5-1924

A Study to Determine the Feasibility of Irrigating the Lands Included in the Cache Valley Water Conservation District No. 1

I. Donald Jerman
Utah State University

Utah Agricultural College,
Logan, Utah.
May 1, 1924.

Professor George D. Clyde,
Acting Head of the Department of Irrigation,
School of Agricultural Engineering,
Utah Agricultural College.

Dear Sir:

In accordance with the rules and regulations of the Department of Irrigation and Drainage of the Utah Agricultural College for a Degree of Master of Science in the Department of Irrigation Engineering. I hereby submit a thesis entitled "A Study to Determine the Feasibility of Irrigating the Lands Included in the Cache Valley Water Conservation District No. 1."

Respectfully submitted.

Candidate for Degree of
Master of Science in Irrigation
Engineering.

A Study to Determine the Feasibility of irrigating the lands Included in the Cache Valley Water Conservation District No. 1

By

I. Donald Jerman

THESIS

Submitted in partial satisfaction of the requirements for the degree of:

MASTER OF SCIENCE

in

Irrigation Engineering

in the

SCHOOL OF AGRICULTURAL ENGINEERING

of

The Utah Agricultural College

Approved....George D. Clyde....
Instructor in charge

Deposited in the Utah Agricultural College Ligrary.

....
Date Librarian

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The results of balancing the cost against the returns, show the interest on the investment to be 7.4%. With this rate of interest, and the assurance of the investment being secure, makes the project a paying proposition, therefore it must be declared feasible.

Due to the fact that the complete area is to be put under cultivation in order to make the above statements correct, the following recommendations should be adhered to:

1. The irregular land should be leveled to insure proper application of water.

2. Drainage should be installed where needed.

3. Organic material should be added to all retentive and compact soils.

4. Alkali resisting crops should be planted and leaching with irrigation water should be practiced ~~and~~ on the areas of high alkali concentration, until the areas are in proper condition for other crops.

5. Systematic rotation should be practiced, with an intense and diversified cropping.

6. Cattle raising should be practiced, by all farmers, which will furnish work the year round. It also means that the waste product from the feeding of the cattle will be left on the farm, which should be added to the soil.

7. Due to the fact that the district is under a heavy indebtedness, an effort should be made by all land holders to

cultivate their lands in a systematic manner. If this is done the indebtedness will be liquidated according to the requirements. The failure of this district to meet their requirements has placed a burden on irrigation districts through out the State. New Districts find that it is almost impossible to sell bonds unless at a heavy discount and the fate of many desirable districts is tied up, due to the supposed failure of this district. It is therefore the duty of all persons concerned to put this district on a paying basis, by cultivating the ground, and producing profitable crops, in this way secure the confidence of the bond houses as well as the public at large.

8. There are possibilities of a progressive irrigation enterprise on this district if the owners put forth the necessary effort. After the lands under the district as it now stands are reclaimed and paying a profit, the district may be extended, but this should not be done until a success is secure on the present area. A success will come, only through intense and diversified farming throughout the complete area.

INTRODUCTION

The purpose of this report is to investigate the feasibility of irrigating the lands of the Cache Valley Water Conservation District No. 1. The district, as it now stands, is very much in need of many improvements. The main canals are now in use and are in a good condition to serve all the lands with the required amount of water, but the few laterals that are now constructed, are in a poor condition, with the remaining laterals yet to be finished.

Before successful irrigation can be practiced, a large portion of the land will require leveling and small areas are water-logged, which will require drainage.

The soils of the area are of an impervious nature, and alkaline to some extent, which will require a definite method of procedure to put them in condition for plant growth.

This report consists of a study of the factors affecting the feasibility of irrigating this district and includes a suggested program of reclamation.

ACKNOWLEDGMENTS

The maps of the district, used in this report, were taken from data secured by the Utah Experiment Station.

Valuable assistance was obtained from Prof. George D. Clyde in assembling material.

Direct information was secured from Mr. W. R. Ballard, President of the District.

Information was obtained from "Principles of Irrigation Practice" by Widtsoe.

"Irrigation Practice and Engineering," by Etcheverry.

CHAPTER 1

Description of Cache Valley.

Cache Valley is a fertile, slightly uneven plain, about twelve miles wide, and sixty miles long, almost entirely under cultivation. It is one of the most attractive and healthful valleys in the west.

Logan is the county seat of Cache County, located in the south-eastern part of the valley and has a population, thrifty and progressive, of nearly ten thousand.

The Agricultural lands of the valley vary in elevation from 4,400 to 5,000 feet above sea level and are included within the old Lake Bonneville area. The soils are alluvial. They were deposited during the lake stage and modified by other deposits, which were carried in by several streams and rivers. After Lake Bonneville receded, these streams and rivers further modified the soil distribution, especially on the east side, by cutting through the old beach line, depositing and redistributing this material further out on the lake bed. Generally speaking, the soils of the east vary from sandy, gravelly benches, to the heavy clay loams near Bear River and on the west side they are of the clay, and clay loam types.

Location of Proposed Project.

Cache Valley Water Conservation District No. 1, is located on the west side of Cache Valley, about ten miles in that direction from Logan City, the same being south of Bear River and west of Logan River, and extending westward to the foot-hills. On the south, it extends to an east-west line, one fourth mile south of Logan--Petersboro road.

History of Project up to Time When an Irrigation District was Proposed.

The land which comprises the district was home-steaded in the early eighties, by the earlier residents of Cache Valley.

The Ballard ditch, which is located in the extreme north-west corner of the district, had been in use for several years prior to the formation of the district. Irrigation was practiced in a moderate form on the area covered by the ditch. This small portion of the district was cultivated more extensively than any other part of the entire area.

Before pumping plants were installed, the better lands of the remaining area were cultivated under dry farm methods, in a few localities, where the soils were the best. On the heavier soils farms were few in number, with poor returns from most of them.

The major crops on the entire area were wheat and barley, with a few small areas of alfalfa. No effort was made to improve the heavy soils.

In 1919 the firm of Skeen and Skeen, a private company, investigated this vast area of non-productive lands, and decided there was an opportunity to develope a large irrigation enterprise. This would reclaim and bring under cultivation this non-productive area.

Late in the year of 1919, the above named firm started to install the irrigation project, which consisted of a pumping plant on Bear River, known as Plant No. 1, of one-hundred second foot capacity. Under a lift of sixty-three feet, water is taken from Bear River through a five foot pipe line, six hundred feet to the main canal. At a point about four miles south on the west bank of the main canal, is located Plant No. 2, containing two booster units. One unit which consists of three pumps, takes a portion of the water from the main canal, through twelve-hundred feet of pipe, and delivers it into Canal No. 2, at an additional elevation of sixty-seven feet. The other unit consists of one pump, which lifts seven second feet of water from the main canal, through seventeen-hundred feet of pipe, an elevation of one hundred and twenty-five feet, to canal No. 3. The above plants, represent in material, workmanship, and equipment, permanent, up-to-date and highly efficient structures.

C H A P T E R 2

Climate, Transportation and Markets, Topography.

The climate of Cache Valley is favorable for crop production. The winter season is from 2.5 to 4 months, and the spring, summer and fall is usually delightful. The period free from killing frost averages from 120 to 150 days and is ample to mature sugar beets, apples, potatoes, beans and similiar crops. The average annual precipitation is (16.46) inches of which about 1.5 inches falls during June, July, August and September. While the snow fall is deep in the mountains, it is seldom more than twelve to eighteen inches in depth in the valley. There are occassional summer showers, usually as thunder storms or light rains, with no destructive winds. The mean difference in temperature between day and night is 21.9 degrees fahrenheit. The average and absolute hottest days in summer are 95 degrees Fahrenheit and 101 degrees Fahrenheit respectively. The average and absolute coldest days in winter are -11 degrees Fahrenheit and -23 degrees Fahrenheit respectively.

Transportation and Markets.

The valley is traversed by the Oregon Short Line Rail Road, and the Utah-Idaho Central Electric Rail Road. The former is a part of the Union Pacific which connects direct with the middle states and the coast, the latter is a local electric system extending from Preston, Idaho to Ogden, Utah. The Bamberger electric line connects with this line at Ogden and runs to Salt Lake City, Utah. The Orem electric connects with this line at Salt Lake City and continues to Payson Utah. These systems afford ample transportation facilities to local and outside markets.

Marketing facilities are good, as the locality is readily accessible to the middle states, with a direct outlet to the ocean by way of Portland and to the east by way of Ogden. Good local markets are in the surrounding mining camps of Utah, Montana, Wyoming, Nevada and other local markets.

In Cache Valley there are thirteen flour mills, five sugar factories, four condensed milk factories and one pea canning factory, with an ample production of farm produce.

The Railroads mentioned above ramify the district and it is not necessary for any farmer to exceed a haul of two miles to place his products at the disposal of the railroads.

Topography.

The west side of the district is on a sloping side hill, with a slope which is not harmful to farming practice. This sloping area gradually extends into a more level surface through-out the middle third, but the general topography of the land in this area is much more irregular with draws, bogs, sloughs, and knolls and will require much leveling. After passing this middle third, a decline is made to a more level surface, which extends to the low-lands, made by the Bear river.

The five foot contours, as shown on the map, were plotted with the plane table. The foot contours were placed by interpolation, in order to aid in the laying out of the irrigation system.

Speaking of the area, as a whole, it may be stated that the topography is very irregular, with numerous draws, cutting across at intervals, making the land appear as very uneven and in a bad shape to reclaim for farming. These draws seemed to have been formed as outlets to surface drainage and appear in rather regular sequence across the land and various sized knolls seem to be prominent through out the area.

CHAPTER 3

Soils.

A soil survey has been conducted by the Utah Experiment station of the Cache Valley Water Conservation District No. 1 by D. S. Jennings, G. D. Clyde, and Karl Harris. The report of Dr. Jennings on the soils of the district is incorporated bodily in this report.

CACHE VALLEY WATER CONSERVATION, District No. 1

Description of the Soils.

On the basis of color and texture the soils of the area are divided into five main types. On the map the types are designated as soils A, A_1, B, B_1, C, C_1, and D.

Considering the classification on the basis of color alone, we have within the area two main divisions: (1) the dark-colored soils having a range in color from dark grey to a brownish grey, and (2) the light-colored soils with a range in color from greyish brown to a light brown. The soil areas mapped as A, A_1, B, B_1, and E are in class 1, while c, c_1, and D. are in class 2. This color classification is a qualitative scheme of indicating the content of organic matter in the soil. Thus in three representative samples of the A and B types the content of organic matter was 3.76 per cent with a range of 3.56 to 4.02 per cent. On the other hand, six representative samples from the C and D types gave an average of 2.01 per cent, the minimum being 1.58 per cent and the maximum 2.38 per cent.

The surface soils within the area are nearly all of fine texture. The entire area is covered with clays and silty loams except a small track near the west center of Sec. 17, Range 1 W, Township 12 North, which is mapped as a very fine sandy loam, and a small track near the southwest corner of the area in Sec. 29, which is mapped as a gravelly silt loam.

On the basis of texture within the profile, the soils are again classified into two series: (1) those having no pronounced textural change to a depth of six feet (A, A_1, and C, C_1, are in this class) and (2) those having a pronounced change within the 6-foot column (this class includes B, B_1, D, and E.)

On the basis of origin, the C and D series have been distinctly influenced by depositions from the Bear River. This appears to be especially true of the surface soil; thus the Bear River sediments appear to contain very little lime. Nine live samples gathered from the C and D series had an average carbonate carbon dioxide content of 0.33 per cent, the maximum being 1.10 and the minimum 0.05 per cent. Two of these samples, however, were gathered from near the boundaries of A and B series and could hardly be considered representative. A better average of the carbonate carbon dioxide is 0.18 per cent, which is the average of seven samples with a range of 0.05 per cent to 0.33 per cent. It must be remembered that series C and D are light-colored soils, low in organic matter as well as low in lime, indicating a deficiency in lime. This is true, however, only for the surface soils, as is shown in the table giving typical profiles.

