overlays stony outwash materials between 3 and 5 feet.

Topography

Gently to moderately sloping upland mesas.

Drainage

Runoff is slow to moderately rapid. Internal drainage is moderate.

Vegetation

Native vegetation consists of sagebrush and native grasses that grow in a climatic zone of 12 inch precipitation.

Use

Where irrigation water is available, a very large percent of this type is utilized for the production of small grain and hay, with some corn, potatoes and sugar beets.

Distribution

This type is widely distributed on the gently sloping mesas along the Colorado River and its tributaries in the 12 to 15 inch precipitation climatic zone.

Type Location

Section 31, T5S, R91W.

BD 3231
C-1

Mapping unit is characterized by moderately developed zonal soil developing on loess in the brown soil zone of Western Colorado. It has been deposited on the broad gently to moderately sloping mesa and bench lands adjacent to major stream systems. Soil horizons are moderately well defined with top soils that vary from 4 to 6 inches in thickness and subsoils that are approximately the same thickness. A very definite lime enrichment zone is characteristic of this type occurring somewhere between 10 and 20 inches. BD 3331 and BD 33K2 occur in conjunction with this soil on steeper slopes adjacent to drainageways. The parent loess from which these types occur is derived from loessial material with a fine sand and coarse silt content of about 60 to 70 percent. Quantity of clay varies from 15 to 25 percent. This soil resembles the Mellenthin of the brown soil zone in Western Colorado. Associated with this soil are BD 33K2, BD 32H1 and BD 32K1.

Soil Profile:

AB	0 - 6"	Dark brown to brown (7.5YR 3.5/2 crushed and moist) loam, weak medium platy that crushes down to weak fine crumb; very friable when moist; slightly calcareous; thin patchy clay skins; clear smooth boundary.
B_2	6 -11"	Dark reddish-brown (5YR 3/2 that crushes down to 3/3) light clay loam; weak medium angular blocky that breaks down to weak fine subangular blocky; friable when moist; strongly calcareous; nearly continuous clay skins; clear smooth boundary; ant sized lime coated gravels.
B_{3ca}	11-17"	Dark reddish-brown to reddish-brown (5YR 4/3 crushes to 3.5/3) loam that breaks into weak fine angular blocky aggregates; friable when moist; strongly calcareous; visible lime; thin patchy clay skins; clear smooth boundary; small amount of lime coated sandstone gravels.
C_{ca}	17-24"	Dark brown to brown (7.5YR 3.5/2 moist) loam; weak medium angular blocky to subangular blocky; friable when moist; violently calcareous; visible lime in cracks and voids; clear smooth boundary; 1 to 2 inch small lime coated sandstone fragments.
B_{2b}	24-38"	Burried soil layer, dark reddish-brown (5.5YR 3/4 moist); moderate medium subangular blocky that breaks into weak fine subangular blocky; firm when moist; violently calcareous; visible lime in cracks and voids; nearly continuous clay skins; clear smooth boundary.
$B_{3ca}b$	38-47"	Burried soil layer; dark reddish-brown to reddish-brown (5YR 3/3 that crushes to 3.5/3) light clay loam; has weak fine subangular blocky structure; firm when moist; violently calcareous; visible lime in cracks and voids; thin patchy clay skins; gradual indistinct boundary.

C	47-60"	Reddish-brown (5.5YR 4/2 that crushes into 4.5/3) silt loam; massive; friable when moist; violently calcareous; high quantity of pinkish-white lime splotches and concretions.
C	60-68"	Brown to light brown (7.5YR that crushes to 5.5/4) loam; massive; friable when moist; violently calcareous, pH of 8.6.
D	68" +	Outwash stones of varying size; usually waterworn.

Range in Characteristics

This soil varies in color from 5YR to 7YR and in texture from very fine sandy loam to silt loam. Soil development varies from weak to moderate; the lime zone ranges between 10 and 20 inches; clay skins are generally thin but nearly continuous in the subsoil layers. This particular type is underlain by weak limy outwash materials that occur between 3 to 6 feet; soil horizons are fairly well defined.

Topography

Gently to moderately sloping upland mesas.

Drainage

Surface runoff is slow to moderately rapid; internal drainage is moderate.

Vegetation

Native vegetation consists of sagebrush and native grasses that grow in the climatic zone of 12 to 15 inch precipitation.

Use

Where irrigation water is available, a very large portion of this type is utilized for the production of small grain and hay with some corn and potatoes.

Distribution

This type is widely distributed on the gently to moderately sloping mesas along the Colorado River and its tributaries in the 12 to 15 inch climatic zone.

Location

This description was taken in the middle of Sec. 12, T15S, R92W.

BD 32K2 The BD 32K2 mapping unit is characterized by weakly developed soils occurring on shallow loessial uplands overlying limy, stony outwash materials. Soil horizons are very weakly defined. This mapping unit is associated with mapping units BD 3231, BD 32H1, BD 32H2, BD 32K2. It occurs on ridge tops, small knolls and windward facing slopes where soil erosion retards normal soil development.

Soil Profile:

A_p	0 - 2"	Dark brown to brown (7.5YR 3.5/2 moist-crushed) loam with weak medium platy structure that breaks into weak fine crumb; very fine when moist; strongly calcareous; clear smooth boundary.
AB	2 - 6"	Dark brown to brown (7.5YR 3.5/2 crushed-moist) heavy loam with weak fine granular structure; friable when moist; violently calcareous; nearly continuous clay skins; clear smooth boundary; fine gritty sand particles intermixed.
BC_{ca}	6 -14"	Dark brown (10YR 3.5/3 crushed-moist) heavy loam, weak fine angular blocky to subangular blocky; firm when moist; violently calcareous; very little clay skin; clear smooth boundary; a few lime coated sandstone fragments.
C_{ca}	14-24"	Very pale brown (10YR 7/3 moist-crushed) loam; massive; hard when dry, firm when moist; violently calcareous with pH of 8.4; gradual smooth boundary; some lime-coated sandstone fragments.
C	24-36"	Very pale brown (10YR 8/3 crushed-moist) stony loam with about 25% lime coated sandstone fragments.

Range in Characteristics

This soil varies in soil development from very weak to weak; in texture from very fine sand loam to silt loam. Included within this mapping unit are loessial soils of varying depth over limy outwash materials. The outwash materials carry a high content of lime but the sandstone fragments and loamy lime materials are not cemented. Alfalfa roots often penetrate this zone. Taxinomic units included within this mapping unit are: BD 3231, BD 32K1, BD 32H2, BD 32K2.

Topography

Moderately steep to steep. It occurs on ridge tops, knolls and windward slopes.

Drainage

Surface drainage is rapid due to steep slope. Internal drainage is moderately rapid.

Vegetation

In its native state, vegetation consists of sagebrush and native grasses adapted to 12 to 15 inch precipitation zone.

Use

Where irrigation water is available, this soil is used for production of hay and grain.

Distribution

This soil occurs wherever loessial soils are found in isolated bodies associated with deep loessial soils.

Location

Sec. 12, T5S, R92W vicinity of Harvey Gap Reservoir.

BD 3231 Mapping unit is characterized by very weakly developed soil occurring on moderately steep to steep slopes in the same area that BD3231 occurs. Normal soil erosion has kept pace with soil development and consequently, this soil has always been thin, even in its native condition. It is developed on the same type of loess as BD3231, varying color from 5YR to 7.5YR and the texture from very fine sand loam to heavy silt loam. It occurs in a 12 to 15" precipitation zone.

Soil Profile:

A_p 0 - 3" Dark reddish-brown to reddish-brown (5YR 3.5/3.5 crushed and moist) loam with weak moderately platy, crushed to weak fine crumb structure; very friable mixture; slightly calcareous with thin patchy clay skins and clear smooth boundary.

AB 3 - 9" Dark reddish-brown to dark reddish-gray (5 YR 3.5/3 moist) loam with weak medium angular blocky to subangular blocky; friable when moist; slightly calcareous; thin patchy clay skins; abrupt smooth boundary.

B_{3ca} 9 -17" Brown to pale brown (10YR 5.5/3 crushed and moist) light loam with weak medium angular blocky to subangular blocky; friable when moist; violently calcareous with visible lime in cracks and old root channels; thin patchy clay skins and clear smooth boundary.

C_{ca} 17-28" Brown (7.5YR 4.5/4 moist, crushed) light loam to very fine sandy loam; massive; hard when dry, friable when moist; moderately calcareous with no clay skins.

Range in Characteristics

This soil varies in color from 5YR to 7.5YR; in texture from very fine sand loam to silt loam. Soil development is very weak with very slight clay skin development in the subsoil and very faint visible lime accumulations in the lime zone. Included within this mapping unit are shallow loessial soils whose total solum is sometimes less than plow depth and consequently under cultivation, the visible lime layer material is turned over and appears on the surface.

Topography

Moderate to steeply sloping side slopes adjacent to drainage ways that traverse or dissect soil type BD 3231.

Drainage

Surface drainage is rapid due to steep slope; internal drainage is moderate.

Vegetation

In its native state, vegetation consists of sagebrush and native grasses adapted to about a 12 inch precipitation.

Use

Where irrigation water is available, this soil is used for the production of hay, pasture and small grains, and an occasional field of corn is grown on this type.

Distribution

This soil occurs wherever loessial soils are found on the upland mesas and slopes.

