WORK REPORT

DETAILED CONSERVATION

SURVEY

****

BLACK FALLS IRRIGATION PROJECT

LAND MANAGEMENT UNIT 3

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U. S. DEPARTMENT OF INTERIOR

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1941

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ALL SERIES NAMES

are provisional

PENDING FINAL CORRELATION

by

THE INTERBUREAU CORRELATION COMMITTEE

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INTRODUCTION

The Black Falls Irrigation Project is on the north side of the Little Colorado River, in the extreme southeastern part of L.M.U. #3, Coconino County, Arizona.

It is 31 miles northwest of Leupp, Arizona and 36 miles south of Tuba City, Arizona by airline. An unimproved road, branching from the Leupp-Oraibi road approximately 16 miles north of Leupp, leads approximately 29 miles northwest to the project.

The project is an elongated or rectangular shaped area, lying adjacent to the Colorado river.

The extent of the survey was limited to the land adjacent to the river below the diversion dam from the Little Colorado River.

The most striking topographic features of the area are the geologically recent Igneous Basaltic-Lava fields that have followed the channel of the River the entire length of the project. These formed the falls from which the area is named; floods have obliterated the falls and a series of rapids is all that is left to mark their location.

These Basaltic-Lava materials are partially embedded beneath recent alluvium. This has acted as a water barrier causing impounding of backwater and consequent deposition of very heavy textured, compact, highly collodial materials impregnated with alkali on the site now included within the project.

The recent alluvium that lies adjacent to the Basaltic-Lava materials has a level to gently undulating or moderately hummocky topographic terrain.

The purpose of the survey was to gather and compile data necessary to evaluate the quality and quantity of land adapted to irrigation.

There are three rather noticeable vegetative associations. Sacaton (Sporobolus airoides) grows on the loamy sand and sandy loam surface types of the Hunt series, a soil having characteristic heavy clay subsoil. Shadscale (Atriplex confertifolia) grows on the clay types of the Hunt series. Greasewood (Sarcobatus vermiculatus) is found in association with both the sacaton and shadscale where the alkali content is often the highest. Scattered clumps of chamise (Atriplex canescens), big rabbit brush (Chrysothamnus biglovii) and Norman tea (Ephedra spp.) are growing on the sandy soils of the Tolani series in the lower part of the areas.

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CLIMATE

No climatological data are available for the project; however, Table I is a summary of the data in tabular form compiled from records at Winslow, Flagstaff, Grand Canyon, Leupp, and Tuba City, Arizona. An estimation of the climatological data for Black Falls is also included.

The elevation of the project is approximately 4100 to 4250 feet above sea level. Low annual rainfall, mild winters, very warm summers, high winds, low humidity, and a high percentage of sunshiny days are characteristic of the area.

AGRICULTURAL HISTORY and PRACTICES

There is no evidence that the area proper has ever been farmed, but there are a few small areas immediately adjacent to the Little Colorado River that are being farmed by utilizing the flood plains areas built up by the river. These areas are not shown on the Conservation map.

CONSERVATION SURVEY

A rapid reconnaissance survey was made of the area in May, 1940 by H. F. Johnson, but the findings were not backed by sufficient soil samples to indicate the excessive alkali content almost universally present.

A Detailed Conservation Survey was made between March 24 and April 1, 1941 by L. A. Bronaugh. Engineering topographic maps of a scale 1" = 200' were used as base maps, except for a small area on the northwest end where an extension to the base map was made at the time of the survey.

Analysis of the data collected indicated that there were only 129 acres or 6.4 percent of the project adapted to irrigated agriculture; while 393 acres or 19.6 percent was considered marginal land; and 1475 acres or 74.0 percent was not recommended because of shallow profiles, rough relief, excessive alkali content, excessive wind accumulations, and/or slowly pervious profiles.

Four factors were mapped and indicated in the composite symbol, namely, soil type, slope group, erosion, and land class. The land use symbol normally included was excluded because all the land was in pasture status. It will be included only in the "Conservation Survey Legend" which gives the complete limitations of the symbols used and is outlined in Appendix IV.