In series A and B the question of origin has not been carried far enough to justify more than a temporary classification. Unquestionably the recent limestone of the West Ridge and the sediments of Logan River, largely limestone, have contributed to these soils. The drainage systems south of Logan River have probably contributed a mixture of volcanic ash and limestone sediments, while local washing from the volcanic ash of West Ridge has contributed a share. Thus a surface sample of soil taken near southwest corner of the project contains 0.09 per cent of carbonate carbon dioxide to a depth of two feet, while a sample taken just east of the center of Section 29 contains 2.27 per cent of carbonate carbon dioxide. Both soils are dark-colored and contain better than 3.5 per cent of organic matter. It appears, therefore, that the resulting soil from the volcanic ash, while decidedly deficient in lime, assumes a dark color similar to the limestone derivative soils. Due to this fact, certain areas of the A and B series may be low in lime. These series are well supplied with organic matter to a depth of 18 to 30 inches, a character which differentiates them sharply from the C and D series which apparently are strikingly low below 10 to 16 inches in depth. The result of this is a tight impervious clay at 8 to 12 inches and often at 6 inches below the surface in the latter series. While this alone is a distinct disadvantage, it is usually accompanied by another which is a rolling surface topography, and the two taken together constitute a strong argument against expensive operations of leveling and irrigation of these series unless the original price of the land should be a small sum. A third disadvantage will be revealed by glancing at the table of alkali salts. Dangerous concentrations of alkali are often found in the subsoil, particularly in series C and D.

Descriptions of Typical Sections of the soil Types.

Soil A. N. W. Corner 10 No. 1, 40 No. 10 Section 29, R 1 W, T 12 N.

	Carbonate CO_2	Lime
0-12---dark grey clay---------------	2.27	5.17
12-24---dark greyish brown clay-----		
24-32---light brown clay compact----	2.27	5.17
32-52---light brown clay compact mottled with Ca CO_3 white mottling increases at bottom-----------	17.58	40.0
52-64---light grey clay--the $CaCO_3$ dominates the color here-------	19.19	45.8
64-72---brownish grey clay-----------	17.65	40.0

Soil B. This is similar to soil A profile except that B contains a layer of sand in its 6-foot column. The thickness of this layer varies from less than one inch to several inches and usually occurs below three feet in depth.

Soil C. Location: Southeast corner 10 No. 1, 40 No. 4, Sec. 5 R 1 W, T 12 N.

	Carbonate CO_2	Lime, i.e., $CaCO_3$ equiv.
0-10---light greyish brown clay, granulation fair--------------	0.09	
11-22---compact layer of heavy clay with		

	Carbonate CO_2	Lime, i.e. $CaCO_3$ equiv.
white streaks, columnar structure----------------------	2.38	5.42
22-36---compact light grey clay, mottled with white, $CaCO_3$ layer	11.75	26.75
36-48---light grey clay, white marks have become a continuous horizon------------------------	14.50	33.00
48-60---light greyish brown compact clay, few white markings----	11.47	26.10
60-72---light brown very compact clay	10;25	23.30

<u>Soil D</u>. The following profile may be seen along the Benson road at the Northwest Corner 10, No. 2, 40 No. 1 Section 17, R 1 W, T 12 N.

0-10---light greyish brown clay

10-20---light grey compact clay

20-32---light compact clay mottled with white ($CaCO_3$ markings)

32-40---light grey compact clay

40-41---very fine sand

41-48---pink clay--heavy and compact.

48-53---very fine bluish green sand

53-56---coarse yellow and green sand

56-72---structureless heavy compact clay.

In the most typical sections the coarse sand is lacking, the fine sand resting directly upon compact clay. In many cases it appears that the sand is in thin strata, alternating with thin layers of clay.

CACHE COUNTY WATER CONSERVATION, DISTRICT NO. 1

Alkali Salts -- 1.

Soil No.	Location	Depth (in.)	Total Salts (%) By Bridge	Total Salts (%) By Evaporation	(%) Cl	(%) NaCl	(%) SO_4	(%) Na_2SO_4
1a	Middle east side,10 #1, 40 #1, sec.6	0-12	0.27	0.90	.0967	0.159		
1b		12-24	0.76	0.90	0.193	0.318	0.321	0.47
1c		24-36	0.85	0.92	0.193	0.318	0.325	0.48
1d		36-48	0.72		0.176	0.290	0.153	0.23
1e		48-60	0.77		0.196	0.323	0.114	0.17
1f		60-72	0.71		0.199	0.327	0.206	0.14
2a	S.E. corner 10 #1, 40 #4, Sec. 5	0-12	1.53	1.10	0.257	0.423	0.609	0.902
2b		12-24	1.37	1.12	0.293	0.483	0.376	0.388
2c		24-36	2.22		0.280	0.461		
2d		36-48	1.14		0.238	0.391		
2e		48-60	1.05		0.228	0.376		
2f		60-72	1.13		0.238	0.391		
20a	N. of S.W.corner,10#2,40#1,Sec. 5	0-12	0.43					
21a	West center,10 #1, 40 #1, Sec. 5	0-12	0.07					
21b		12-24	0.08					
21c		24-36	0.07					
24a	Near southwest corner, Sec. 4	0-12	0.07					
25a	Near south center of Sec. 32	0-12	0.06					
26a	Center 10 #2, 40 #3, Sec. 32	0-12	0.05					
27a	Near S.W. corner 10#4,40#9,Sec 31	0-12	0.10					
28a	South center of 10#3, 40#3, Sec. 8	0-12	0.13					

(continued)

CACHE COUNTY WATER CONSERVATION, DISTRICT NO. 1

Alkali Salts 2 (continued)

Soil No.	Location	Depth (in.)	Total Salts (%) By Bridge	Total Salts (%) By Evaporation.	Cl (%)	NaCl (%)	SO_4 (%)	Na_2SO_4 (%)
29a	Junction of Ballard & Main Roads	0-12	0.05					
31a	S. W. corner 10 #3, 40 #2, Sec. 5	0-12	0.08					
32a	Center of Sec. 5	0-12	1.14					
43a	Center of 10 #3, 40 #16, Sec. 8	0-12	0.26					
43b	(In thin wheat stubble)	12-24	0.45					
43c	(" " " ")	24-36	0.63					
43d	(" " " ")	36-48	0.70					
43e	(" " " ")	48-60	0.86					
43f	(" " " ")	60-72	0.70					
44a	Middle of 10 #1,40 #16, Sec. 8	0-12	0.07					
44b		12-24	0.26					
79a	Near S. W. corner 10 #4,40#15, Sec 9	0-12	0.065	0.08	0.0105	0.0175	0	0
79b		12-24	0.0927	0.15	0.0197	0.328	0	0
79c		24-36	0.37					
79d		36-48	0.13					
79e		48-60	0.75					
79f		60-72	0.73					
84a	South middle, Sec. 9	0-12	0.05	0.08	0.0105	0.0175	0	0
84b		12-24	0.21					
84c		24-36		1.33	0.0420	0.070	0.925	1.37
84d		36-48		2.32	0.060	0.100	1.56	2.031
84e		48-60	0.57					
84f		60-72	0.50					
87a	N.W. center 10 #4, 40#14,Sec.9	0-12	0.07					
87b		12-24	0.41					
87c		24-36	0.67					
87d		36-48	0.46					
87e		48-60	0.29					
87f		60-72	0.23					

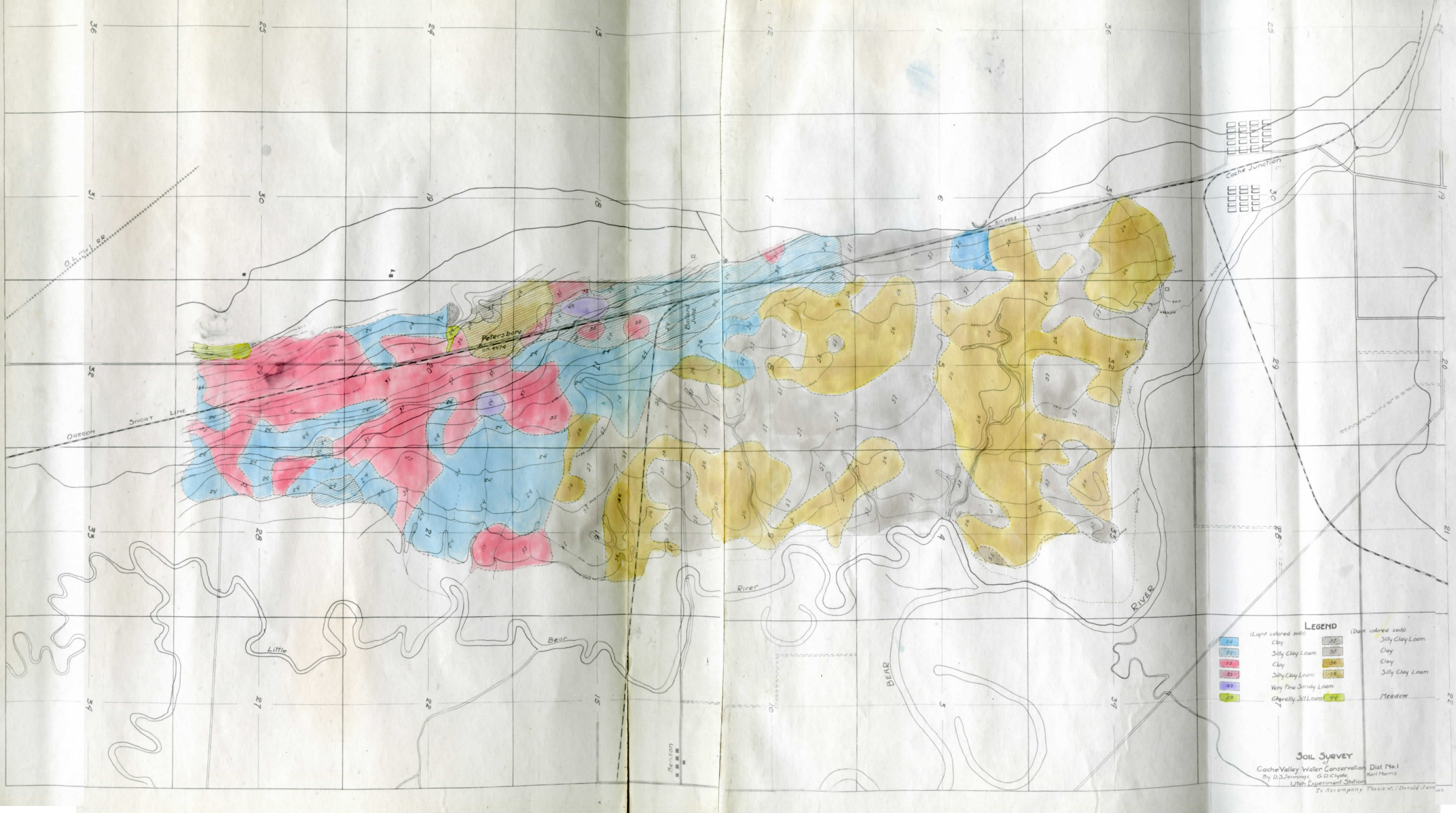
(continued)

Alkali Salts 3. CACHE COUNTY WATER CONSERVATION, DISTRICT NO. 1

(concluded)

Soil No.	Location	Depth (in.)	TOTAL SALTS (%) By Bridge	TOTAL SALTS (%) By Evaporation	(%) Cl	(%) NaCL	(%) SO_4	(%) Na_2SO_4
88a	East center 10 #4,40 #13, Sec.9	0-12						
88b		12-24	0.17					
88c		24-36	0.29					
88d		36-48	0.27					
88e		48-60	0.22					
88f		60-72	0.22					
90a	S. E. corner, Sec. 8	0-12	0.054					
90b		12-24	0.080					
90c		24-36	0.074					
90d		36-48	0.11					
90e		48-60	0.11					
90f		60-72	0.17					
91a	40 #13, Sec. 9	0-12	0.36					
91b		12-24	0.81					
91c		24-36	0.59					
91d		36-48	0.50					
91e		48-60	0.38					
91f		60-72	0.38					

Map 18 A



Oregon Short Line
Peterboro
Bullard Junc.
Cache Junction
Little Bear River
Bear River
Benson
Legend
(Light colored soils)
24 Clay
29 Silty Clay Loam
33 Clay
35 Silty Clay Loam
49 Very Fine Sandy Loam
28 Gravelly Silt Loam
(Dark colored soils)
57 Silty Clay Loam
51 Clay
56 Clay
56 Silty Clay Loam
44 Meadow
Soil Survey
of
Cache Valley Water Conservation Dist. No. 1
By D. S. Jennings, G. D. Clyde, Karl Harris
Utah Experiment Station
To Accompany Thesis of I. Donald Jerman

From the above report it is quite evident that some of the land is in poor condition, physically and chemically; they are also low in organic matter. The poorer area is east of the Oregon Short Line railroad and north of Peterson's ranch. The soils west of the railroad track, are physically and chemically, in good condition for plant growth.