Location

950 feet S, 100 feet East in the northeast corner of the NW $\frac{1}{4}$ Sec. 3, T6S, R92W.

BE 3331-B or C This is a Brown zone soil developing in locally transported but unassorted alluvial-colluvial sediments weathered from the shales and sandstones of Wasatch formation and miscellaneous materials of outwash and aeolian origin. The parent materials are medium textured, weakly to strongly calcareous, and occasionally contain significant amounts of sodium salt. The topsoils are non-chernozemic. This unit closely resembles Unit 30 Mam loam described in the Pitkin County legend, but has a faint in place of distinct lime zone described for Mam.

Soil Profile:

A_p	0 - 2"	Dark brown (7½YR 4/2 moist) loam; slightly hard when dry, friable when moist; weak coarse platy structure that breaks into weak fine crumbly peds; weakly calcareous; lower boundary clear and smooth.
AB_p	2 -12"	Dark brown (10YR 3/3 moist) loam; weak medium subangular blocky structure that breaks into weak fine subangular peds; slightly hard when dry, friable when moist; thin patchy clay skins; weakly calcareous; lower boundary clear and smooth.
B_{21}	21-18"	Dark brown to brown (10YR 4/2 moist) loam; weak moderate prismatic structure that breaks into weak medium angular to subangular peds; hard when dry, firm when moist; slightly calcareous; nearly continuous clay skins; lower boundary clear and smooth.
B_{22}	18-33"	Brown (10YR 5/3 moist) loam; weak medium subangular blocky structure that crushes down to weak fine subangular blocky peds; thin patchy clay skins; gradual smooth lower boundary.
C_{ca}	33-47"	Dark yellowish-brown (10YR 4/4 moist) loam; massive structure; slightly hard when dry, friable when moist; violently calcareous; faint veins of lime; gradual smooth lower boundary.
C	47-60"	Brown to yellowish-brown (10YR 5/3-4 moist) loam; massive; slightly hard when dry, friable when moist; violently calcareous; lime disseminated.

Range in Characteristics

The calcareous horizon ranges from weak to moderate veining. Subsoil development ranges from thin patchy to nearly continuous clay skins with a modal of thin patchy. Structural development ranges from weak medium angular to sub-angular blocky, being sufficient to be called a structural B horizon. Topsoil color ranges from 7½YR 3.5/2-3 to 7½YR 4/2-3. Topsoil thickness ranges from 2 to 5 inches. Subsoil may be as much as 2 feet thick. Faint indications of buried profiles occur from 1 to 3 feet.

Topography

Occupies gently sloping benches and fans midway between present river bottoms and mesa lands. Slope ranges from 1 to 6 percent.

Drainage

Surface runoff is moderate; internal drainage is moderate but may be slightly impeded on nearly level areas.

Vegetation

Native vegetation consists of big sagebrush and western wheatgrass, with an occasional greasewood and saltbush shrub.

Use

Wherever irrigation water is available, a large percentage of this unit is devoted to the production of alfalfa, small grain, sugar beets and corn for silage. None of this unit is dry farmed.

Description

This unit has been observed in Garfield and Rio Blanco Counties in Colorado.

Unit Established

Observed and mapped in WP-3 Silt Reclamation Project in 1958 and 1959.

Type Location

300 feet N and 500 feet W of the southeast corner of Sec. 3, T6S, R92W, Garfield County, Colorado.

Described by

J. L. Nielsen, November 1959.

BM 32C1 The BM 32C1 mapping unit consists of deep to medium deep, moderately developed loamy soil weathering in place on Mesa Verde silty shale. It occurs in a rainfall zone of approximately 12 to 15 inches at an elevation of about 5600 feet. Included within this mapping unit are the closely related taxonomic types BM 3231 and BM 32C2. The depth to shale and soft sandstone varies from 2 to 5 feet and may be entirely absent at the foot of the slope. Also associated with this mapping unit is the very shallow soil SM 33C3.

Soil Profile:

A_p	0 - 3"	Dark grayish-brown (10YR 4/2 moist, crushed) heavy loam; weak medium platy that breaks down into weak fine crumb; friable when moist; moderately calcareous; patchy clay skins; clear smooth boundary.
B_{21}	3 -11"	Very dark grayish-brown (10YR 3/3 moist and crushed) light clay loam with moderately medium subangular blocky structure that breaks into moderate fine subangular blocky structure; firm when moist; moderately calcareous; nearly continuous clay skins; clear smooth boundary.
B_{22}	11-20"	Gray brown (10YR 4.5/2 - 5/2 moist and crushed) loam with weak coarse angular blocky to subangular blocky structure that breaks into weak fine subangular blocky aggregates; friable when moist; violently calcareous; nearly continuous clay skins and clear smooth boundary.
B_{3ca}	20-27"	Gray brown (10YR 4.5/2 - 5/2 moist and crushed) light loam with fine weak subangular blocky structure; very friable when moist; slightly calcareous with 5 percent visible lime streaks of 10YR 5/2 (buried layer).
	37" +	Shale (10YR 3.5/2 moist and crushed) clay loam texture.

Range in Characteristics

This soil herewith described is a taxonomic unit which is mapped under the symbol BM 32C1. Included in this mapping unit are: BM 3231, BM 32C2 and BM 32C1. Due to the wide range in topography on which this soil occurs, soil development varies from weak to moderately mature. On the tops of the ridges, the depth to shale is shallow; at the foot of the slope, the depth to shale is deep. All degrees of soil development occur between these two points. Color ranges from hue 10YR to hue 2.5YR, depending upon the amount of intermixed materials from sandstone and in some cases, loess. Ordinarily, this soil is not affected by seep, salt or alkali, except in the swales where surplus water due to over-irrigation may cause a seep and salt condition.

Topography

Topography consists of moderately sloping to steeply sloping ridges and rolling hills that run north and south with drainages in between.

Drainage

Internal drainage is generally moderate but may be slow where the shale layers impede water movement. Surface drainage is moderate to rapid due to slope.

Vegetation

In its native state, this was probably a grassland site, but due to vegetative deterioration, most of the native areas are covered with sagebrush, with some native grasses adapted to a 12 inch precipitation zone.

Use

Where water is available, this type is devoted to hay, pasture and grain production. Occasionally, the land is used for potatoes, corn and sugar beet production.

Distribution

This type is of very limited acreage occurring adjacent to the mountainous areas of Mesa Verde formation.

Location

660 feet N and 330 feet W, southeast corner, Sec. 26, T5S, R92W.

BM 32H2 This mapping unit covers slightly to moderately developed soils on reworked materials from the Mesa Verde formation. The parent material consists of a mixture of sandstone, shale alluvium and colluvium. There is a great deal of variation in this mapping unit. The amount of sandstone fragments intermixed with the profile varies from 1 to 2 percent in the upper part to as much as 30 to 40 percent in the substratum layers. Textures range from heavy sandy loams to light clay loams. Subsoil development is weak to moderate. The lime zone ranges from clearly discernible to almost undiscernible. This soil occurs in an approximate 12 inch precipitation zone.

Soil Profile:

A_{11} 0 - 2" Dark brown (7.5YR 3.5/2 moist and crushed) loam with weak coarse platy structure that breaks into weak fine crumb; soft when dry, friable when moist; slightly calcareous with abrupt smooth boundary.

AB 2 - 6" Dark brown (7.5YR 3/2 moist and crushed) loam with weak coarse prismatic structure that breaks into weak medium angular blocky to subangular blocky aggregates; slightly hard when dry, moderately firm when moist; slightly calcareous; thin patchy clay skins; clear smooth boundary, very small sandstone fragments intermixed.

B_2 6 -15" Dark brown (7.5YR 3.5/3 moist and crushed) light clay loam; weak medium prismatic structure that breaks into weak medium angular blocky to subangular blocky peds; hard when dry, moderately firm when moist; very slightly calcareous; nearly continuous clay skins; clear smooth boundary, occasional small sandstone fragments intermixed.

B_{3ca} 15-24" Dark brown to brown (10YR 4.5/3 moist and crushed) loam with weak medium angular blocky structure; hard when dry, firm when moist; violently calcareous with visible lime and patchy clay skins; clear smooth boundary.

C 30-40" Dark brown to brown (10YR 4/3 moist and crushed) sandy loam; massive; loose when dry, loose when moist; violently calcareous with pH of 8.5; lime on sandstone fragments; 30 to 40 percent sandstone fragments intermixed with soil.

Range in Characteristics

This soil is a taxonomic unit occurring in several closely related soils that are mapped under the general mapping unit BM 32H2. They are derived from a mixture of reworked Mesa Verde sandstone and shale and loessial material. Soil development ranges from very weak to moderately mature; thickness

and texture of all horizons vary considerably. Amount of intermixed sandstone varies widely, especially in the substratum layers. Ordinarily, this soil is not affected by salt or alkali. Other taxonomic units included with this soil are: BM 33H2, BM 3331, BM 3231 and BM 32H1.

Topography

Topography consists of gently sloping to moderately sloping upland fans and foot slopes. The areas are associated with a series of small drainage systems that come out of the adjacent mountains.

Drainage

Due to loam and gravelly loam substratum layers, internal drainage is good; surface drainage is moderate due to slope.

Vegetation

In its native state, this was probably a grassland site, but due to vegetative deterioration, most of the native areas are covered with sagebrush with some grass remnants.