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Table I. Climatological Data from Weather Stations near Black Falls*

Station & Length of Complete Record	Elevation (Feet)	Length of Growing Season (Days)	Average Annual Temperature (F°)	Average Maximum Temperature (F°)	Average Minimum Temperature (F°)	Extreme Minimum Temperature (F°)
Flagstaff 27	6907	116	45.4	60.0	30.8	-25
Grand Canyon 21	6866	133	47.3	62.4	32.3	-22
Leupp 9	4750	-	53.4	-	-	-12
Tuba City 22	4500	179	54.7	-	-	-15
Winslow 18	4848	165	54.3	70.7	37.8	-10
Black Falls **	4175	130	55.0			-10

Table I. (cont'd)

Extreme Maximum Temperature (F°)	Average Annual Precipitation (in.)	Average Date Last Killing Frost in Spring	Average Date First Killing Frost in Fall	Latest Date of Killing Frost in Spring	Earliest Date of Killing Frost in Fall
92	22.8	June 6	Sept. 30	July 5	Sept. 9
98	18.13	May 21	Oct. 1	June 17	Sept. 5
105	-	-	-	-	-
104	6.94	April 23	Oct. 19	May 9	Sept. 19
106	8.73	May 4	Oct. 16	June 2	Sept. 27
110	6.0	April 20	Oct. 20	-	-

* "The Climate of Arizona", by H. V. Smith, University of Arizona, College of Agriculture, Agriculture Experiment Station Bulletin No. 130.

** Estimated.

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The soils have been systematically classified according to origin, profile characteristics, and surface texture into 3 series representing 11 soil types, phases and complexes, exclusive of rough broken land, rough stony land, igneous materials, Dune sands and Riverwash.

These soils are light brown to dark reddish brown in color, extremely low in organic matter, contain large quantities of alkali salts, vary from low to high in lime (calcium carbonate) content, and contain large quantities of various calcium, magnesium, sodium, and potassium salts. Phosphorus, while probably present in comparatively large quantities, occurs as an insoluble compound with calcium and is largely unavailable to plants.

The three series mentioned above, Dinnehotso, Tolani, and Hunt, are listed according to their numerical importance. See Appendix I for typical description of each series.

Dinnehotso sandy loam soil type (57.7), comprises 107 acres or 5.3 percent of the total, and is the only soil type of this series. It was evaluated as Class C land because of its high alkali content and steep slope; with specific reference to those areas fanning from the sandstone escarpments, the topsoil has essentially been lost by the combined action of wind and water removal. The remaining soil profile is extremely low in organic matter and soil nutrients, and high in alkali salts.

The Tolani (68) soil types, namely;loamy sand, sandy loam, and clay loam, totalling 248 acres or 12.5 percent of the area, were mapped entirely in the extreme lower end of the project.

The loamy sand and sandy loam soil types were rated the best in the project; however, they contain appreciable amounts of black alkali and have a very high pH value. They are the only soils which do not contain sufficient white alkali salts to exceed the tolerance of most cultivated plants. These soils are extremely sandy throughout the profile, consequently, they are droughty. Most of the water available for irrigation from the Little Colorado River contains a considerable amount of suspended material, primarily silt and clay. This material should build the sandy land up from season to season. The high border method of impounding water would probably effect silting the most rapidly.

The low organic matter content could be built up by the usual application of barnyard manure, growing legumes, and turning under green manure crops.

The present high pH of these soils may limit the growing of certain crops. If the application of irrigation water and incorporating manures does not lower this, small application of sulphur should be made.

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FIGURE I

Tolani clay loam soil type (68.13) near Base line Station 229+62 represents the area classified D land because of extremely high alkali salt accumulations. Note the crusted surface soil and the sparse vegetative cover. San Francisco Peaks, near Flagstaff, Arizona in the background.