There are a wide variation of conditions to meet in the reclamation of the poorer soils. Some are very compact and need organic materials; others are infested with alkali in harmful amounts; some are water-logged and aeration is lacking. Another condition, which is very objectionable, is encountered due to the leveling of the rougher areas. As shown by above report the upper eight to twelve inches of soil is useful for plant growth. Below this depth, the soils are inactive and compact. Due to this condition, where leveling is necessary to various depths below the surface, a spotted seed bed will be exposed. The productive soils of the surface, which are placed in the low depressions are, in many cases, covered by the poorer soils. Due to the above conditions certain areas, such as section 5, cannot be reclaimed for irrigation practice without an excessive cost.

Section 4 is practically in the same condition as section 5, except in that it has a lower concentration of alkali salts. This section would also be very expensive to reclaim, but with proper methods, it might be put in condition for irrigation.

C H A P T E R 4

Drainage.

In an investigation of the drainage problem, it appears quite evident that the efforts made previous to this time, to drain the water-logged lands, were very inefficient. The few drains, that are now constructed, are very shallow, and the grade low, allowing plant life, and other foreign materials to obstruct them. Some of the drains are placed on high ground, where it is impossible for them to function in the proper manner.

In the construction of a drainage system for this district, a system of open drains must be used, because:

(1) The first cost is low, which is very desirable for a district in financial distress.

(2) It is the best way to collect surface waters.

(3) The drains can be located in the depressions.

The minimum grade to be used shall be 1/5 ft. per hundred feet. The depths of the drains are to be from four to six feet, depending on the texture and structure of the soils. The drains when constructed to this depth will intercept sand layers and allow the water to flow more freely into the drain.

From a study of the ground water, it is determined that the source is from the west hills, the water entering the ground and flowing toward the valley, along impervious layers, which come to the surface in various places within the district. This water percolates into the area continually.

supplying and raising the present water table. Water entering the district from such a source must be eliminated by the construction of an intercepting drain, constructed across the west side of the district, starting about 1/4 mile west of the O. S. L. Railroad track on the south and extending toward the north, following a grade of .4 feet per hundred feet. This drain must be deep enough to intercept the impervious stratas, which carries the water to the district.

The wells that are flowing, within the district, must be capped, until such a time as the over-supply of ground water has been eliminated.

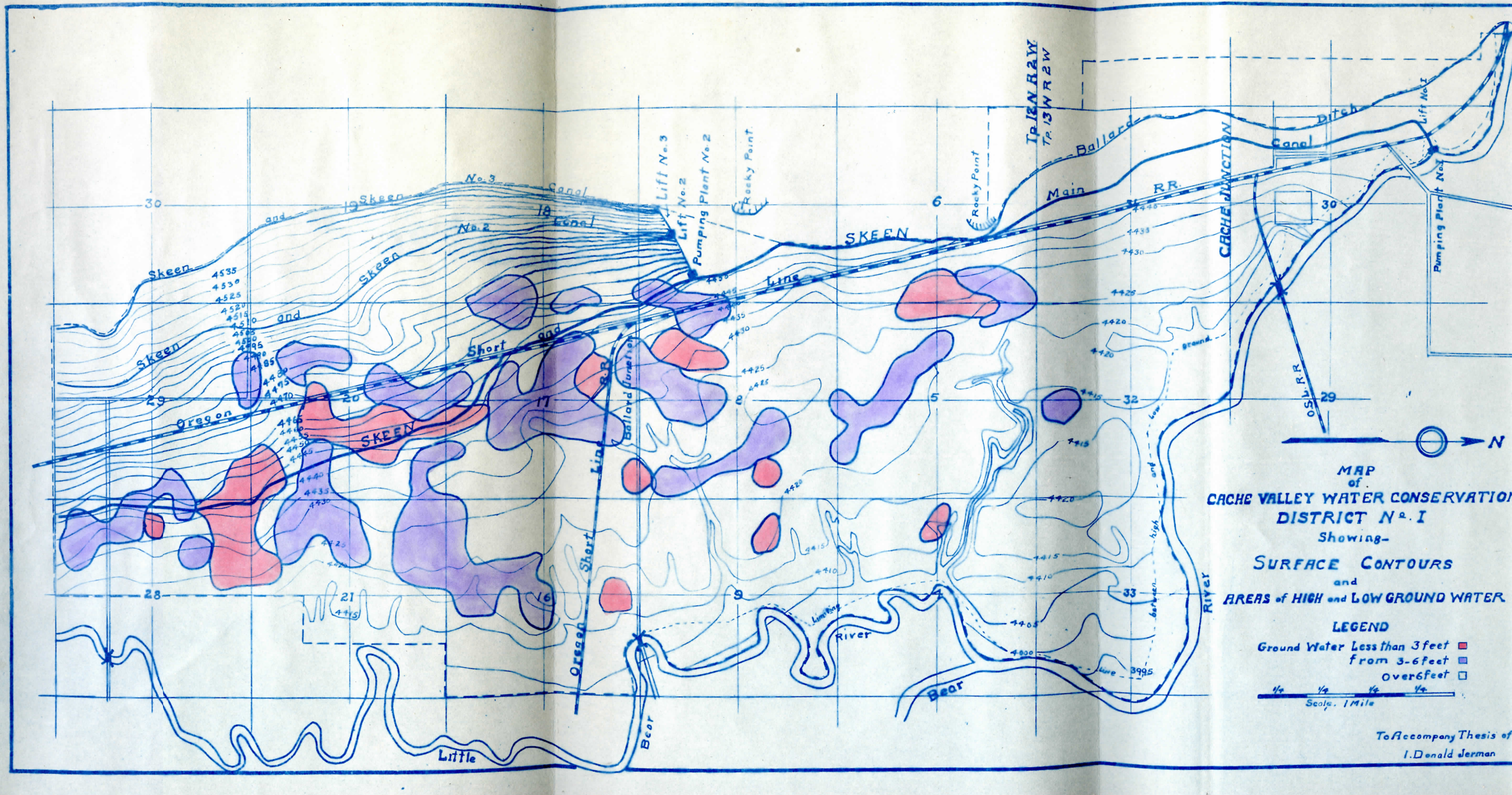
The entire area east of the main canal with the exception of a small area on the extreme north end of the project is in need of drainage. Practically all this area is badly waterlogged, except the Peterson ranch which is in good condition for irrigation.

In walking across the area it is noted where the draws exist to any noticeable depth, that the land on each side is well drained for various distances, depending on the depth of the draw, and the extent to which it is kept free from plant growth and obstructions. This prevents the water from drawing off freely. It is also noted in the V-shaped drain, located in the south end of the district, that the compact clay soil seems brecciated and the water flows freely through the fissures. From this example it is quite evident that, if this drain were dug to a depth of six feet, it would function properly, and remove the excess water in the area.

The ground water map shows the water table as it was in the month of August 1923.

The depths of the water table as shown varies from less than 3 feet to 6 feet in depth.

Map


MAP
of
CACHE VALLEY WATER CONSERVATION
DISTRICT No. I
Showing
SURFACE CONTOURS
and
AREAS of HIGH and LOW GROUND WATER
LEGEND
Ground Water Less than 3 feet
from 3-6 feet
Over 6 feet
Scale, 1 Mile
To Accompany Thesis of
I. Donald Jerman
N
Skeen No. 3 Canal
Skeen No. 2 Canal
Skeen and Skeen
Lift No. 3
Lift No. 2
Pumping Plant No. 2
Rocky Point
Tp. 12 N R 2 W
Tp. 13 W R 2 W
Ballard Canal Ditch
Lift No. 1
Pumping Plant No. 1
Main R.R.
Skeen Line
Oregon Short Line
Ballard Junction
Cache Junction
O.S.L. R.R.
Little Bear River
Bear River

CHAPTER 5

Preparation of the Land.

The object of the smoothing and leveling the surface of the land is to permit the application to the land of water supplied from a system of distributaries. When the work is well done and in a systematic manner the water will be easily and uniformly distributed over the surface. When done in this manner the waste will be a minimum. The amount of leveling necessary will depend on the surface of the ground.

Some of the land included in the district is very unlevel and irrigation, in its present condition, is impossible. It is therefore necessary that these irregular areas be leveled. The larger knolls will require a plow and fresno scraper, the smaller knolls requiring a common box-level, weighted enough to cut the high places and deposit the excess earth in the lower depressions. A method to gradually reclaim the larger draws is to place straw, manure or some waste product across the draw at intervals which will form a dam. The water entering the minature dam, carrying sediment, will deposit it and gradually reclaim the draws. An example of the effectiveness of this method is shown on a draw, in the south end of the district, which proves it is a successful method. Its effectiveness being determined by the amount of water entering the dam on the amount of sediment carried by water. A good practice is to place all refuse from the farm in these depressions. The lands west of the O. S. L. Railroad are fairly level and leveling is not needed. The area east of the track and starting from the south end of the district going toward the north is quite unlevel. The first three miles of this area could be leveled with a common box level, with the exception of the three large draws that are present. These draws could be gradually reclaimed by the ponding method as stated above. Sections 8 and 9 are fairly level, all this leveling can be accomplished with the box level. Sections 4 and 5 are very irregular with draws running in all directions and a series of large knolls between. These sections, especially section 5, is almost beyond reclamation as far as leveling is concerned. These bad areas run into other sections surrounding them, but only to a small extent. The area from the north side of Sections 4 and 5, and extending to the north boundary requires little or no leveling to put it in good shape for irrigation. From a study of the topography of the district approximately 2640 acres, including section 5 which is exceptionally rough, will require leveling. It is estimated that the cost of this leveling will approach $2.00 per acre, distributed over the entire irrigated area, giving a total cost of leveling of $14,900.00

C H A P T E R 6

Extent of Water Right.

The district has an ample supply of water which is secure, and not liable to any infringments.

Filings, from the State Engineer's office, approved by the State engineer, show 112 second feet of water available for the district. Of this amount, one hundred shares are allotted to the Skeen & Skeen Canals and 12 second feet to the Ballard Ditch, decreed by a district Court of Water rights, under the Utah Power & Light case versus water users of Cache Valley.

The water supply, other than that obtained by pumping, is of minor importance. A few small streams flow from the West mountain in the early spring and after the heavier rains. There is a small stream which issues from the Wasatch fault from an upheval of strata, in the south half of the district. This stream is used completely for Culinary purposes and small gardens.

The water for culinary purposes may be secured from wells in any part of the district, Some of them will be flowing wells, while others will require pumping.

Distribution of Water by Months.