Use

Where water is available, a high percentage of this type is devoted to hay and grain production. In years past, such crops as potatoes and sugar beets have been grown successfully. It will grow almost any crop that is adapted to this climatic zone.

Distribution

This soil occurs in the northern part of the Silt project area. Its extent in other parts of Western Colorado is not determined as yet.

Location

50 feet South, 100 feet West in NE corner of Sec. 36, T5S, R92W.

BM 3231 Mapping unit covers slightly to moderately developed soils on reworked materials from the Mesa Verde formation. The parent material consists of a mixture of sandstone and shale, alluvium and colluvium. There is a great deal of variation in the soil. The amount of sandstone fragments intermixed within the profile varies from 1 or 2 percent to as much as 10 percent. Textures range from heavy sandy loams to light clay loams. Subsoil development is weak to moderate with considerable clay skin showing on the peds. The lime zone ranges from discernible to almost undiscernible. This soil occurs in an approximate 12 inch precipitation zone.

Soil Profile:

* AP_1	0 -1½"	Very dark grayish-brown to dark grayish-brown (moist 10YR 3.5/2) coarse platy, moderately friable loam; slightly calcareous.
AP_2	1½-5½"	Very dark grayish-brown to dark grayish-brown (moist 10YR 3.5/2); moderately firm; slightly calcareous loam that grades abruptly into the underlying subsoil layer; the weak prismatic structure breaks down into medium sub-angular blocky peds.
B_2	5½-12"	Dark brown to very dark brown (10YR 3.5/2.5 moist); clay loam with moderate medium sub-angular blocky structure; hard when dry, moderately firm when moist; clay skins are nearly continuous; slightly calcareous; calcareous condition probably due to polution from irrigation water.
B_{31ca}	12-22"	Dark grayish-brown (10YR 4.2 moist) loam with weak, coarse angular blocky structure that breaks into weak, fine angular blocky peds that are hard when dry and moderately friable when moist; strongly calcareous with thin patchy clay skins; lime is visible in old root channels and between peds.
B_{32}	22-36"	Dark grayish brown (10YR 4.2 moist) loam with weak coarse angular blocky structure that is hard when dry, moderately friable when moist; violently calcareous; lime is well disseminated.
C_1	36-52"	Brown (10YR 5/3 moist) massive loam; hard when dry, friable when moist; violently calcareous; gradual boundary.
C_2	52-60"	Dark grayish-brown (10YR 4/2 moist) massive loam; hard when dry, moderately friable when moist; violently calcareous.

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* Note: The color of this profile is an intergrade between the 10YR and 2½Y hues. This is especially noticeable for the dry color.

Range in Characteristics

This soil is a taxonomic unit occurring in several closely related soils that are derived from mixtures for reworked Mesa Verde sandstones and shales and loessial materials. Soil development ranges from very weak to moderately mature brown zone types. Thickness and texture of all horizons vary considerably. Amount of intermixed sandstone fragments varies from 1 to about 10 percent. Mapping unit BM 32H2 is closely related to this soil but is influenced much more by loess. Ordinarily, this soil is not affected by salt or alkali.

Topography

Ranges from gently sloping to moderately sloping upland fans and foot slopes. The areas are associated with a series of small drainage systems that come out of the adjacent mountains.

Drainage

Due to the loam or clay loam texture, internal drainage is generally good. Surface drainage is adequate due to moderate slope.

Vegetation

In its native state, this was probably a grassland site, but due to vegetative deterioration, most of the native areas are covered with sage brush.

Use

Where water is available, a high percentage of this soil type is devoted to hay and grain production. In years past, such crops as potatoes and sugar beets have been grown successfully. It will grow any crop that is adapted to the climatic zone.

Distribution

This soil occurs in the northern part of the Silt Project area, its extent in other parts of Western Colorado is not determined as yet.

B03H Mapping Unit B03H covers a wide group of shallow stony soils that are developing on outwash stony loam material that was deposited when the Colorado River system was several hundred feet higher than it is today. Most of the stones are rough sandstone fragments that range from 2 to 24 inches in diameter. Some shale and basalt fragments make up part of the mixture. The parent soil material ranges from sandy loam to heavy loam and is violently calcareous but not cemented. The unit occurs in a 12 inch precipitation zone on breaks, mesa edges and steep slopes adjacent to present stream courses.

Soil Profile:

A_1 0 - 4" Brown to dark brown (10YR 4/3 moist) light loam; course platy structure that breaks into weak fine crumbs; firm when dry, moderately friable when moist; slightly calcareous. Clear boundary.

C_1 4 -21" Brown (10YR 5/3 moist) massive stony, heavy sandy loam; violently calcareous with at least 30% lime coated sandstone fragments.

C_2 21-60" Brown (10YR 5/3 moist) massive stony loam; violently calcareous with 50% lime coated sandstone and shale fragments varying in size from 2 to 24 inches.

Range in Characteristics

This mapping unit covers stony types that range from stony sandy loams to stony clay loams that are too stony for cultivation. Color varies from brown to light brown.

Topography

Topography consists of steep breaks, mesa edges and slopes adjacent to present stream courses.

Drainage

Internal drainage is rapid. Surface drainage is very rapid due to steep slope.

Use

Pasture land. Extra irrigation water will increase grass growth.

Vegetation

Native vegetation consists of pinon-juniper, sagebrush with a sparse stand of grass.

Distribution

Widely distributed in Western Colorado.

Location

Pit silo on east side of road on Ellison Place north of Silt. 1400 feet South and 2000 feet West of northeast corner, Sec. 31, Township 5S, Range 91W.

ZD 3231 This mapping unit consists of brown zonal soils developing in loessial material that is partially derived from salty Wasatch shales that give rise to a black alkali condition. Two principal taxinomic units are mapped under this unit. One is a fairly well developed solonetz soil that has columnar structure with a weak A_2 horizon, and a slightly affected sodium soil that does not have columnar structure nor the A_2 horizon.

Soil Profile: (Solonetz type) This is the solonetz soil comprising approximately 20% of this mapping unit.

A_1	0 - 4"	Dark yellowish-brown (10YR 4/4 moist) that crushes to reddish-brown (5YR 4/4) very fine silty loam; moderate platy structure breaks into moderate fine crumb; slightly hard when dry, friable when moist; non calcareous with abrupt smooth boundary.
B_{21}	4 - 8"	Dark reddish-brown to reddish-brown (5YR 3.5/4) heavy clay loam to clay medium columnar structure that breaks into moderate fine angular blocky aggregates; very hard when dry, firm when moist; non calcareous; thin continuous clay skins; clear smooth boundary. Included within and on top of this layer is a very thin showing of highly dispersed clay material that is too thin to show as A_2.
B_{22}	8 -12"	Reddish-brown (5YR 4/4 moist-crushed) heavy clay loam; moderate medium columnar structure that breaks into medium fine angular blocky aggregates; very hard when dry, firm when moist; strongly calcareous; nearly continuous clay skins; clear smooth boundary.
B_{3ca}	12-20"	Reddish-brown (7.5YR 4.5/4 moist) clay loam with moderate medium subangular blocky structure; very hard when dry, firm when moist; strongly calcareous; visible lime in cracks and voids; thin patchy clay skins; clear smooth boundary.
C_{ca}	20-40"	Dark brown to brown (10YR 4.5/3 moist) loam with weak medium subangular blocky structure; hard when dry, friable when moist; violently calcareous; visible lime in cracks and seams; gradual smooth boundary.
C	40-60"	Dark brown to brown (7.5YR 4.5/4 moist and crushed) massive loam; hard when dry, friable when moist; strongly calcareous loess.

This is non-solonetz and comprises approximately 80% of the mapping unit.

A_1	0 - 3"	Dark brown to brown (7.5YR 4/4 crushes to 4.5/4) very fine sandy loam; medium platy structure that crushes into weak

very fine crumb; slightly hard when dry, loose when moist; non-calcareous; no clay skins; clear smooth boundary.

B_{21} 3 - 6" Reddish-brown (5YR 4/4 crushed and moist) silt loam; weak coarse platy structure that crushes into weak fine crumb; slightly hard when dry, firm when moist; slightly calcareous; clear smooth boundary.

B_{22} 6 -14" Reddish-brown (5YR 4.5/3 moist) clay loam with weak medium prismatic structure that breaks into weak medium angular blocky structure; very hard when dry, firm when moist; slightly calcareous; nearly continuous clay skins; clear smooth boundary.

B_{3ca} 14-20" Dark brown to brown (7.5YR 4.5/4 moist) clay loam with weak fine subangular blocky structure; very hard when dry, firm when moist; strongly calcareous with lime in seams and cracks; clear smooth boundary; lime zone.

C 20-40" Brown (10YR 4.5/3 that crushes into 5/3) loam; massive; hard when dry; violently calcareous; lime well disseminated.

C 40-60" Dark brown to brown (10YR 4.5/4 crushed and moist) loam; massive; hard when dry; strongly calcareous; parent loess.