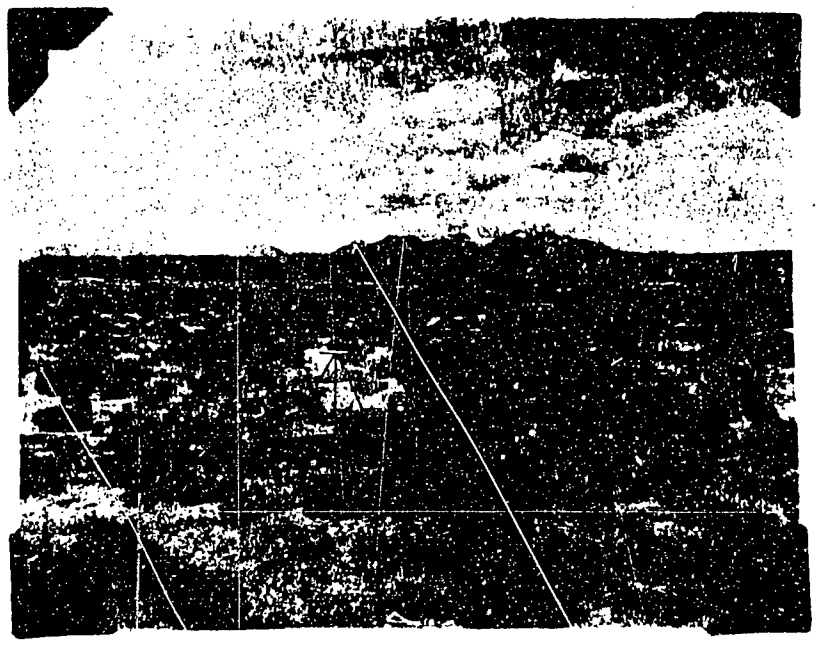

FIGURE II

Moderate wind accumulations on the Hunt loamy sand soil type (60.4). This soil appears to be good land; however, the sandy top-soil is closely underlain by slowly pervious clay and alkali inhabited substratum and was classified C land. This area is centrally located between Base line Stations 166+60 and 185+70. Note the Lava Flow materials that mark the southern boundary of the alluvial soil in immediate background and San Francisco Peaks in the distance.

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The clay loam soil type is not recommended because of excessive quantities of alkali present throughout the profile. See Table IV, soil type 68.13; also Figure I. Reclamation of this land would probably be unsuccessful because the present high water table would probably interfere with attempts to leach the alkali salts.

The Hunt (60) soil types, namely; loamy sand, loamy sand wind blown phase, loamy sand - Igneous (lava) complex, clay loam, light clay, heavy clay, and heavy clay - Igneous (lava) complex, represent 793 acres or 39.8 percent of the total, all classified as Class C or D land, with the exception of 8 acres of the loamy sand wind blown phase which was classified as Class B-.

This group of soils constitutes the main body of land in the project, but with the exception of the above noted area they are not agriculturally adapted to most crops.

Approximately 300 acres, which include portions of loamy sand, Clay loam, and light clay soil types, were classified as C land because these areas quite possibly could be irrigated successfully for a number of years, but it is expected that eventually profitable cultivation could not be maintained without resorting to intensive artificial drainage or reclamation.

Within the loamy sand soil type of the Hunt series, probably the best land is found surrounding soil sample #23 or northwest of Base line Station 185+70 and the second best soil within the soil type delineation marked by soil sample #20. Figure II shows the area immediately west of sample #20. These areas have from 2 to 3 feet of sandy and mostly alkali free topsoils, but are underlain by very compact and slowly pervious clay subsoils. This part of the profile contains high concentration of alkali salts, but not nearly the concentrations associated with the areas classified as D land.

If subjugated, the sandy topsoil should remain essentially intact and thereby prevent exposing the less productive and alkali inhabited subsoil.

The best of the relatively poor clay loam and light clay soil types are found immediately surrounding the escarpment at Base line Station 124+65 and are class "C" land. The remaining areas were classified as D land mainly because of the high alkali content and extremely heavy surface texture. See Figure III. These high alkali concentrations would not be considered so serious if it were not for the compact and slowly pervious clay subsoil universally exhibited in all profiles. Very little leaching of white alkali can be expected and the amount