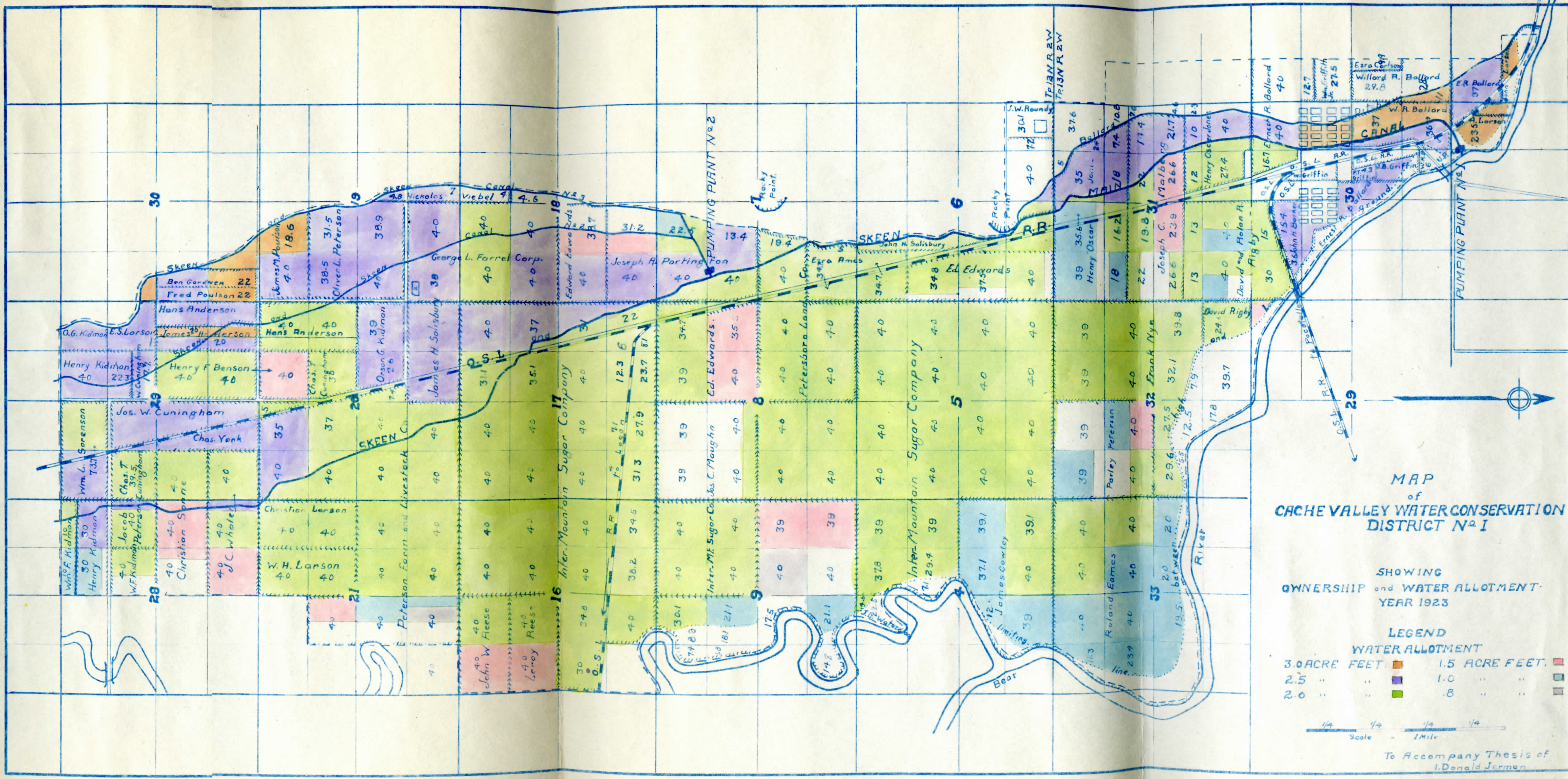
The distribution of water is not constant throughout the irrigation season. The variable duty is due to the variable water requirements of crops. For most crops it is desirable to keep the moisture content of the soil uniform during the irrigation season. The various crops have different water requirements and the growing season varies throughout the irrigation season. These various crops have maximum and minimum water requirements at different stages of their growth. Alfalfa requires early irrigation, while grains and sugar beets are not watered until later in the season. A deversified combination of crops will increase the length of irrigation period and produce a more uniform duty throughout the irrigation season.

Due to the above conditions, the water has been distributed throughout the irrigation district in the following manner.

Month	% each month	Acre'per Month	Sec. ft. flow per month
April	4	625.00	10.5
May	18	2816.00	47.0
June	25	3900.00	65.0
July	30	4693.00	78.0
August	20	3129.00	52.0
September	3	469.00	7.8

Total- --------- 15,645.00 acre feet per year.

Map 26 A


MAP
of
CACHE VALLEY WATER CONSERVATION
DISTRICT No I
SHOWING
OWNERSHIP and WATER ALLOTMENT
YEAR 1923
LEGEND
WATER ALLOTMENT
3.0 ACRE FEET
2.5
2.0
1.5 ACRE FEET
1.0
.8
Scale - 1 Mile
To Accompany Thesis of
I. Donald Jerman
PUMPING PLANT No 2
Rocky Point
Skeen Canal
Main Canal
Inter-Mountain Sugar Company
Peterson Farm and Livestock Co
Petersboro Land Co.
Bear River
O.S.L. R.R.
T.12N R.2W
T.13N R.2W
Joseph R. Porting Fon
George L. Farrel Corp.
Ed. Edwards
Frank Nye
Jos. W. Cuningham
Henry F. Benson
Hans Anderson
W. H. Larson
Christian Larson
Chas. York
James H. Salisbury
John H. Salisbury
Ezra Ames
Roland Eames
James Cowley
Parley Peterson
Willard R. Ballard
W. R. Ballard
E.R. Ballard
David Rigby
Henry Oscar Jones
J. W. Roundy
Ben Gardner
Fred Poulson
O.G. Kidman
E.S. Larson
Henry Kidman
Wm. L. Sorenson
Jos. C. Maughn
Ernest R. Ballard

C H A P T E R 7

Duty of Water.

The term "Duty of Water" may be defined as the number of acres of land that may be irrigated by a definite quantity of water. The term is expressed in a depth of water, on the land, in feet.

"Net" duty of water is the quantity measured at the point of application. It includes such losses as evaporation, seepage, percolation, and waste. The irrigator is always concerned with the net duty.

"Gross" duty of water, is the quantity measured at the point of division. It includes the net duty and losses in conveyence. The engineer is concerned with the gross duty.

An investigation has been made of various duties of water, for various types of soil. As shown in Bulletin 6, "Irrigation Requirements of California Lands" the duty of water varies from 1.25--3 second feet per acre. On areas that are similar to this district the duty varies between these limits, but does not exceed 2.5 second feet per acre.

With a thorough knowledge of the conditions under this district, and comparing it with other similiar areas, the following duty has been assumed.

Duty of Water for Various Crops.

Alfalfa	2.5 acre feet
Potatoes	2.0 acre feet
Sugar Beets	2.0 acre feet
Other crops	2.0 acre feet
Grains	1.5 acre feet

There are several factors which enter in the determination of the duty of water as follows:

1. Crops grown
2. Precipitation
3. Type of soil
4. Methods of irrigation
5. Topography and Preparation of land.
6. Conveyance losses

1. Some crops require more water than others, as shown by "Widtsoe." Older alfalfa requires more water than young alfalfa. Grains require less water than alfalfa. Sugar beets require more water than potatoes.
2. Precipitation, which falls during the growing season, acts the same as an irrigation, its value depending on the quantity of water added to the soil.
3. The type of soil affects the duty of water; loose, porous soils have a low duty, due to the deep percolation. The clay soils have a greater water holding capacity than the courser soils. Although the course soils may give the water up to plant growth more readily than the finer soils, they will not hold the water.
4. The method of irrigation is strictly determined by the knowledge and skill of the irrigator. If he uses the best methods greater returns will be realized.

5. The topography and preparation of the land depends on the character of the surface. The better the surface is prepared, the better the irrigation can be applied, covering the complete area.
6. Conveyence losses lower the amount of water which is applied to the field and the heavier the losses the lower the duty of water.

C H A P T E R 8.

Design of Distribution System.

The main canals and pumping plants were installed prior to the formation of the District and were sold outright to the District. Therefore this report will only cover the design of the distribution system, which will be constructed to deliver water to each forty acres.

An effort has been made to follow the property lines with the laterals and eliminate the crossing of fields as much as possible. In some cases drops have been necessary to take up the excess grade and to keep the velocity within the required limits. At the head of each lateral a metal gate is provided to turn the water into the laterals. A bulkhead will be placed across the lateral at each turn out and a divider where necessary. The bulkhead will have a cippoletti weir notch and measurements can be made at each turn out.

The cost of the excavation for the laterals was figured from a comparison of the cost of constructing similiar ditches on the same area. Most of the excavation was done with a plow and scraper, the cross section resembling as near as possible the typical cross sections as shown in Figure I.

Required Capacity of Main Canal.

The quantity of water necessary to irrigate the entire district is 15,545 acre feet and the maximun draw of 30% comes in the month of July. This draft determines the heaviest capacity necessary at any time.

Computation, for Maximum Draft.

$$\frac{15,645 \text{ acre feet} \times 30\%}{2 \times 30} = 79 \text{ second feet.}$$

Due to seepage, evaporation, and percolation losses a certain quantity has to be added to the flow. The soil in this area being clay and rather impervious, the length of the main canal short, therefore 5% loss is estimated to cover these losses. The capacity at the head of the main canal will be 83 second feet. This quantity will be diminished at pumping plant No. 2.

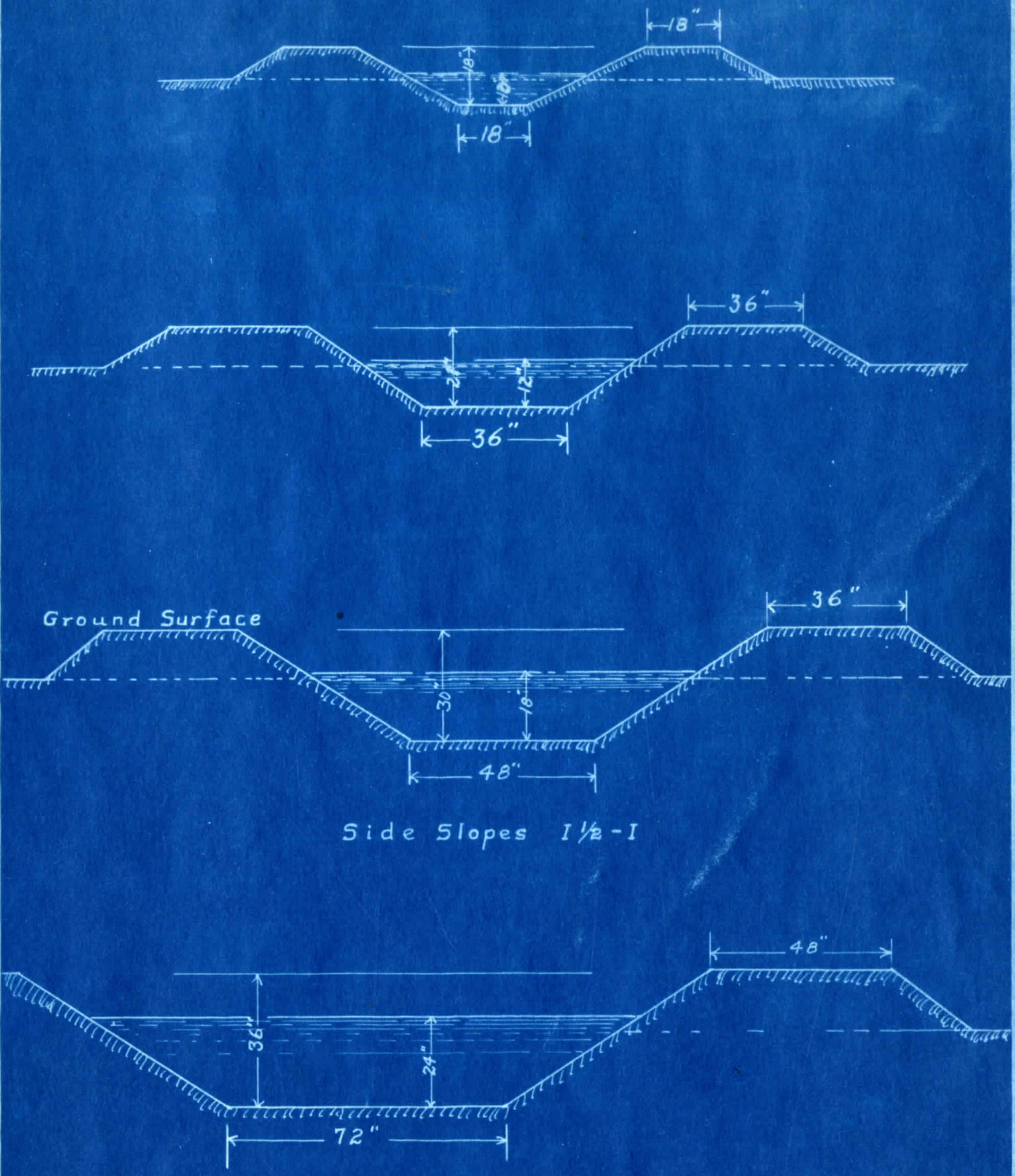
Acre Feet Used by Each Canal Per Season.

This was computed from the monthly draft and the number of acres served by each canal per season.

Main Canal	11,655.00 acre feet
Skeen and Skeen Canal No. 2.	2,782.50 acre feet
Skeen and Skeen Canal No. 3.	1,207.50 acre feet

Design of Laterals.