Range in Characteristics

This mapping unit ZD 3231 is a soil complex in which the above two taxinomic units are so closely associated and in such fine detail that it is physically impossible to separate the types in any kind of a soil survey. Due to the material of the parent materials from which these soils are derived, many variations of sodium affected soil types occur. Solonetz development ranges from very weak to very strong. In places, the affects of sodium are non-discernible and a soil such as BD 3231 and BD 3331 may occur intermixed with the sodium characterized soils. Depth of top soil and thickness of subsoil varies from 3 or 4 inches to as much as 8 to 10 inches of subsoil. Usually, a very definite B_{3ca} soil zone occurs somewhere between 10 and 20 inches with visible lime in cracks, seams and voids. The parent materials of these types consist of a mixture of loess that is fairly typical of the area except that it shows varying amounts of sodium affectation.

Topography

This mapping unit occurs on generally sloping to moderately steep topography on mesa areas that lie adjacent to actively eroding Wasatch bad lands.

Drainage

Surface drainage is moderate to rapid; internal drainage is moderate but may be very slow where solonetz subsoils predominate. Under irrigation, seep and alkali spots are common in this type.

Vegetation

In its native state, vegetation consists of greasewood and a sprinkling of the present native cover.

Use

Where irrigation water is available, this soil is used for the production of hay and grain. Yields range from poor to good, depending upon the amount of the surface that is affected by black alkali spots.

Distribution

This soil occurs in small bodies within the loessial group of soils and although the acreage is not large, the distribution is quite wide.

Location

General area - Sec. 33, T5S, R92W.

ZE 2221 Mapping unit occurs in a rainfall zone of approximately 12 inches where the summers are warm and winters are cold. Soil development is weak to moderate with ill-defined soil horizons. This soil is developing on reworked clay loam alluvium derived from sandstone and shale of the Wasatch formation. In its native state, it is covered with greasewood and the effects of sodium salts are visible on the surface as slick spots.

Soil Profile:

A_1	0 - 3"	Brown to gray brown (10YR 4.5/2 - 5/3 moist- crushed) loam; weak coarse platy structure that breaks down into weak fine crumb; friable when moist; slightly calcareous with pH of 8.5; patchy clay skins; clear smooth boundary.
AB	3 - 9"	Dark brown to brown (10YR 4.5/2 - 4/3 crushed-moist) heavy clay loam with weak course angular blocky structure that breaks into weak fine angular blocky structure; firm when moist; moderately calcareous with pH of 8.6; nearly continuous clay skins; clear smooth boundary.
B_{22}	16-24"	Gray brown (10YR 5/2 moist) clay loam; weak medium angular blocky structure that breaks into weak fine angular blocky to fine subangular blocky aggregates; firm when moist; strongly calcareous, pH of 8.8; thin patchy clay skins.
B_{3ca}	24-31"	Brown (10YR 5/2 moist-crushed) loam; weak fine angular blocky to subangular blocky peds; friable when moist; violently calcareous, pH of 9; lime is faintly visible in cracks and voids.
C	31-48"	Gray brown (10YR 5/2 moist-crushed) light clay loam; weak medium angular blocky structure; friable when moist; violently calcareous, pH 9.2; thin patchy clay skins; no lime.
	48-60"	Dark grayish-brown (10YR 4/2 moist) heavy loam; massive; friable when moist; strongly calcareous, 9.1 pH with visible lime and gyp in cracks and voids.

Range in Characteristics

This mapping unit consists of two principle taxonomic units, ZE 2221 A_1W_1 and ZE 2221 W_1. In the limited areas where this type has been observed, seep and salt affect the entire area to a limited extent. It is not known whether this is due to over irrigation or whether this is naturally part of the soil. Soil horizons are ill-defined and hard to recognize. Clay skin development is weak to moderate in the subsoil. The lime zone which occurs generally

between 2 and 3 feet is weak, with the lime faintly visible. The entire profile is calcareous, either naturally or from limy irrigation water. The surface layers have a pH that ranges from 8.5 to 8.7, with 8.7 to 9.2 in the subsoil. The parent materials vary from heavy clay loam to loam and may carry an occasional sandstone or shale fragment.

Topography

Gently sloping fan areas broken by drainage ways that originate in Wasatch formation bad lands.

Drainage

Internal drainage is slow to very slow due to heavy texture of materials and gentle slope; surface runoff is slow.

Vegetation

Native vegetation consists of greasewood with a sprinkling of sagebrush; alkali weeds are also common.

Use

Where irrigation water is available, a large portion of this type is used for the production of hay and small grain. Due to over irrigation, a portion of this type has been abandoned because of seep and alkali.

Distribution

This type occurs wherever soils derived from the heavy members of the Wasatch formation occur. The total acreage is small but distribution is wide.

Location

2000 feet north, 300 feet east southeast corner Sec. 35, T5S, R92W.

ZE 3331 The ZE 3331 mapping unit covers slightly developed soils on reworked alluvial materials of the Wasatch formation. It consists of a mixture of sandstone and shale alluvium that has a noticeable amount of sodium salts. It is developing in a rainfall zone of approximately 12 inches. Soil development is weak to very weak. Summers are warm and winters are cold.

Soil Profile:

A_{11}	0 - 3"	Dark grayish brown to brown (10YR 4/2½ moist) weak coarse platy, moderately loose loam; abrupt boundary.
AB	3 - 12"	Dark grayish brown (10YR 4/2½ moist) loam, weak coarse subangular blocky structure; slightly hard when dry, moderately friable when moist; slightly calcareous; thin patchy clay skins.
C_1	12-16"	Dark grayish-brown to gray-brown (10YR 4½ moist) loam; massive; friable; slightly calcareous; gradual boundary.
C_{ca}	16-36"	Dark brown to brown (10YR 4/3 moist) light loam; very weak fine subangular blocky structure; moderately friable when moist; violently calcareous, with some visible lime in voids and old root channels.
C_2	36-60"	Brown to dark brown very fine sandy loam to loam; massive; violently calcareous; lime well disseminated.

Range in Characteristics

This soil is a taxonomic unit occurring as one of several closely associated soils mapped under the heading of ZE 3331. It is generally affected by both salt and alkali. The native vegetation is greasewood with a sprinkling of sagebrush. Slick spots are common but gradually disappear after 30 to 40 years of good farming practices. Textures vary from heavy sandy loams to light clay loams. Subsoil development is very slight and is absent in some locations. The A horizon is always thin and grades imperceptibly into the subsoil or substratum materials. Mapping unit ZE 2221 is the clay loam equivalent of this type and the two soils often grade into each other.

Topography

Gently sloping, small to large alluvial fans at the foot of Wasatch breaks and badlands.

Drainage

Due to the gently sloping topography and over-irrigation, almost all of this mapping unit is affected by seep. Surface drainage is generally slow due to gently sloping topography.

Vegetation

In its native state, this type is always covered by a mixture of greasewood and sagebrush. The quantity of greasewood varies with the amount of active sodium in the soil. Alkali weeds are also part of the native vegetation and occupy the slick spots in the cultivated fields.

Use

Where water is available, a high percentage of this type is used for production of all crops adapted to the climate of this area. Where the alkali and salt conditions have become worse due to over-irrigation, abandonment is common. Areas that have been drained are now being cultivated again with success. Over a period of years with good farming practices, the slick spots gradually disappear and the land becomes productive.

Distribution

In the Silt project, most of this area occurs north of Antlers and vicinity.

Location

Two locations of this type are 1/4 mile of the SW corner, Sec. 1, T6S, R93W and 200 feet West in the NE corner, Sec. 1, T6S, R93W.

ZE 3331 A_3W_3 This is a Brown zone soil developing in partially assorted alluvial sediments weathered from shale and sandstone of Wasatch formation. Parent materials are medium textured; weakly to strongly calcareous and occasionally contain significant amounts of sodium salt. It occurs on gently sloping benches and fans midway between present river bottom and mesa land. Slope ranges from 1 to 6 percent. The unit is imperfectly drained with weak gleyed condition occurring somewhere between 20 and 30 inches. Due to poor drainage, salt accumulations are evident on the surface during the summer season when the soil dries out. This unit may be a phase of ZE 3331. Both soils are without significant B horizon development.

Soil Profile:

A_p	0 - 6"	Gray brown to dark grayish-brown loan (10YR 4/2 - 5/2 crushed moist); weak fine crumb structure; slightly hard when dry, friable when moist; strongly calcareous; clear gradual boundary.
A_1	6 -12"	Gray brown to very grayish-brown (10YR 4/2 - 4.5/2 crushed moist) loam; weak fine crumb structure; hard when dry, friable when moist; strongly calcareous; clear gradual boundary.
BC	12-22"	Olive brown (2YR 4.5/2 - 5/2 crushed and moist) loam; very weak moderate subangular blocky structure that crushes down to very weak fine subangular blocky peds; hard when dry, friable when moist; weakly calcareous; faint thin patchy clay skins; clear gradual boundary.
C_g	22-31"	Gray brown to dark grayish-brown (10YR 4.5/2 to 5/2 crushed and moist) loam; very weak medium subangular blocky that crushes to very weak fine subangular blocky; hard when dry, friable when moist; weakly calcareous; weakly gleyed with gray and rust mottlings; clear gradual lower boundary.
C_g	36-50"	Grayish-brown (2.5Y 5/2 crushed and moist) loam; massive structure; hard when dry, friable when moist; violently calcareous; weakly gleyed.