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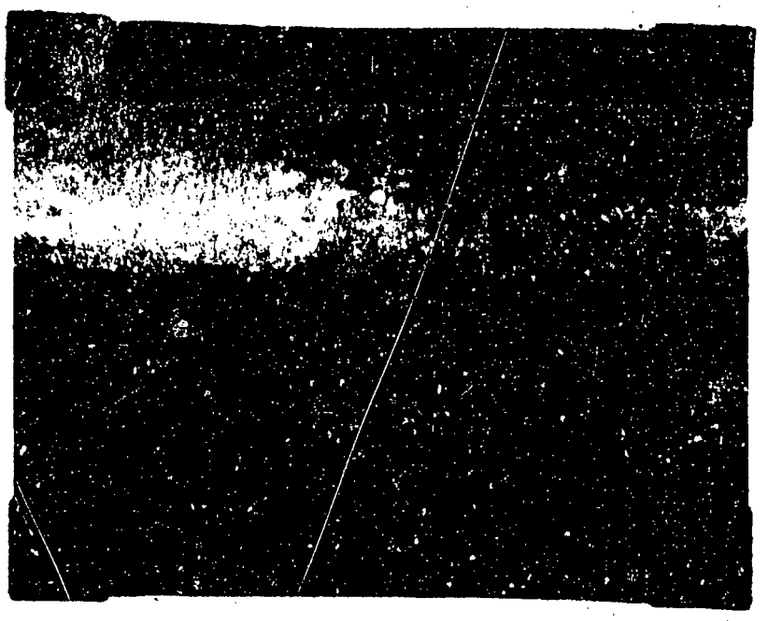

FIGURE III

Typical vegetative growth on Hunt heavy clay soil type (60.18). This and similar areas were classified D land because of high alkali salt accumulations within the compact, heavy-textured and slowly pervious profiles. Note the dispersed "slick" nature of the surface soil.

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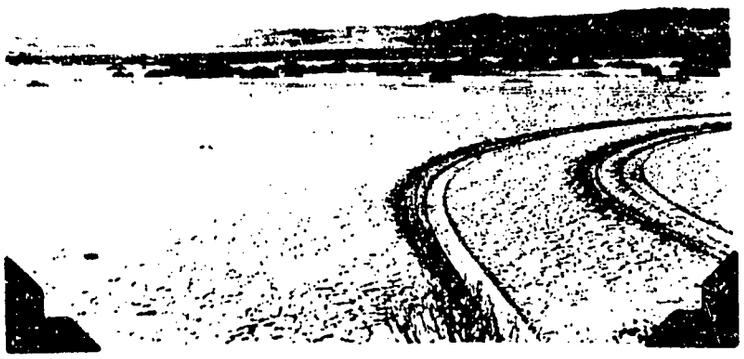

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already present is considered detrimental to the g th of most cultivated plants.

Four types of Skeleton soil materials and one area called Dune Sand, constituting 849 acres or 42.4 percent of the total, were classified as D land, namely:

Riverwash (35). The bottoms of wide drainages, low flats and sand bars are mapped as riverwash. They comprise 50 acres or 2.5 percent of the total. These areas consist of a wide variety of unsorted materials and have very little value, either for crops or grazing.

Rough Broken Land (19B). The rough broken land, occupying 25 acres or 1.3 percent of the total area, consists primarily of bare, exposed and badly eroded residual geologic materials.

Rough Stony Land (19S). This land consists primarily of bare, exposed sandstone slopes and escarpments and is devoided of vegetation. It represents 225 acres or 11.1 percent of the total area in project.

Igneous-Lava materials (19I). This lava material comprises 538 acres or 26.9 percent of the area and is very prominent throughout the project. It marks the southern boundary of most of the arable area in the lower part of the project and is scattered rather densely over the area in the upper part.

Dune Sand (D). This represents areas of extreme wind accumulations and consequently are very sandy, unstable, and unproductive. If economical to subjugate, some of this land may be made productive by the application of silty water.

SLOPE

The slope grouping is an array of slopes as outlined in Appendix IV. These are general and not as accurate in any way as the topographic maps.

EROSION

This project is located in an area of high summer temperature, low humidity, low annual rainfall, and strong southwesterly winds, with wind the primary eroding factor.

Most seriously affected are the Tolani loamy sand and sandy loam soil types in the extreme lower end of the project. Portions of this area have been rendered useless for irrigation by sand dunes. Pre-

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cautionary measures against further wind activity should be taken in this area because it constitutes the best soil in the project. The sand dunes located along the extreme western side of the project should be controlled because they are gradually spreading to the arable land. The wind action elsewhere on the project is confined to the sandy loam and loamy sand soil types and is only moderately severe because these surface textures are closely underlain by a compact clay subsoil.