The theoretical cross sections on which these computations are based and the average form, which these cross sections will be given is shown by Figure I. A side slope of 1½ to 1 has been selected, as it represents the average use for farm ditches. The results were obtained from Kutter's Chezy formula, ($Q = C A \sqrt{r s}$), using a coefficient of roughness equal to .025. Knowing the slope from the contour map and required flow which was figured by knowing the number of acres under each lateral, and the highest duty, which came



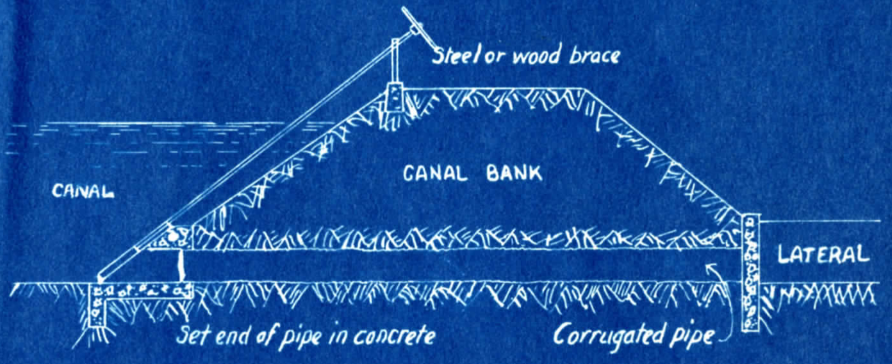
DESIGN OF
TYPICAL CROSS SECTIONS
FOR FARM DITCHES

Fig I

To Accompany Thesis of
I. Donald Jerman

NOTE:

SLOPE of GATE WILL VARY ACCORDING to
CONDITIONS of CANAL BANK



ILLUSTRATING USE OF SLOPING GATES

PRICE LIST For CANAL and LATERAL GATES For 1¼:1 SLOPE

DIAMETER	8"	10"	12"	15"	18"	24"
HEIGHT OF FRAME	PRICE					
5'	$36.60	$37.25	$45.40	$51.75	$65.34	$101.00
6'	38.07	40.90	48.70	54.74	67.10	104.00
7'	39.45	44.30	50.44	56.48	70.83	109.00
8'	42.84	45.69	54.19	60.20	73.57	110.00
9'	44.22	47.07	55.19	61.97	74.31	112.75
10'	45.62	48.45	57.60	63.71	76.00	114.50

DESIGN OF

— LATERAL HEAD GATE TO BE USED ON DISTRIBUTION SYSTEM

CACHE VALLEY WATER CONSERVATION

DISTRICT NO. 1

Fig. 2.

To Accompany Thesis of
I. Donald Jerman

in July, I then entered the table as shown in "Etcheverry's" Vol. I "Irrigation Practice and Engineering" and choose the most desirable cross section which would give the velocity that was required. The ratio of bed width to depth of farm ditches is given by the following formula:

B = Bottom width, D = Depth.

$B = D^2 + 1$ where the grade of the ditch is small.

$B = 2D^2 \quad 2$ where the grade of the ditch is large.

Those dimensions were not strictly adhered to but were used as a guide.

<u>Design of Culverts (Figure 3).</u>

The diameter of the pipe used for the culverts was figured from the equation $Q = C A \sqrt{2GH}$

Q = quantity in second feet.

C = Coefficient, assumed to be .8.

A = Cross section area in square feet.

2GH = Velocity in feet per second.

Knowing all these values except A, it can readily be determined. With this information the diameter is determined, which will carry the required amount of water.

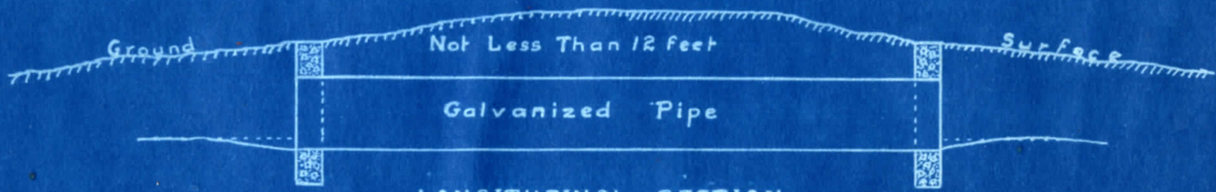
<u>Design of Cippoletti Weir (Figure 4).</u>

The depth of water on the crest should be, not greater than 1/3 the length of the weir and not smaller than one inch. Where fall is available a large length and small depth will be used.

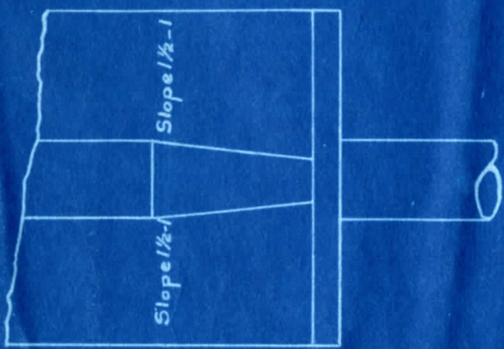
The distance from the crest of the weir to the bed of

Note:

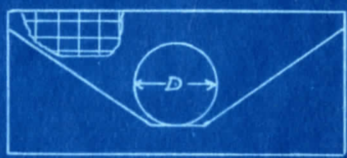
Dimensions and Sizes to be Governed by Field Conditions –



LONGITUDINAL SECTION



PLAN of OUTLET



END VIEW

COST of STEEL .05#

Capacities of Pipe Crossings
About 20 Feet in Length for Corresponding Differences in Elevation Between Inlet and Outlet Water Levels

Difference in levels in inches	2	4	6	8	10	12	14	16	18
Capacity in Second Ft. for									
6-in. pipe	0.45	0.60	0.75	0.85	0.95	1.05	1.15	1.20	1.30
12-in. Pipe	1.85	2.62	3.20	3.70	4.15	4.55	4.90	5.24	5.55
18-in. pipe	4.25	6.00	7.30	8.45	9.45	10.35	11.15	11.95	12.65
24-in. pipe	7.90	11.20	13.70	15.85	17.70	19.40	20.95	22.40	23.75
30-in. pipe	12.90	17.70	21.70	25.00	28.00	30.70	33.15	35.40	37.60

Cost of Corrugated Pipe per Foot

Diameter	Gauge	Cost
8"	16	$0.80
1'	16	1.00
2'	14	1.65
3'	14	3.00
4'	14	4.50

DESIGN OF PIPE CULVERT

To Be Used On

DISTRIBUTION SYSTEM OF

[illegible]

CACHE VALLEY WATER CONSERVATION DISTRICT NO.1.

Fig. 3

To Accompany Thesis of I. Donald Jerman

S= Plate, Sheet Iron or Steel

T= T Beam of Steel or Iron

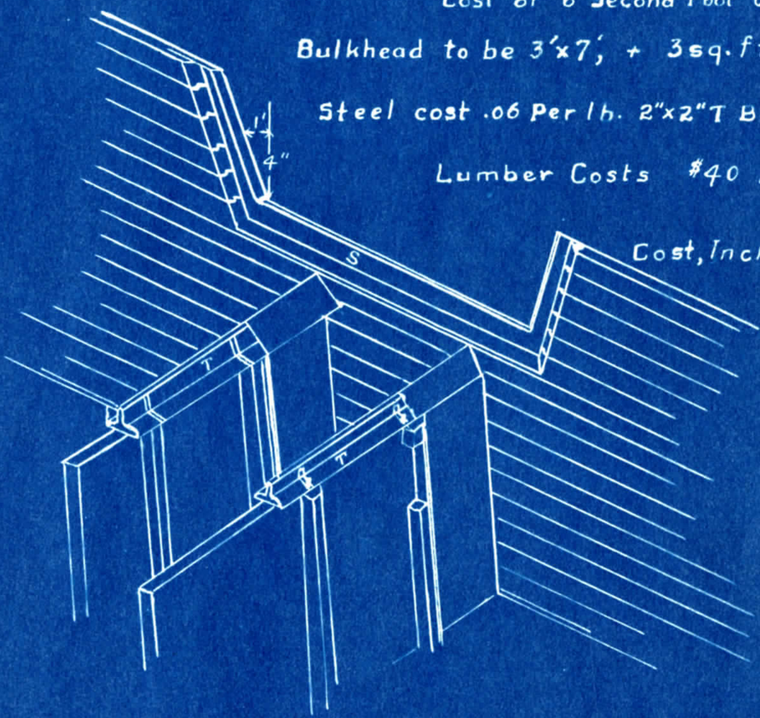
Cost of 6 Second Foot Capacity, 2.5' Crest

Bulkhead to be 3'x7', + 3 sq. ft. for One Divider

Steel cost .06 Per lb. 2"x2" T Beam Weighs 4.3# Per Ft.

Lumber Costs #40 Per M.

Cost, Including Labor, $4.80



Cippoletti Weir to be used for Measuring Water.

Where Divisions are to be Made of Streams Use Dividers

DESIGN OF

CIPPOLETTI WEIR WITH EQUALIZING DIVIDERS, ADJUSTABLE

TO BE USED ON IRRIGATION SYSTEM OF

THE CACHE VALLEY WATER CONSERVATION

DISTRICT NO.1

Fig. 4

To Accompany Thesis Of
I. Donald Jerman

canal, on the upstream side of the weir should be at least twice and preferably three times the depth of water on the weir. This is necessary to produce full bottom contractions.

The distance from the edge of the weir notch to the sides of the canal should be at least twice the depth of water on the weir. This is necessary to produce full side contractions.

The upstream edge of the notch must be sharp to give accurate measurements.

Design of Combination Check and Drop (Figure 5).

It consists of a breast wall across the canal with a rectangular opening regulated with flash boards, which permits using the structure for a check gate; a concrete lining on the sides and floor of the downstream side. This structure is made of wood.

Design of Bridge.

I have assumed a live load of 15 tons, which is somewhat larger than the usual loads, but it is necessary, to be on the side of safety.

Assumed live load to be 15 tons.

S = 1200 pounds per square inch. Using 4 stringers to carry load.

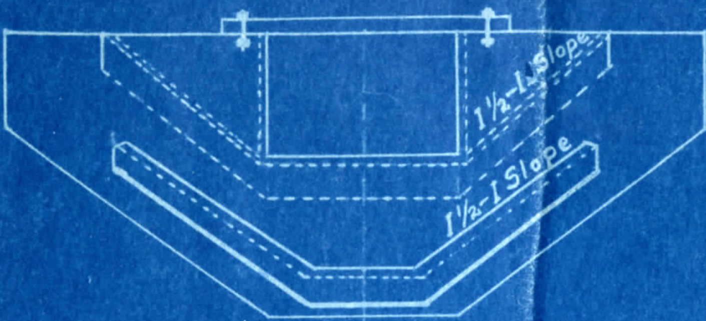
$$M = \frac{Wl}{4} = \frac{20{,}000 \times 48 \text{ inches}}{4} = 240{,}000\#\text{inches}$$

$$\frac{240{,}000}{\text{Assume 4 stringers resists load}} = 60{,}000 \text{ pound inches.}$$

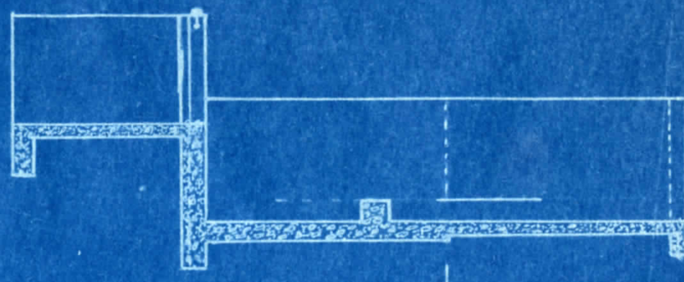
$$M = \frac{S\,b\,d^2}{6} \quad . \quad d^2 = \frac{6M}{Sb} = \frac{6 \times 60{,}000}{1200 \times 3''} = 100.$$

$D = 10''$

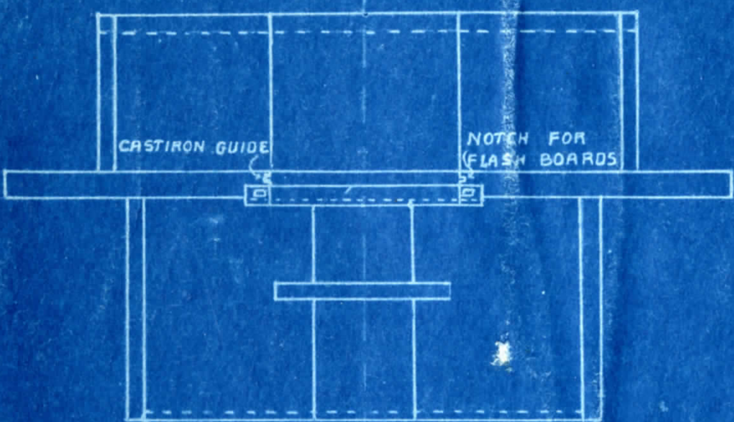
Therefore stringers will be 3", 10" - 10' allowing 2 feet for bearing. Stringers will be placed on concrete abutments,