Range in Characteristics:

This soil is a taxonomic unit occurring as one of several closely associated soils mapped under heading of ZE 3331. It is generally affected by both salt and alkali. The native vegetation is greasewood with a sprinkling of sagebrush. Slick spots are common but gradually disappear after 30 to 40 years of good farming practices. Textures vary from heavy sandy loams to light clay loams. Stratification of parent materials is quite common,

varying as much as sandy loam to light clay loam in the same profile. Subsoil development is very slight or absent. The A horizon is always thin and grades imperceptibly into the subsoil or substratum materials; faintly discernable buried profiles may occur in the C horizon. Mapping Unit ZE 2221 is the clay loam equivalent of this type and the two soils often grade gradually into each other.

Topography:

Gently sloping benches and fans occurring at the foot of Wasatch formation, breaks and bad lands.

Drainage:

Due to the gently sloping topography, almost all of this unit is affected by seep, especially where it occurs below other irrigated land. Surface drainage is generally slow; permeability is moderate; internal drainage is usually impeded by topographic position. Since almost 100% of this soil unit is irrigated, it is affected by poor drainage of varying degrees.

Vegetation:

In its native state, this unit is covered by a mixture of greasewood and sagebrush. Quantity of greasewood varies with the amount of active sodium in the soil. Alkali weeds are also part of the native vegetation.

Use

Where water is available, a high percentage of this type is used for production of all crops adapted to the climate of this area. Where the alkali and salt conditions have become considerable due to over-irrigation, abandonment is common. Areas that have been drained are now being cultivated again with success. Over a period of years with good farming practices, the alkali and saline areas gradually disappear and the land becomes productive.

Distribution

In the Silt project most of this area occurs north and west of Antlers and vicinity. It also occurs in similar areas in other parts of Garfield and Rio Blanco Counties where soils derived from Wasatch shales and sandstones occur in a 10" to 15" precipitation zone.

Location

800 feet E, 300 feet N, SW corner of Sec. 34, T5S, R92W.

Described by:

J. L. Nielsen, December 3, 1959.

ENGINEERING SECTION

Engineering Table 1. - Climatological data, Silt project

Month	Daylight Hours 1/ Percent	Mean Temperatures Rifle W/B 2/	Mean Temperatures Harvey & Davie Mesas 3/	Mean Temperatures Dry Elk Valley 3/	Effective Precipitation on Project Areas Rifle W/B 4/	Effective Precipitation on Project Areas Harvey & Davie Mesas 5/	Effective Precipitation on Project Areas Dry Elk Valley 6/
March	8.33	38.5	37.5	35.9	0.75	0.75	0.91
April	8.94	48.9	47.9	46.3	0.97	0.97	1.08
Mah	10.00	57.2	56.2	54.6	0.63	0.63	0.82
June	10.06	64.5	63.5	61.9	0.31	0.31	0.57
July	10.20	71.4	70.4	68.8	1.18	1.18	1.24
August	9.53	69.3	68.3	66.7	0.81	0.81	0.96
September	8.38	60.8	59.8	58.2	1.35	1.35	1.38
October	7.76	50.0	49.0	47.4	0.75	0.75	0.91
November	6.74	36.2	35.2	33.6	0.62	0.62	0.81
April-September					5.15	5.15	6.05

Estimated Average Irrigation Season

	Harvey & Davie Mesas	Dry Elk Valley
Pre frost-free period	May 1 - May 12	May 1 - May 22
Frost-free period	May 13 - Sept. 30	May 23 - Sept. 27
Post frost-free period	Oct. 1 - Oct. 22	Sept. 28 - Oct. 18
Frost-free days	141	128
Total days	175	171

1/ Latitude 39°35' N.
2/ USWB Bulletin W, Supplement 11-5, 1931-52
3/ Based on adiabatic lapse rate adjustments, 3°/1000 ft.
4/ USWB Bulletin W, Supplement 11-5; average of ten driest consecutive years (1931-1940).
5/ Effective (assumed 85% of average) precipitation estimated same as average for Rifle.
6/ 85% of average of ten driest consecutive years, based on correlated relationship between Rifle W.B. and Collbran W.B. (approximate same elevation as Dry Elk Valley average).

Engineering Table 2. - Consumptive use factors, Silt project

Month	t	p	f	r
		Harvey and Davie Mesas		
March	37.5	8.33	3.12	.75
April	47.9	8.94	4.28	.97
May	56.2	10.00	5.62	.63
June	63.5	10.06	6.39	.31
July	70.4	10.20	7.18	1.18
August	68.3	9.53	6.51	.81
September	59.8	8.38	5.01	1.35
October	49.0	7.76	3.80	.75
		Dry Elk Valley		
March	35.9	8.33	2.99	.91
April	46.3	8.94	4.14	1.08
May	54.6	10.00	5.46	.82
June	61.9	10.06	6.23	.57
July	68.8	10.20	7.02	1.24
August	66.7	9.53	6.36	..96
September	58.2	8.38	4.88	1.38
October	47.4	7.76	3.68	.91

Engineering Table 3. - Consumptive use coefficients used, Silt project

	Frost-free period	Pre and post frost-free period
Alfalfa	.85	.70
Clovers and rotation pasture	.80	.65
Grass pasture and hay	.75	.60
Corn	.75	---
Small grain	.75	---
Sugar beets	.70	---
Potatoes	.70	---

Engineering Table 4. - Peak daily consumptive use rates, inches per day

Depth of water application required (inches)	Peak monthly consumptive use rate, inches									
	3.0	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
	Peak daily design rate use, inches per day									
1.0	0.16	0.22	0.25	0.27	0.30	0.33	0.35	0.38	0.41	0.44
1.5	0.15	0.20	0.23	0.25	0.28	0.30	0.33	0.35	0.38	0.40
2.0	0.14	0.18	0.21	0.23	0.26	0.28	0.30	0.32	0.35	0.37
2.5	0.13	0.17	0.20	0.22	0.24	0.26	0.28	0.31	0.33	0.35
3.0	0.12	0.17	0.19	0.21	0.23	0.25	0.27	0.29	0.31	0.33
3.5	0.12	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32
4.0	0.11	0.16	0.18	0.19	0.21	0.23	0.25	0.27	0.29	0.31
4.5	0.11	0.15	0.17	0.19	0.21	0.23	0.25	0.27	0.28	0.30
5.0	0.11	0.15	0.17	0.18	0.20	0.22	0.24	0.26	0.28	0.29
5.5	0.10	0.14	0.16	0.18	0.20	0.22	0.23	0.25	0.27	0.29
6.0	0.10	0.14	0.16	0.17	0.19	0.21	0.23	0.25	0.27	0.28
7.0	0.10	0.13	0.15	0.17	0.18	0.19	0.22	0.24	0.26	0.27
8.0	0.10	0.13	0.15	0.16	0.18	0.19	0.21	0.23	0.25	0.26

Engineering Table 5. - Generalized irrigation efficiency criteria, Silt project, Colorado [1/]

Soil Groups	Farm [2/] conveyance losses	Field application efficiency	Farm [3/] irrigation efficiency
	Percent		
IIc,e,s; IIes,1,2; IIe1s1; IIIs,1,2,3; IVs	30	65	57
IIIes2, IVs2,4,5	25	55	53
IIIes1,3; IVs1,3	10	50	55
IIIe, IIIes	25	60	54
IVe2	10	45	52
IVe,1,4	20	50	49
Weighted Averages [4/]			
Evaluation Area A			55
B			49
C			56
D			49
E			55
F			50
G			55
H			51
Project			53

1/ By dominant soils
2/ Includes estimated losses in farm supply laterals
3/ Includes estimated re-use of tail water
4/ Rounded