LAND CLASS

A definition of the five land classes is outlined in Appendix II. A summary of the acreage of land class by soil types is found in Table II.

No class "A" land was mapped because the soils encountered were high in various alkali salts.

Forty-eight acres of class "B" and 81 acres of class "B-" land were mapped and represented 6.4 percent of the total.

A higher dispersion ratio and black alkali content were tolerated within these two classes than usually is excepted because this represents the best soils of an otherwise poor or doubtful group of soils.

Three hundred and ninety three acres or 19.6 percent of the total acreage were placed in the Class "C" group. These soils carry excessive accumulations of various alkali salts. The concentration of both white and black alkali as well as the dispersion ratio exceeds the tolerance limitations set up for C land.

The largest group, comprising 1475 acres or 74.0 percent, were the soils evaluated as class "D". Very high concentrations of alkali, high dispersion and heavy compact clay in the topsoil and/or subsoil warranted this evaluation. The skeleton soils materials and the highest alkali inhabited soils were confined to this class.

IRRIGATION, DRAINAGE, and ALKALI

Irrigation is necessary for the production of crops in the Black Falls Project. The source of irrigation water is direct diversion from the Little Colorado River, a stream that usually goes dry for a period during the early summer months.

Analysis of the water samples collected to date from the Little Colorado River at Leupp, Arizona indicates that the quality of the

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water as adapted to irrigation, varies from poor to good, apparently depending upon the origin of the run-off from the upper watershed.

An average of all the water samples were compiled and consequent result checked against the various methods used in determining the suitability of the water for irrigation. See Table IIIA. A summary of these methods indicates the quality of the water over a period of time to be fair or permissible for use on soils having excellent subdrainage such as the Tolani and Dinnehotso soil types, and of doubtful quality when applied on the heavy subsoil lands of the Hunt soil types. How soon trouble might be anticipated on the heavier land would be difficult to anticipate.

Additional water and silt samples are being collected, and a supplement report will be written on these samples, if they do not correlate with the original findings.

In general, internal drainage is inadequate. This is particularly true for the Hunt soil types, representing two-thirds of the alluvial land, because they universally have a compact, heavy-textured, and slowly pervious substrata. To successfully effect artificial drainage would probably necessitate drains so close together that the cost would be prohibitive.

The Dinnehotso sandy loam soil type has adequate subdrainage and the Tolani sand and sandy loam soil types are almost excessively drained.

The alkali salt concentrations and the dispersion ratio are very high, irrespective of soil series, soil type, or location with the exception of small areas of Tolani loamy sand and sandy loam soil types representing 6.4 percent of the total area.

In most of the areas already affected it is felt that leaching cannot be effected because of poor subdrainage.

SUMMARY

Of the total 1997 acres within the Black Falls Project, 129 acres or 6.4 percent are recommended for irrigation; 393 acres or 19.6 percent are placed in the marginal group; and 1475 acres or 74.0 percent are not recommended.

The best land is located immediately north of Base line Station 240+92 or within the Tolani loamy sand and sandy loam soil types.

The quality of the irrigation water as adapted to irrigation, varies from poor to good, apparently depending upon the origin of the run-off from the upper watershed.

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Lawrence A. Bronaugh
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Table II. Acreage of Soil Types in Agricultural Soil Groups

Soil Types	A	B	B-	C	D	Total Acres Type	Series Total Acres	Percent
35					50	50	50	2.5
D					11	11	11	.6
19B					25	25	25	1.3
19S					225	225	225	11.1
19I					538	538	538	26.9
57.7				77	30	107	107	5.3
60.4				146	83	229		
60.4 W			8			8		
60.4 (19I)				84		84		
60.13				24	94	118		
60.16				62	113	175		
60.18					94	94		
60.13(19I)					85	85	793	39.8
63.4		73				73		
68.7	48					48		
68.13					127	127	248	12.5
Total	48	81	302	1475		1997	1997	
Percent	2.4	4.0	15.1	74.0				100.0

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