Elevation
Down Stream



Section Through Center



Plan

All Dimensions and Sizes of Materials to be Governed By Field Conditions

NOTE:

The Total Cost of Labor and Materials Including Excavation and Backfilling Averaged $45.00 For The Larger Structures With One Foot Drop Containing 3.2 Cubic Yards of Concrete and $38.00 For The Smaller Sizes Containing 2.7 Cu. Yds. of Concrete

Design of

Combination, Check and Drop to be Used on Distribution System

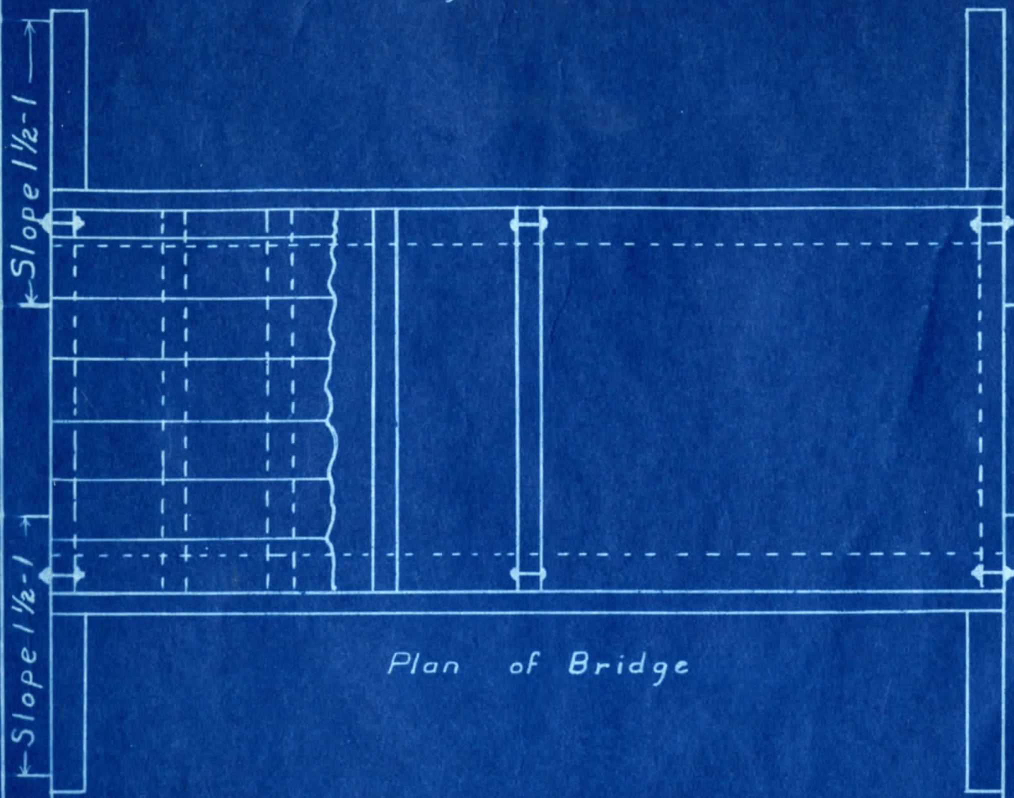
of The

CACHE VALLEY WATER CONSERVATION DISTRICT NO. I.

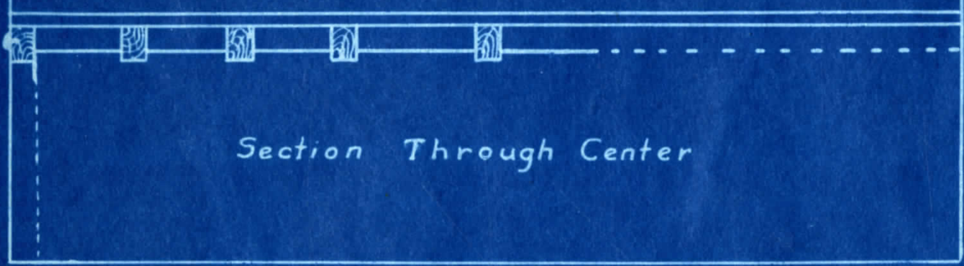
Fig. 5

To Accompany Thesis of
I. Donald Jerman.

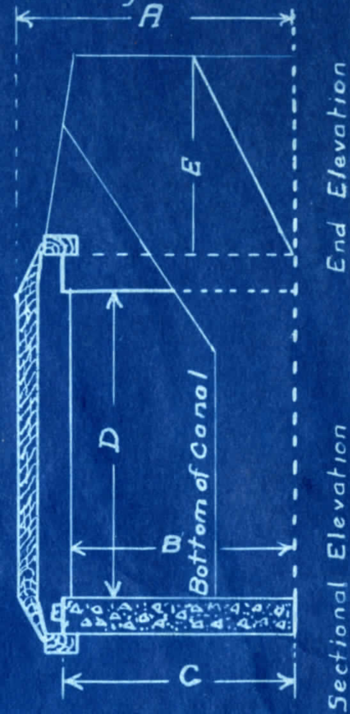
Bridge must be built at a height that will give a depth of clearance between full supply water level and the lower edge of the stringer of about 12 inches



Plan of Bridge



Section Through Center



STRINGER BRIDGE on CONCRETE ABUTMENTS

Dimensions and Cost

Dimensions of Ditch		Dimensions of Bridge						Actual Cost
Bottom Width	Depth	A	B	C	D	E	Stringers	
8'	4'	5'3"	4'	4'2"	10'8"	4'6"	4"×12"-12'	$102
8'	3'6"	4'10"	3'11"	4'	10'8"	4'	4"×12"-12'	95
6'	3'6"	4'10"	3'11"	4'	8'8"	4'	4"×12"-10'	90
4'	3'6"	4'10"	3'11"	4'	5'8"	4'	4"×8"-7'	83

Bridge to be built according to Conditions in the field

Clear Span in Feet	No. of Stringers	Spacing of Stringers in in.
7	10	21.
8	11	18 7/8
9	12	17 3/16
10	13	15 3/4
11	14	14 9/16
12	15	13 1/2
13	16	12 5/8
14	17	11 13/16

DESIGN of BRIDGE

TO BE USED

AT ROAD CROSSINGS MADE NECESSARY BY THE CONSTRUCTION OF THE DISTRIBUTION SYSTEM OF THE

CACHE VALLEY WATER CONSERVATION DISTRICT NO. 1

Fig. 6

To Accompany Thesis of T. Donald Jerman

12 inches on centers over full width of bridge. For flooring use 2 inch by 10 inch plank.

Design of Metal Flume.

Required capacity 6 second feet. Value of N for corrugated pipe = .022.

A = Area of Cross Section.

P = Wetted perimeter.

$r = \frac{A}{P}$ = Hydraulic radius.

R = Radius = $\frac{D}{2}$ = depth of semi-circular pipe.

Freeboard = 10% of depth.

$A = 1.37 R^2$

$r = 0.46 R = .23 D$

$V = C \sqrt{rs}$

Q = A V = Cubic feet per second carrying capacity.

V = Velocity in feet per second.

$S = \frac{h}{L}$ = Fall of water surface in L distance.

Knowing these values I entered the table in the, "R. Hardesty Manufacturing Co. catalogue" and selected the required size timbers for the flume. These values being based on the formula:

$$P = F \times \frac{700 + 15 c}{700 + 15 c + c^2}$$

P = Ultimate strength in # per square inch.

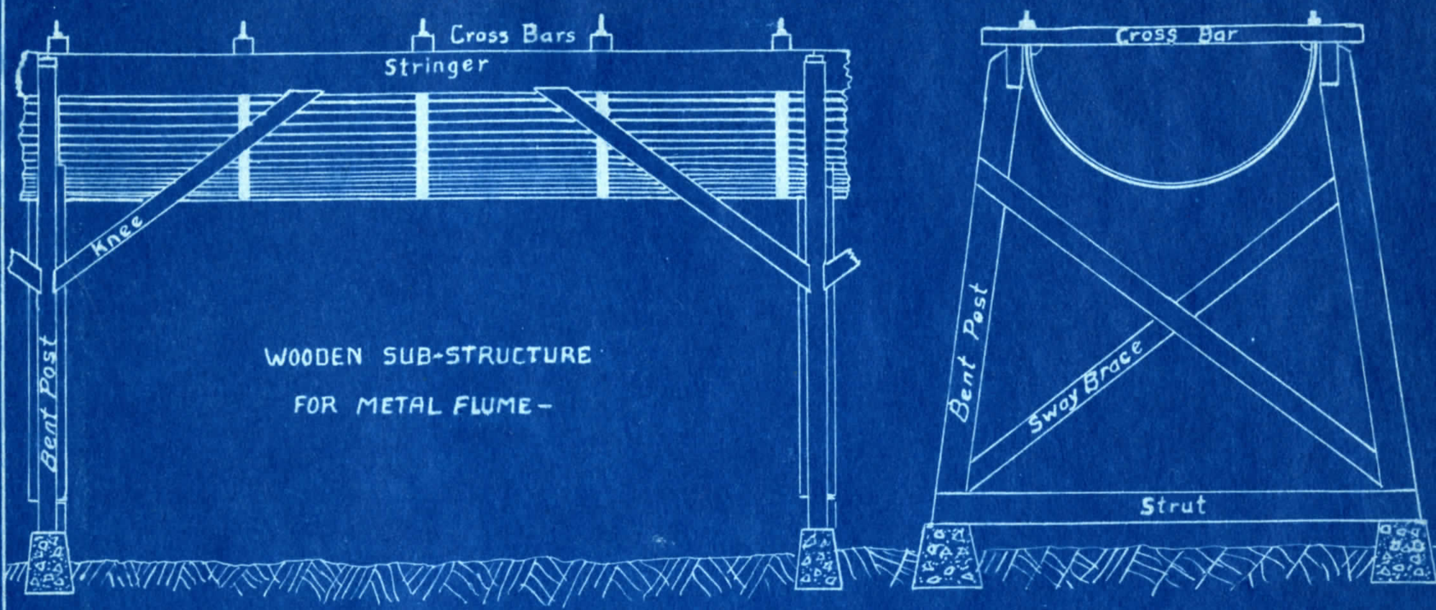
F = 4000 = Ultimate crushing strength of timber.

L = Length of unsupported portion of column in inches.

d = Least diameter of column in inches.

$c = \frac{L}{d}$

Safe load taken as 0.2P.



WOODEN SUB-STRUCTURE
FOR METAL FLUME -

TABLE OF WOODEN SUB-STRUCTURE 16 FOOT BENTS, 5 FEET HIGH

Width Between Stringers	Size of Stringers	Knees	Bent Posts	Sway Braces	Cross Bars	Struts	Foot Board Measure Per Lineal Foot Flume
2′ 9″	2×6	2×6	4×4	2×4	2×4	2×4	6.5

Cost of 20 Gauge Flume 3′ Diameter $1.60 Per Ft.

Cost of Douglas Fir Per M - $40

Cost of Cement Per Sack - $1.00

Capacity, Flume 6 Second Feet

Cost of Flume Complete, Per Lineal Foot = $1.90

Design Of

Wooden Structure For Metal Flume To Be Uused On

Distribution System Of The

CACHE VALLEY WATER CONSERVATION -

DISTRICT NO. 1

Fig. 7

To Accompany Thesis of
I. Donald Jerman

Design Data for Distribution System (Table A B C).

These tables show detailed data, assembled for the purpose of having definite information on the factors which influence the design of the irrigation system. It also gives the laterals and their respective turn outs, the acres of land under each turn out and the length of laterals. It also gives the cost of the structure to be used on the system and the excavation, with it's cost.

The Cost as Shown on Table A

Main Canal

Structures	$9,594.40
Excavation	389.00
Total	$9,983.40

The Cost as Shown on Table B

Skeen and Skeen Canal No. 2.

Structures	$1,339.80
Excavation	396.00
Total	$1,735.80

The Cost as Shown on Table C

Skeen and Skeen Canal No. 3.