GENERALIZED IRRIGATION CRITERIA
For
SILT PROJECT REAPPRAISAL REPORT

SOILS			CROPS					IRRIGATION SPECIFICATIONS					
L.C.U.	Typical profile description 1/	Typical available moisture holding capacity by foot increments of depth in./ft.	Locally adapted crops	Root zone depth feet	Average water replacement each irrigation 2/ Net inches	Peak period consumptive use rate in./day	Irrigation frequency during period of maximum consumptive use Max. days	Usual irrigation methods	Estimated typical average intake rate Furrow or corrugation g.p.m./100'	Maximum stream size Furrows or corrugations g.p.m.	Typical furrow or corrugation spacing inches	Approximate maximum length of run feet	Estimated time required hours
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Slope Group 2. percent (0-3)												
IIc,s	3231 3331	1.6	Alfalfa	6	5.0	.19	26	Corrugation	0.5	12	22	500	24
IIes,1,2		2.4	Rotation pasture	3	3.5	.19	18	Corrugation	0.7	12	22	400	12
IIe		2.4	Small grain	3	3.5	.18	19	Corrugation	0.7	12	22	400	12
IVs4	32H1	1.5	Corn	4	4.0	.18	22	Furrow	0.6	10	34	420	24
		1.5	Sugar beets	4	4.0	.17	23	Furrow	0.6	10	22	420	16
IIIs,1,2,3	2221 2231												
IVs	2121												
	Slope Group 4. percent (3-6)												
IIIe	3331	1.6	Alfalfa	6	5.0	.19	26	Corrugation	0.5	5	22	350	24
IIIes	3231	2.5	Rotation pasture	3	3.0	.20	15	Corrugation	0.6	4	22	250	12
		2.5	Small grain	3	3.0	.18	17	Corrugation	0.6	4	22	250	12
		1.6	Corn	4	3.7	.18	21	Furrow	0.5	4	34	270	27
		1.6	Sugar beets	4	4.0	.17	23	Furrow	0.5	4	22	270	18
IIIes1,3	2221	2.3	Alfalfa	6	4.0	.19	21	Corrugation	0.2	3	22	330	48
IVs3		2.3	Rotation pasture	3	4.0	.18	22	Corrugation	0.2	3	22	330	48
IVs1		2.3	Small grain	3	3.1	.17	18	Corrugation	0.2	3	22	280	36
		2.3	Corn	4	2.8	.20	14	Furrow	0.2	3	34	270	48
		2.3	Sugar beets	4	3.3	.18	18	Furrow	0.2	3	20	300	36
IIIes2	3331	1.5	Alfalfa	6	4.8	.19	25	Corrugation	0.4	4	18	300	23
IVs2		1.5	Rotation pasture	3	2.8	.20	14	Corrugation	0.5	4	20	240	12
IVs4,5		1.5	Small grain	3	2.8	.18	15	Corrugation	0.5	4	20	240	12
VIIs,s1		1.5	Corn	4	3.8	.18	21	Furrow	0.4	4	34	270	34
		1.5	Beets	4	3.8	.17	22	Furrow	0.4	4	22	270	22
	Slope Group 8. percent (6-12)												
IVe,e1	3231 3331	1.6	Alfalfa	6	4.0	.19	21	Corrugation	0.37	2	20	260	24
VIs1	3H	1.6	Rotation pasture	3	2.8	.20	14	Corrugation	0.56	2	22	200	12
		1.6	Small grain	3	2.8	.18	15	Corrugation	0.56	2	22	200	12
IVe2	2221 2231	2.3	Alfalfa	6	4.0	.17	23	Corrugation	0.17	2	10	250	24
		2.3	Rotation pasture	3	4.0	.18	22	Corrugation	0.17	2	10	250	24
		2.3	Small grain	3	4.0	.16	25	Corrugation	0.17	2	10	250	24
IVe4	33H3 32H3	1.5	Alfalfa	6	4.5	.20	22	Corrugation	0.4	2	20	180	24
	3331 3231	1.5	Rotation pasture	3	2.7	.20	13	Corrugation	0.56	2	24	140	12
		1.5	Small grain	3	2.7	.18	15	Corrugation	0.56	2	24	140	12
VIs	2121 22E2	2.0	Grass pasture	3	2.8	.19	15	Corrugation	0.5	2	20	200	12
	33C3 21H2	1.8	Small grain	3	2.8	.17	16	Corrugation	0.5	2	20	200	12
		1.6											
VIIs1,2	33H3 3H	1.5	Grass pasture	3	2.6	.20	13	Corrugation	0.56	-	22	140	12
		1.5											
	Slope Group 14 percent (12-25)												
VIe	3331	1.6	Grass pasture	3	2.8	.20	14	Contour ditch	---	-	--	100	8
		1.6	Small grain	3	2.8	.18	15	Contour ditch	---	-	--	100	8
VIIs,1,3		1.5	Grass pasture	1	1.0	.25	4	Contour ditch	---	-	--	100	4

1/ Grouped by characteristics of dominent acreage

2/ Normal replacement based on 60% extraction; salt content limiting in some soil units; replacement arbitrarily limited by time requirements or local conditions in some cases.

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Engineering Table 7. - Consumptive use requirements, Silt project

Month	Dates	f	Alfalfa k	Alfalfa u	Alfalfa r	Rotation pasture k	Rotation pasture u	Rotation pasture r	Corn k	Corn u	Corn r	Small grain k	Small grain u	Small grain r	Sugar beets k	Sugar beets u	Sugar beets r
Davie and Harvey Mesas - Evaluation Areas A, B, C and D																	
May	1-12	1.93	.70	1.35	.21	.65	1.25	.21									
	13-31	3.69	.85	3.14	.42	.80	2.95	.42	.75	2.77	.42	.75	2.77	.42	.70	2.58	.42
June		6.39	.85	5.43	.31	.80	5.11	.31	.75	4.79	.31	.75	4.79	.31	.70	4.47	.31
July		7.18	.85	6.10	1.18	.80	5.74	1.18	.75	5.38	1.18	.75	5.38	1.18	.70	5.03	1.18
Aug.	1-15	3.35										.75	2.51	.41			
	1-30	6.51	.85	5.53	.81	.80	5.21	.81	.75	4.88	.81				.70	4.56	.81
Sep.	1-15	2.70							.75	2.02	.67						
	1-30	5.01	.85	4.26	1.35	.80	4.01	1.35							.70	3.51	1.35
Oct.	1-22	2.94	.70	2.06	.56	.65	1.91	.56									
Totals				27.87	4.84		26.18	4.84		19.84	3.39		15.45	2.32		20.15	4.07
Consumptive use requirement (U-R) ins.				23.03			21.34			16.45			13.13			16.08	
Dry Elk Valley - Evaluation Areas E, F, G and H																	
May	1-22	4.00	.70	2.80	.61	.65	2.60	.61									
	23-31	1.46	.85	1.24	.21	.80	1.17	.21	.75	1.10	.21	.75	1.10	.21	.70	1.02	.21
June		6.23	.85	5.30	.57	.80	4.98	.57	.75	4.67	.57	.75	4.67	.57	.70	4.36	.57
July		7.02	.85	5.97	1.24	.80	5.62	1.24	.75	5.27	1.24	.75	5.27	1.24	.70	4.91	1.24
Aug.	1-25	5.27										.75	3.95	.72			
	1-31	6.36	.85	5.41	.96	.80	5.09	.96	.75	4.77	.96				.70	4.45	.96
Sep.	1-20	3.40							.75	2.55	.93						
	1-27	4.45	.85	3.78	1.24	.80	3.56	1.24							.70	3.12	1.24
	28-30	.43	.70	.30	.14	.65	.28	.14									
Oct.	1-18	2.33	.70	1.63	.54	.65	1.51	.54									
Totals				26.43	5.51		24.81	5.51		18.36	3.91		14.99	2.74		17.86	4.22
Consumptive use req. (U-R) ins.				20.92			19.30			14.45			12.25			13.64	

Engineering Table 8. - Water supply requirement estimates, Silt project

Crop	Net consumptive use requirement Inches	Net crop acres	Seasonal consumptive use requirement Acre-feet	Net crop acres	Seasonal consumptive use requirement Acre-feet	Net crop acres	Seasonal consumptive use requirement Acre-feet	Net crop acres	Seasonal consumptive use requirement Acre-feet
		- Evaluation Area A -		- Evaluation Area B -		-Evaluation Area C -		- Evaluation Area D	
Alfalfa	23.03	1253	2404.7	658	1262.8	148	284.0	60	115.1
Pasture	21.34	633	1125.7	326	579.7	241	428.6	85	151.2
Corn	16.45	270	370.1	-	-	77	105.6	-	-
Small grain	13.13	492	538.3	390	426.7	77	84.3	58	63.5
Beets	16.08	375	502.5	-	-	75	100.5	-	-
Total			4941.3		2269.2		1003.0		329.8
Weighted average farm irrigation efficiency			55%		49%		56%		49%
Total farm delivery requirement, acre-feet			8984.2		4631.0		1791.1		673.1
Irr. acres per evaluation area			3218		1462		657		215
Farm headgate delivery reqmt. acre-feet/irrigable acre			2.79		3.17		2.73		3.13
		- Evaluation Area E -		- Evaluation Area F -		- Evaluation Area G -		- Evaluation Area H	
Alfalfa	20.92	107	186.5	108	188.3	123	214.4	88	153.4
Pasture	19.30	15	24.1	12	19.3	72	115.8	144	231.6
Corn	14.45	24	28.9	-	-	19	22.9	-	-
Small grain	12.25	24	24.5	47	48.0	57	58.2	93	94.9
Beets	13.64	-	-	-	-	50	56.8	-	-
Total			264.0		255.6		468.1		479.9
Weighted average farm irrigation efficiency			55%		50%		55%		51%
Total farm delivery requirement, acre-feet			480.0		511.2		851.1		941.0
Irr. acres per evaluation area			181		177		341		346
Farm headgate delivery reqmt. acre-feet/irrigable acre			2.65		2.89		2.50		2.72

Engineering Table 9. - Project water supply requirement summary

	Harvey Mesa	Davie Mesa	Dry Elk Valley	Project Total
Evaluation areas	A & B	C & D	E,F,G & H	
Irrigable acreage	4680.	872.	1045.	6597.
Gross irrigation water requirement at farm headgate, acre-feet	13615.	2464.	2783.	18862.
Acre-feet/irrigable acre	2.91	2.83	2.66	2.86
Proposed average project water supply at farm headgate, acre feet/ irrigable acre	2.74	2.71	2.74	2.74
Percent of estimated requirements met by proposed project water supply	94.1	95.8	100.	95.7

Engineering Table 10. - Development cost estimates, Silt project, Colorado

	Cost Per Irrigable Acre				
	Clearing	Leveling	Farm Irrig. System	Drainage	Total
	Dollars				
Evaluation Area A	1.20	36.24	15.43	12.16	65.03
Evaluation Area B	0.90	15.05	8.59	1.53	26.07
Evaluation Area C	-	31.70	34.83	-	66.53
Evaluation Area D	-	23.44	28.93	-	52.37
Evaluation Area E	-	24.86	14.18	-	39.04
Evaluation Area F	-	18.15	8.75	-	26.90
Evaluation Area G	2.63	39.82	27.32	-	69.77
Evaluation Area H	4.56	18.00	15.36	-	37.92