Structures	$ 757.40
Excavation	105.00
Total	$ 862.40

Total Cost Main Canal	$9,983.40
Total Cost Skeen & Skeen No. 2	1,735.80
Total Cost Skeen & Skeen No. 3	862.40
Total Cost, Structures & Excavations	$12,581.60

MAIN CANAL
DESIGN DATA FOR DISTRIBUTION SYSTEM

Table A

LATERAL	TURN OUT NO	ACRES	LENGTH-LATERAL in FEET	FALL in Ft.	CAPACITY IN Cu.Ft.S.	VELOCITY Ft Per Sec	FALL in Feet Per 1000	LATERAL DIMENSIONS Bottom	Depth	EXCESS SLOPE In Feet	COST of EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
A		300	4,300	35	3	2.5	8	1.5'	6"		$64.50		
	I											Metal Gate	$66.00
	I											Wood Turnout	3.20
												Metal Culvert	33.75
												Bridge	90.00
	2											Wood Turn-out	3.20
	3											" "	3.20
	4											" "	3.20
B		350	3,500	25	3.5	2.7	7	2'	8"		60.00		
	I											Metal Gate	66.00
	I											Wood Turn-out	3.60
												Metal Culvert	33.75
												Bridge	90.00
	2											Wood Turn-out	3.60
	3											" "	3.60
	4											" "	3.20
C		1,080	2,300	25	11	3	11	2'	12"	3	46.00	2-1.5' Drops	76.00
			2,000	4	9	1.8	2	3'	15"		40.00		
			1,000	0.5	6	1	0.5	4'	15"		23.00		
			3600	1	6		0.28	3' diameter				Metal Flume	6,840.00
			2400	12	3	2.5	5	1.5'	8"		36.00		
			1200	4	3	1.8	3.5	1.5'	9"		26.00		
	I											Metal Gate	101.00
	I											Wood Turn-out	4.50
												Metal Culvert	41.25
												Bridge	90.00
	2											Wood Turn-out	4.50
	3											Divider	5.00
	4											Wood Turn-out	4.50
	5											" "	4.50
	6											" "	3.20
	7											" "	3.20
	8												3.20
C_1			3500		3								
	I											Wood Turn-out	3.20
	2											" "	3.20

M.

MAIN CANAL

Table A Con't

LATERAL	TURN OUT NO	ACRES	LENGTH LATERAL IN FEET	FALL IN FEET	CAPACITY IN Cu. Ft. S.	VELOCITY FT. PER SEC	FALL IN FEET Per 1000 Ft	LATERAL DIMENSIONS Bottom	Width	EXCESS SLOPE In FEET	COST of EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
C_1	3											Wood Turn-out	$ 3.20
C_2			3800		3								
	1											Wood Turn-out	3.20
	2											" "	3.20
D		440	3200	28	4	2.5	9	2'	8"		$48.00		
			5000	10	3	1.5	2	2'	8"		48.00		
	1											Metal Gate	71.20
	1											Wood Turn-out	3.20
												Metal Culvert	41.25
												Bridge	90.00
	2											Wood Turn-out	3.20
	3											" "	3.20
	4											" "	3.20
	5											" "	3.20
	6											" "	3.20
	7											" "	3.20
E		560	1500	20	6	1	1.3	3'	12"		45.00		
			2500	4	8	1	1.2	3'	12"		75.00		
			2500	8	3	1.4	3	1.5'	9"		32.50		
	1											Metal Gate	101.00
	1											Wood Gate	4.50
												Metal Culvert	41.25
												Bridge	90.00
	2											Divider	40.00
	3											Wooden Turn-out	4.50
	4											Divider	40.00
	5											Wood Turn-out	3.20
	6											" "	3.20
	7											" "	3.20
	8											" "	3.20
E_1			2600		3						39.00		3.20
	1											Wood Turn-out	3.20
	2											" "	3.20
E_2			2600		3						39.00		3.20
	1											" "	3.20
	2											" "	3.20

M2

MAIN CANAL

Table A Con't

LATERAL	TURN OUT NO	ACRES	LENGTH LATERAL IN FEET	FALL IN FEET	CAPACITY IN Cu.Ft.S.	VELOCITY FT. PER SEC	FALL IN FT. Per 1000	LATERAL DIMENSIONS Bottom	Width	EXCESS SLOPE IN FEET	COST OF EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
F		730	2200	24	7	2.9	11	2'	10"	3	$55.00	2-1.5' Drops	$76.00
			1700	3	6	1.7	2	2'	12"		34.00		
			1000	0.5	6	0.85	0.05	3'	14"		25.00		
			4000	4	3	1	1	1.5'	10"		68.00		
	1											Metal Gate	101.00
	1											Wood Turn-out	4.50
												Metal Culvert	41.25
												Bridge	90.00
	2											Wood Turn-out	4.50
	3											" "	4.50
	4											" "	4.50
	5											" "	4.50
	6											" "	3.20
	7											" "	3.20
	8											" "	3.20
F_1			2600		3						39.00		
	1											Wood Turn-out	3.20
	2											" "	3.20
F_2			1300		3						20.00		
	1											" "	3.20
F_3			2600		3						39.00		
	1											" "	3.20
	2											" "	3.20
G		550	2600	26	6	1	1	3'	12"		52.00		
			3900	6	3	1.2	1.5	2'	9"		70.00		
			1200	6	3	2	5	1.5'	8"		32.00		
	1											Metal Gate	101.00
	1											Wood Turn-out	4.50
												Metal Culvert	41.25
												Bridge	75.00
	2											Wood Turn-out	4.50
	3											" "	3.20
	4											" "	3.20
	5											" "	3.20
	6											" "	3.20
	7											" "	3.20

M3

MAIN CANAL

Table A con't

LATERAL	TURN OUT NO	ACRES	LENGTH-LATERAL In Feet	FALL In Feet	CAPACITY In Cu.FT.S	VELOCITY FEET PER SEC	FALL In Feet Per 1000	LATERAL DIMENSIONS Bottom	Depth	EXCESS SLOPE In Feet	COST of EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
G_I			1300		3						$20.00		
	1											Wood Turn-out	$3.20
G_a					3							Metal Gate	36.30
H		370	4000	10	4	1.5	2.5	2'	9"		68.00		
			2600	8	3	2	3	1.5	9"		41.00		
	1											Metal Gate	65.30
	1											Wood Turn-out	4.50
												Metal Culvert	33.75
												Bridge	75.00
	2											Wood Turn-out	4.50
	3											" "	3.20
	4											" "	3.20
	5											" "	3.20
	6											" "	3.20
H_1			1300		3						20.00		
	1											Wood Turn-out	3.20
H_a												Metal Gate	36.25
												Metal Culvert	56.25
I		360	2000	20	4	2.5	10	1.5'	8"		32.00		
			2600	11	3	2	4	1.5'	9"		33.00		
	1											Metal Gate	65.00
	1											Wood Turn-out	4.50
	2											Divider	45.00
	3											"	"
	4											Wood Turn-out	4.50
	5											" "	3.20
I_1			1300		3					2	26.00	2' Drop	50.00
	1											Wood Turn-out	3.20
I_2			1300		3								
	1											" "	3.20
	1_a											Metal Gate	37.25
J		320	3700	26	3	2	7	2'	6"		59.00		
	1											" "	45.40
	1											Wood Turn-out	3.20
	2											" "	3.20
	3											" "	3.20

M4

MAIN CANAL

Table A Con't

LATERAL	TURN OUT NO	ACRES	LENGTH LATERAL IN FEET	FALL IN FEET	CAPACITY IN Cu. Ft. S.	VELOCITY FT. PER SEC	FALL IN FEET PER 1000 Ft.	LATERAL DIMENSIONS BOTTOM	LATERAL DIMENSIONS WIDTH	EXCESS SLOPE IN FEET	COST OF EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
J	4											Wood Turn-out	$ 3.20
K		180	1200	10	3	2.5	8	1.5'	7"		$ 18.00		
	1											Metal Gate	37.25
	1											Wood Turn-out	3.20
	2											" "	3.20
L		75	1200	12	3	2.5	10	1.5'	6"		18.00		
	1											" "	3.20
	2											" "	3.20
M		80	1200	16	3	2.5	13	1.5'	6"	3	25.00	2-1.5' Drops	76.00
	1											Wood Turn-out	3.20
	2											" "	3.20
N		80	1200	12	3	2.5	10	1.5'	6"		18.00		
	1											" "	3.20
	2											" "	3.20

MS

SKEEN and SKEEN CANAL NO. 2

DESIGN DATA FOR DISTRIBUTION SYSTEM

Table B

LATERAL	TURN OUT No	ACRES	LENGTH LATERAL IN FEET	FALL IN FT.	CAPACITY IN Cu. FT. S.	VELOCITY FT. PER SEC.	FALL IN FT. PER 1000 FT.	LATERAL DIMENSIONS Bottom	Width	EXCESS SLOPE IN FT.	COST OF EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
	A	60			3							Metal Gate	$45.40
B		150	2000	42	3	2.5	21	1.5'	6"	11	$30.00		
	1											Metal Gate	45.00
	1											Check Drop To.	60.00
	2											" "	60.00
	3											" "	55.00
C		190	3400	47	3	2.5	14	1.5'	6"	4	51.00		
	1											Metal Gate	45.40
	1											Wood Turn-out	3.20
	2											Check Drop To.	40.00
	3											" "	40.00
												Metal Culvert	25.00
												Bridge	35.00
D		90	1,000	21	3	2.5	21	1.5'	6"		30.00		
	1											Metal Gate	45.40
	1											Check Drop To.	60.00
												Drop	30.00
												"	30.00
	2											Wood Turn-out	3.20
E		240	2800	50	3	2.5	20	1.5'	6"	7	80.00		
	1											Metal Gate	45.40
	1											Check Drop To.	40.00
	2											" "	40.00
	3											Wood Turn-out	3.20
												Metal Culvert	25.00
												Bridge	35.00
F		270	3500	46	3	2.5	13	1.5'	6"	3	98.00		
	1											Metal Gate	45.40
	1											Check Drop To.	40.00
												Bridge	25.00
												Check Drop To.	40.00
	3											Wood Turn-out	3.20
												Metal Culvert	25.00
G		230	1900	34	3	2.5	18	1.5'	6"	8	57.00		
	1											Metal Gate	45.40
	1											Check Drop To.	60.00

SKEEN and SKEEN NO2 — Table B con't

LATERAL	TURN OUT NO	ACRES	LENGTH LATERAL IN FEET	FALL IN FT.	CAPACITY IN CU FEET	VELOCITY FT. PER SEC	FALL IN FT. PER 1000 FT.	LATERAL DIMENSIONS Bottom	Width	EXCESS SLOPE IN FT.	COST OF EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
	2											Check Drop To.	$45.00
	3											" "	"
												Bridge	25.00
												Metal Culvert	25.00
H	.	95	1800	29	3	2.5	16	1.5'	6"	6	$50.00		
	1											Metal Gate	45.40
	1											Check Drop To.	50.00
	2											" "	"

SKEEN and SKEEN NO.3 CANAL — Table C

DESIGN DATA FOR DISTRIBUTION - SYSTEM

LATERAL	TURN OUT NO	ACRES	LENGTH LATERAL IN FEET	FALL IN FT.	CAPACITY IN CU FEET	VELOCITY FT. PER SEC	FALL IN FT. PER 1000 FT.	LATERAL DIMENSIONS Bottom	Width	EXCESS SLOPE IN FT.	COST OF EXCAVATION	KIND OF STRUCTURE	COST OF STRUCTURE
	A	40			3							Metal Gate	45.40
	B	90			3							" "	"
C		140	1000	20	3	2.5	20	1.5'	6"	10	30.00		
	1											Metal Gate	45.40
	1											Check Drop To.	80.00
												2-2' Drops	90.00
	2											Wood Turnout	3.20
												Metal Culvert	25.00
D		130	1500	30	3	2.5	20	1.5'	6"	10	45.00		
	1											Metal Gate	45.40
	1											Check Drop To.	75.00
												Drop	80.00
												"	40.00
	2											Wood Turn-out	3.20
												Metal Culvert	25.00
E		120	2000	20	3	2.5	10	1.5'	6"		30.00		
	1											Metal Gate	45.40
	1											Wood Turn-out	3.20
	2											" "	3.20
F												Metal Gate	45.00

SkB

C H A P T E R 9.

Crops and Program of Reclamation.

The crop map for 1923, shows approximately three hundred acres of sugar beets. This is a marked development over previous years. Various crops are now grown over different parts of the area, with fair returns from most of them. Recent developments seem to assure the land holders that the growing of peas and beans will in the future, furnish a return equal to that received from sugar beets.