E C O N O M I C S E C T I O N

Economic table 1 - Projected farm operating costs, Silt project, Colorado

Item	Unit	Price
		Dollars
Crops		
Alfalfa seed (10# per acre)	Pound	.40
Pasture seed (19# per acre)	Pound	.40
Corn seed (17# per acre)	Pound	.17
Sugar beets (6# per acre)	Pound	.55
Custom and contract hire:		
Farm labor	Man hour	1.00
Cutting hay	Acre	1.00
Raking hay	Acre	1.00
Baling hay	Ton	5.00
Baling straw	Ton	7.50
Chopping corn	Acre	16.00
Hauling corn silage	Hour	3.00
Combining grain	Acre	5.50
Thinning beets	Acre	17.50
First hoeing	Acre	8.00
Second hoeing	Acre	5.00
Pulling topping, loading by machine	Per ton	1.50
Hauling to dump	Per ton	1.00
Baling twine	Ton	.60
Baling wire	Ton	.90
Plastic silage cover	Per ton of silage	.50
Commercial fertilizer:		
Phosphate (available)	Pound	.10
Nitrogen (available)	Pound	.15
Spraying: 1/		
Alfalfa (insects per cutting)	Acre	.50
Corn (weeds)	Acre	.50
Grain (weeds)	Acre	.50
Livestock		
Veterinary and supplies (beef)	Cow	2.00
Veterinary and supplies (feeders)	Head	1.50
Veterinary and supplies (dairy)	Cow	8.50
Veterinary and supplies (sheep)	Ewe	.50
Artificial insemination	Cow or heifer over 1 year	7.00

1/ Includes cost of materials only.

Economic table 1, continued

Item	Unit	Price
		Dollars
Livestock, continued		
Bull depreciation (beef)	10% of inventory value	
Buck depreciation	10% of inventory value	
Shearing (30¢ shearing + sack, twine, etc. 20¢)	Per head	.50
Salt	AU	.50
Death loss breeding herd (dairy)	3% of number or 3% of inventory value	
Death loss breeding herd (beef)	3% of number or 3% of inventory value	
Death loss feeder steers	2% of number or 2% of sales value	
Death loss farm sheep ewes	7.5% of number or 4.5% of inventory value and 4.5% of wool sales	
Range permits (beef): National forest, 3½ months $1.75; BLM, 1 month 15¢; private range, ½ month $1.50	Cow and calf	3.40
Herder (beef): Five months, $250 per month (500 cows)	Cow and calf	2.50
DHIA (.925¢ per cow month first 12 cows plus 30¢ per cow month over 12 cows)		
Concentrates	Ton	60.00
General		
Electricity (farm share):		
All farm types except dairy	Year	30.00
Dairy farms	Per cow	5.00
Telephone (farm share)	Year	20.00
Truck license and insurance	Year	45.00
Fire insurance (per $1,000 of building inventory)	Year	5.00
Blacksmith	Year	40.00
Farm organization fees (all except dairy)	Year	25.00
Auto (farm share)	Year	150.00
Truck (mileage 3,000 per year)	Fuel, oil & grease per mile	.029
Tractor	Fuel, oil & grease per hour	.41
Miscellaneous expenses (2% of crop, livestock and general expenses)		

Taxes	Assessed valuation
Livestock:	
Dairy cows	$50.00 per head
Range cows	36.00 per head
Calves	22.50 per head
Long yearlings	36.00 per head
Stock sheep	4.50 per head
Range bulls	90.00 per head
Bucks	15.00 per head

Taxes, continued	Assessed valuation
Machinery and equipment:	One-half of inventory value
Truck:	License and insurance $45.00
Buildings, other improvements	Twenty-seven percent of inventory value
Land:	
Evaluation areas A, B (without and all areas with)	$67.00
Evaluation areas E & F (without)	40.00
Irrigated permanent pasture	13.00 per acre
Rangeland	2.50 per acre

Mill levy 1957 includes ½ mill for Silt Water Conservancy District

School Dist. C-1	48.05	
School Dist. C-2	48.32	
School Dist. 10	44.16	
School Dist. 13	39.16	
Simple average	44.92	Use 44 mills without, 45 with

Projected inventory values

	Values per acre
Land and present water supply:	
Evaluation area A	$200.00
Evaluation area B	190.00
Evaluation area E	115.00
Evaluation area F	100.00
Range, improved	25.00
Range, unimproved	15.00
Permanent pasture (evaluation areas A & B)	75.00
Permanent pasture (evaluation areas E & F)	50.00

Livestock:	Value per head
Dairy cow	$250.00
Dairy heifer (over 1 year)	150.00
Dairy heifer (under 1 year)	75.00
Beef cow	175.00
Beef replacement heifer	75.00
Feeder steer	90.00
Feeder heifer	75.00
Range bull	250.00
Ewe (mature)	15.00
Ewe (young)	12.00
Buck	30.00
Buildings and improvements	60% of new cost
Machinery	60% of new cost

Based on price projections by the U. S. Department of Agriculture, September 1957.

Economic table 2 .- Estimated new cost, repairs and service life of farm equipment, Silt project, Colorado

Item	Description	New cost 1/	Annual repairs 2/	Service life 3/
		Dollars	Percent	Years
Truck	1 ton, dump hoist	2,450	3.0	10
Tractor	35-40 horsepower	2,450	1¼¢/hr. use	10
Plow	2X14" bottom, 2-way	480	4.0	16
Disk	Tandem	300	3.0	15
Harrow	3-section, spike	196	1.0	15
Land leveler 4/	Eversman	196	2.0	20
Grain drill 4/	10'	314	2.0	16
Corn planter 4/	2-row	113	2.0	16
Beet drill 4/	4-row	237	2.0	16
Combination cultivator 4/	Corn & beet, 5-row	250	2.0	10
Corn cultivator 4/	5-row	182	2.0	10
Corrugator shovels	5	20	---	10
Sprayer	Tractor-mount	195	5.0	10
Ditcher 4/	Blade, 7'	108	2.0	20
Mower	7'	323	5.0	10
Rake	Side delivery, 8'	460	5.0	15
Baler	PTO, large	2,360	3.0	12
Wagon	Rubber tired, hay	230	3.0	20
Trailer	Lowboy	196	2.0	20
Elevator	Portable, w/motor	200	5.0	20
Manure spreader 4/	75 bu.	274	2.0	15
Manure loader 4/		279	3.0	15
Fence control	Electric	50	5.0	11
Pipeline milker	3-unit, circular washing	2,140	3.0	30
Stalls & feeders 6/	Automatic feeders	1,017	2.0	30
Milk tank	Bulk, 300 gal.	2,500	2.0	30
Milk tank	Bulk, 400 gal.	2,895	2.0	30
Water heater	40 gal, electric	80	3.0	10
Sink	2-compartment	75	3.0	10
Small tools				5

1/ Inventory value 60 percent of new cost.
2/ Percentage of new cost.
3/ Based on a straight-line depreciation and a salvage value of 10 percent.
4/ One-half ownership.
5/ Five percent of new cost of all equipment except tractor, truck, baler, and dairy equipment.

Based upon price projections by the U. S. Department of Agriculture, September 1957.

Item	Description	Capacity	New cost 1/	Annual repairs 2/	Annual depreciation 3/
			Dollars	Percent	Percent
Milking parlor	Herringbone, double 3	50 cows	4,700	3.0	6.0
Open shed	26' X 96'	45 cows or 500 ewes	2,676	2.0	6.0
Open shed	26' X 72'	35 cows or 375 ewes	2,135	2.0	6.0
Open shed	26' X 48'	25 cows or 250 ewes	1,653	2.0	6.0
Calf shed	15' X 30'	11 calves	804	2.0	6.0
Calf shed	15' X 24'	9 calves	686	2.0	6.0
Calf shed	15' X 16'	6 calves	523	2.0	6.0
Lambing shed	See appropriate open shed				
Machine shed	26' X 36', open	Shown on all farms	1,332	2.0	6.0
Fence silo	24' X 80'	200 tons	217	5.0	15.0
Fence silo	24' X 64'	150 tons	168	5.0	15.0
Fence silo	24' X 40'	100 tons	113	5.0	15.0
Corral fences (dairy)	1½" pipe, 2 pipes high	175 sq. ft./cow	2.00/lin. ft.	---	6.0
Corral fences (feeders)	Slab-board, 6' high	100 sq. ft./head	1.00/lin. ft.	2.0	6.0
Corral fences (sheep)	Slab-board, 4' high	30 sq. ft./ewe	.75/lin.fft.	2.0	6.0
Corral & chutes (beef)	200'X100', pole fence, branding chute, adjustable loading chute	100-200 cows	1,300	2.0	6.0
Farm fences(dairy, beef, feeders)	4-strand barb	5 rds/acre	1.80/rod	2.0	6.0
Farm fences (cash crop)	4-strand barb	3/rds/acre	1.80/rod	2.0	6.0
Farm fences (sheep)	1-strand barb & net	5 rds/acre	2.75/rod	2.0	6.0
Mangers (dairy)	1½" pipe & concrete	30"/head of stock	4.85/lin. ft.	---	6.0
Mangers (feeders)	Lumber & concrete	24"/head	3.95/lin. ft.	2.0	6.0
Feeder panels (sheep)	Lumber	18"/head	1.00/lin. ft.	2.0	6.0
Concrete corral (dairy)	4" slab, reinforced	50 sq.ft./head	.25/sq. ft.	---	6.0
Domestic water supply	Dairy		500	2.0	6.0
Domestic water supply	Livestock		375	2.0	6.0
Domestic water supply	Cash crop		250	2.0	6.0

1/ Inventory value 60 percent of new cost.
2/ Percent of inventory values.