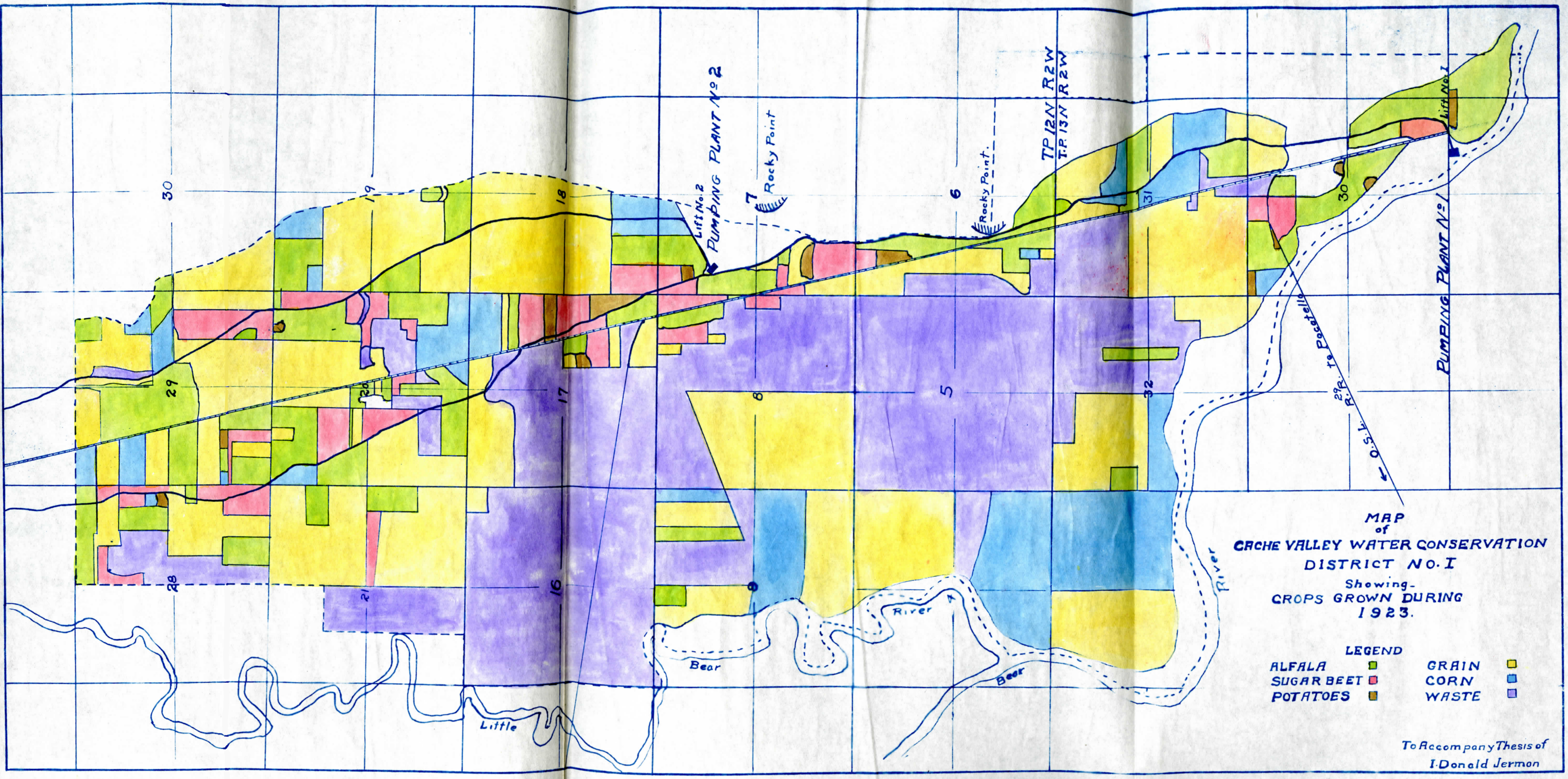
The yield of sugar beets varies from six to twenty tons per acre with the larger percent of the ground yielding above twelve tons. The alfalfa tonnage varies from four to six tons per acre; potatoes one hundred fifty to three hundred bushels per acre, the average being about two hundred bushels. The wheat yield is low in most cases.

With a production on this area, as shown above, with practically no effort toward reclamation, it may be assured that in the future, after a continued effort has been made toward its reclamation, the production will be increased. Also the area will show a more diversification of crops as well as increased acreage planted.

Distribution of Cropped Area.

Alfalfa	40% of	irrigated	area	
Sugar Beets	20%	"	"	"
Grain	20%	"	"	"
Potatoes	10%	"	"	"
Miscellaneous	10%	"	"	"

Map 43 A


MAP
of
CACHE VALLEY WATER CONSERVATION
DISTRICT NO. I
Showing
CROPS GROWN DURING
1923.
LEGEND
ALFALA
SUGAR BEET
POTATOES
GRAIN
CORN
WASTE
To Accompany Thesis of
I. Donald Jermon
PUMPING PLANT No 2
Lift No. 2
Rocky Point
Rocky Point.
TP 12N R2W
T.P. 13N R2W
PUMPING PLANT No 1
Lift No. 1
O.S.L. R.R. To Pocatello
Bear
River
Bear
River
Little
30
19
18
7
6
31
30
29
20
17
8
5
32
28
21
16
9
4

The soils west of the railroad track, and the area east of the track on the south end of the district, extending to sections 16 and 17, are fertile and in good condition to grow any of the crops grown by farmers in this locality. These lands have an ample supply of organic materials as well as plant food, and are recognized as being profitable, producing areas. There is also a small area east of the track in section 17, and one in the north end of the district which are equally compared to the better lands of the district.

The remaining area, with a few exceptions, represents the impervious and alkaline soils, which will be difficult to reclaim. Due to these poor qualities, the time for their reclamation will extend over different periods of time, according to their condition. It is estimated that this period of reclamation will extend from three to eight years.

With such conditions existing on this infertile area, it places a burden on the better lands, making the cost per acre higher than it would be if the entire area was productive. With this fact in view, it will be to the interest of the district, and the individuals concerned, to reclaim the poorer areas as soon as possible. The soils of these areas being of a retentive nature, low in organic matter, and of various concentrations of alkali, crops must be grown which will aid in the reclamation of these objectionable characteristics.

A large percent of the acreage on this area is chosen to grow alfalfa because it is a profitable crop and adds nitrogen to the soil, which is useful as a fertilizer. The rooting system of alfalfa is known to penetrate the earth to a greater depth than ordinary crops; this tends to ramify the earth and make aeration possible, especially after the roots have decayed. The feeding of alfalfa on the farm is a very important item, if the barnyard manure is used to the best advantage; this adds humus to the soil which is badly needed in these areas.

Sugar beets is also a desirable crop; it comes next to the clover in the resistance of alkali. It is a cash crop with a sure market, which is an asset to any farmer. The tops should be left on the ground as much as possible to help add the organic matter to the soil.

Potatoes are good producers and when placed on the market for a fair price they are a good cash crop.

The yield of grain on this area is low, due to the successive cropping that has been practiced in the past. This crop does not tolerate alkali, only to a limited amount, so it cannot be grown where alkalin salts exists to any great extent. The straw which is produced by the grain is also valuable, if made into barn yard manure and added to the soil.

Miscellaneous crops refers to the remaining crops grown by farmers such as garden produce. On the retentive and alkaline soils, a large percent of this area will be planted to clover which is the most tolerant to alkali of any of our useful crops. Due to this fact, clover will be grown in the areas where alkali exits in the highest concentrations.

With the above crops grown on the lands and an effort made by the farmers to replace all the organic matter back on the soil, a start will be made towards its reclamation.

Stock raising should be practiced by all the farmers in order to convert the materials into barnyard manure which will be a rapid aid to the reclamation of the soil by the addition of organic matter as well as a profitable business.

The above crops should be rotated, not allowing the same crop to stay on the same ground at very long periods of time. A systematic rotation should be worked out by each farmer, in order to reclaim the whole area in as short a period of time as possible.

Cropping Against Alkali.

The land infested with alkali should be planted to alkaline resisting plants. Unfortunately, most of the alkali resisting plants have very little agricultural value, they are usually unpalatable, low in feeding value and have a low digestibility. There are a few that are palatable and make a fair food for stock, the Australian salt bush, tried out in California, which yields well and makes a fairly palatable forage is used in California for stock food. Sweet clover grows rank in this area and will resist alkali to a higher concentration than any of our useful crops.

Experiments have been carved out by the Montana Experiment Station which varifies this statement. They found from experiment that if the clover was cut when young it made a palatable crop for stock.

Young alfala does not resist alkali to any extent, and therefore cannot be grown where alkali is very concentrated, altho after it once gets a start it is considered a good alkali resisting crop. Considering all the factors outlined above, the following program for the reclamation of the poor land which consists of approximated three thousand acres.

1. The land has to be leveled and prepared for irrigation. Out of this three thousand acres, approximately two thousand can be leveled with a common box level and plough. This will require at least two plowings, each plowing followed by a thorough leveling.

2. Drainage.

   This area can be drained by a system of open drains.

3. The application of water to leach out the alkali.

4. The first year the area should be planted to clover and barley, these crops being alkali resistant. On those areas where the alkali content is low, alfalfa will be grown. The clover will be grown until the alkali content has been lowered enough to permit the growth of other crops.

C H A P T E R 10.

Feasibility.

If an enterprise of any kind is feasible it must pay a profit, to the persons concerned. From this point of view the estimated returns and the cost will be balanced, if the results show that it is possible to farm this area and make a fair profit it will be declared feasible, if not, it will be declared unfeasible.

Cost of Distribution System.

(Reference tables A, B, C.)

Structures	Main Canal	$9,594.00
Excavation	Main Canal	389.00
Structures	Skeen & Skeen Canal No. 2	1,339.00
Excavation	Skeen & Skeen Canal No. 2	396.00
Structures	Skeen & Skeen Canal No. 3	757.00
Excavation	Skeen & Skeen Canal No. 3	105.00
Paid for Skeen & Skeen Interests		275,000.00
Total Cost of Distribution System		$287,580.00

Cost of Leveling Land	$14,900.00
Cost of drainage $8.00 per acre	59,600.00
Total	$74,500.00

Crop Returns.

Crop	Acreage	Yield Per Acre	Yield	Price	Cash Returns
Alfalfa	2980	4T	11,920T	$8.00T	$95,360.00
Sugar Beets	1490	15T	22,350T	6.00T	134,100.00
Grain	1490	20B	29,800B	.80B	23,840.00
Potatoes	745	200B	149,000B	.50B	74,500.00
Misc.	745				10,000.00
Returns per year					$337,800.00

T & B means Ton or Tons and Bushels respectively

Cost of Growing Crops Per Acre.

	Beets	Alfalfa	Potatoes	Grain	Misc.
Plowing	$2.50	$.50	$2.50	$2.50	$2.50
Horrowing	1.50	1.00	1.00	1.00	1.50
Seed	2.75*	.90	5.00	1.60	5.00
Planting	*	.75	1.50	.75	4.00
Hoeing	3.00		3.00		5.00
Thinning	7.50				
Irrigating	.40	.20	.40	.30	.40
Cultivating	2.00		2.00		3.00
Taxes	3.00	3.00	3.00	3.00	3.00
Harvesting	8.00	1.20	10.00	4.60	8.00
Interest on capital Invested	8.00	8.00	8.00	8.00	8.00
Totals	$38.65	$15.55	$36.40	$21.75	$40.40
10% overhead	3.86	1.55	3.64	2.17	4.04
Total Cost	$42.51	$17.10	$40.04	$23.92	$44.44

*Seeding and Planting Sugar Beets $2.75 per Acre.

Cost of Growing Crops, Over Complete Area.

Crop	Acreage	Cost per Acre	Amount
Alfalfa	2980	$17.10	$50,958.00
Sugar Beets	1490	42.51	63,339.01
Grain	1490	23.92	35,640.00
Potatoes	745	40.04	29,829.00
Misc.	745	44.44	33,107.00
Total			$212,873.00

<u>Returns.</u>

Crop Returns per year	$337,800.00
Cost of Growing Crops	212,873.00
Total Net Returns from Crops	$124,927.00

Acre return $\frac{\$124,927.00}{7,450 \text{ acres}} = \$16.65$

Subtracting cost of pumping per acre $2.35, cost of interest on bonded indebedness per acre $2.35, and maintenance $2.00 per acre the net acre returns is $9.95.

The average value of the land is $75.00 per acre plus the cost of improvements $59.00 per acre giving a total value of the land of $134.00 per acre. $\frac{9.95}{\$134.} = 7.4\%$ interest on investment.