Based on price projections by the U. S. Department of Agriculture, September 1957.

Economic table 4.- Projected livestock production rates and feed requirements, 1/ Silt project, Colorado

Kind	Production	Annual basis: AU	Forage requirements: Winter AU	Winter Mo.	Pasture AU	Pasture Mo.	Residue AU	Residue Mo.	Concentrates
Dairy									
Cow	325# b.f.; calf crop 95%; 2/ 8 tons manure from cow and replacement; (cull cow wt. 1,200#)	1.41	1.27	7	1.27	5	---	-	1000# grain
Heifer (over 1 yr.)		.74	.74	6	.74	5	.74	1	
Heifer (under 1 yr.)		.37	.29	6	.29	5	.29	1	400# grain, 25# b.f.
Beef									
Cow	Calf crop 82%; 2/ Calf weight, steers 410#, heifers 375#; 2 tons manure (cull cow wt. 1000#)	.96	.70	6	1.32	5	.70	1	
Heifer (replacement)		.55	.42	6	.68	5	.68	1	
Feeders									
Heifer (yearling)	Purchase wt. 375#, sale wt. 750#) 2 ton manure	.55	.42	6	.68	4	.68	1	
Steer (yearling)	Purchase wt. 410#, sale wt. 800#) 2 ton manure	.61	.49	6	.73	5	.73	1	
Sheep									
Ewe	Lamb crop 120%; wool 10#; 3/ lamb wt. 90#; .4 tons manure (cull ewe wt. 135#)	.216	.18	6	.24	5	.18	1	74# barley

Dairy heifers required for herd replacement 25 percent of cow inventory.
Beef heifers required for herd replacement 20 percent of cow inventory.
Ewe lambs required for herd replacement 20 percent of mature ewe inventory.

1/ 5,110 TDN per AUM annually or 425 TDN per AUM net. When computing forage fed allow 6 percent loss or 450 TDN per AUM.

2/ At time of sale. For dairy calves, dal old; beef calves, 6-7 months; lambs 5-6 months.

3/ Average weight per head sheared.

Economic table 5 .- Labor requirements, man-hours per unit of livestock and miscellaneous items, Silt project, Colorado

Item	Unit	Hours
Livestock		
Dairy (45 cows) 1/	Per cow	65.0
Dairy (35 cows) 1/	Per cow	70.0
Dairy (25 cows) 1/	Per cow	80.0
Beef, breeding herd (100-150 cows) 1/	Per cow	10.0
Feeder calves	Per head	4.0
Sheep, breeding flock (240-450 ewes) 1/ 2/	Per ewe	3.0
Miscellaneous		
Hauling manure 3/	Per ton	.4
Spreading commercial fertilizer 3/ 4/	Per acre	.5
		Percent
Machinery repair 5/	Inventory value	0.5
Overhead 3/	Crop & livestock labor	5.0

1/ Includes replacement stock.
2/ Includes shearing.
3/ Both man and tractor hours.
4/ Applies only when commercial fertilizer is applied separately from manure.
5/ Man hours only.

Economic table 6 .- Labor, tractor, and truck requirements, per acre of different crops by evaluation areas, Silt project, Colorado

Crop	Without project development				With project development			
	Yield	Man labor Hours	Tractor Hours	Truck Hours	Yield	Man labor Hours	Tractor Hours	Truck Hours
Evaluation area A								
Alfalfa	3.0	11.60	5.10	2.1	4.0	14.7	6.2	2.7
Barley	60.0	8.75	5.85	.7	70.0	9.75	5.85	.8
Corn silage	11.5	15.95	9.75	2.0	15.0	17.3	10.0	2.1
Sugar beets	13.5	40.55	8.55	4.8	16.0	41.85	8.65	5.0
Rotation pasture	6.0	3.1	1.0	-----	8.0	5.1	1.8	-----
Evaluation area B								
Alfalfa	2.8	12.75	5.8	1.95	3.5	15.85	7.05	2.4
Barley	55.0	9.35	6.0	.65	60.0	10.4	6.0	.6
Rotation pasture	5.6	3.75	1.05	-----	7.0	6.2	1.9	-----
Evaluation area C								
Alfalfa	-----	-----	-----	-----	4.0	14.7	6.2	2.7
Barley	-----	-----	-----	-----	70.0	9.75	5.85	.8
Corn silage	-----	-----	-----	-----	15.0	17.3	10.0	2.1
Sugar beets	-----	-----	-----	-----	16.0	41.85	8.65	5.0
Rotation pasture	-----	-----	-----	-----	8.0	5.1	1.8	-----
Evaluation area D								
Alfalfa	-----	-----	-----	-----	3.5	15.85	7.05	2.4
Barley	-----	-----	-----	0----	60.0	10.4	6.0	.6
Rotation pasture	-----	-----	-----	-----	7.0	6.2	1.9	-----
Evaluation area E								
Alfalfa	1.7	6.45	2.55	1.10	3.7	14.3	6.1	2.55
Barley	50.0	8.10	5.75	.6	70.0	9.75	5.85	.8
Corn silage	-----	-----	-----	-----	15.0	17.3	10.0	2.1
Sugar beets	-----	-----	-----	-----	16.0	41.85	8.65	5.0
Rotation pasture	3.4	2.1	.9	-----	7.4	5.1	1.8	-----
Evaluation area F								
Alfalfa	1.5	7.0	2.80	1.00	3.2	15.35	6.85	2.25
Barley	45.0	8.6	5.9	.55	60.0	10.4	6.0	.6
Rotation pasture	3.0	2.45	.95	-----	6.4	6.2	1.9	-----
Evaluation area G								
Alfalfa	-----	-----	-----	-----	3.7	14.3	6.1	2.55
Barley	-----	-----	-----	-----	70.0	9.75	5.85	.8
Sugar beets	-----	-----	-----	-----	16.0	41.85	8.65	5.0
Rotation pasture	-----	-----	-----	-----	7.4	5.1	1.8	-----

Economic table 6, continued

Crop	Without project development: Yield	Without project development: Man labor Hours	Without project development: Tractor Hours	Without project development: Truck Hours	With project development: Yield	With project development: Man labor Hours	With project development: Tractor Hours	With project development: Truck Hours
Evaluation area H								
Alfalfa	----	----	----	----	3.2	15.35	6.85	2.25
Barley	----	----	----	----	60.0	10.4	6.0	.6
Corn silage	----	----	----	----	15.0	17.3	10.0	2.1
Rotation pasture	----	----	----	----	6.4	6.2	1.9	----
Permanent pasture								
Evaluation areas A&B	3.0	2.3	.55	----	3.0	2.3	.55	----
Evaluation areas E&F	2.0	1.45	.45	----	2.0	1.45	.45	----

onomic table 7.- Method of arriving at annual value of rotation pasture per AUM based on alfalfa hay value, when fed to livestock on farms, evaluation area A, with project development, Silt project, Colorado

Item and description	Alfalfa (4.0 tons)					Pasture (8.0 AUM)				
	Man-hours per acre	Production costs				Man-hours per acre	Production costs			
		Materials	Tractor 1/	Labor 2/	Total		Materials	Tractor 1/	Labor 2/	Total
	Hours	Dollars	Dollars	Dollars	Dollars	Hours	Dollars	Dollars	Dollars	Dollars
lowing, seedbed preparation and planting (misc. crop)	- - - - -	- - - - -	- - - - -	- - - - -	charged to small grains	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
eed		.80			.800		1.52			1.52
ertilizing 3/	.1	3.00	.055	.111	3.166	.6	9.60	.330	.666	10.596
praying	.4	1.50	.22	.444	2.164					
preading droppings						.5		.275	.555	.830
enovating	.3		.165	.333	.498					
lipping pasture						1.0		.55	1.11	1.66
owing	1.5		.825	1.665	2.490					
aking	1.5		.825	1.665	2.490					
aling	2.2	2.40	1.22	2.442	6.062					
auling & stacking	5.4			5.994	5.994					
itching	.3		.165	.333	.498	.3		.165	.333	.498
rrigating	3.1			3.441	3.441	3.3			3.663	3.663
nventory 4/		1.03			1.030					
verhead 5/	.74		.174	.821	.995	.29		.066	.322	.388
iscellaneous 6/		.175	.073		.248		.222	.028		.250
Total	15.54	8.905	3.722	17.249	29.876	5.99	11.342	1.414	6.649	19.405
xpense difference										10.47
alue of alfalfa @$20.60										82.40
ess 5% shrinkage										4.12
ross value of alfalfa										78.28
ess difference in expenses										10.47
ross value of pasture										67.81
alue per AUM										8.48

1/ Tractor cost 55¢ per hour.
2/ Man labor cost $1.11 per hour.
3/ Assumes phosphate applied at time of seeding and trogen applied annually.
4/ One-fourth of alfalfa production, $20.60 per ton @5 percent
5/ Five percent of tractor and man labor cost.
6/ Two percent of material costs.