Albuquerque,N.M.,May 26,1915.

Mr.H.P.Robinson,

Supt.of Irrigation,

Albuquerque,N.M.,

Dear Sir,

I have the honor to submit the following report,estimate and plansfor the irrigation project at Marsh Pass, Western Navajo Reservation, Arizona.

Under date of Dec. 5,1914,I submitedda preliminary report and estimate upon the project,based upon a two and a half days visit.For a general description of the project,materials available,labor conditions,etc.,reference is made to this report.

This report is based upon levels and stadia surveys made by me during April 21-27 last.

Plate I isa general map of the entire project,showing the diversion dam and ditch,reservoir,distribution ditch and irrigable land.

Plate II is a map of the diversion dam site on a larger scale, showing the position of the diversion dam,dike,water surface after the dam is constructed for low water and flood stages,rock outcroppings,test pits, and line of ditch at heading.Test pits 2 and 3 were dug to bedrock,the elevation of which is shown,and pit 1 was was dug to elevation 84.8,with no indication of rock.The formation seems to show that there is a ridge of sand rock running in a general east and west direction across the bed of the creek just below the dam and there has been a deposit of earth upstream from this in the flat where pit 1 is located.The dam will rest upon this rock,and the bed of the stream below the dam will be thru rock for nearly 1000 feet.

The diversion dam,as described in my previous report will be a rock

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crib structure, 1.0' between abutments, with a maximum height of 13.5 feet, the top and back sheeted with 3"x 12" lumber. The abutments are rock-filled cribs, trapezoidal in plan, rising 8 feet above the crest of the dam, which will allow for a flood discharge of about 7000 second feet with 7' of water on the crest. The crib dam is placed across the deepest section of the stream, opposite where the main thread of the stream should be in flood stage, and backed on either end with a dike, rising 10' above the crest of the dam. This dike is to be riprapped on the upstream side, with a small trench running along the upstream toe filled with riprap, to prevent erosion and undermining should there ever be a strong current formed along the dike.

On the downstream side of the dam there is a rock crib water-cushion built to half the height of the dam, to secure against erosion from the impact of the falling water in flood stage.

Plate III is a detailed drawing of the diversion dam. In this drawing it has been assumed that the logs of the cribs are to average 8" in thickness. Should larger logs be easily obtainable, they should be used, in the lower portion of the dam at least. The logs resting upon the bedrock will be anchored to it by anchor bolts set in the rock with cement, and having threads for nut and washer. The remainder of the logs will be fastened together with drift pins. The rock for the cribs is found about two miles from the damsite, and is a very hard dense variety of dolomite. The sandstone occuring at the damsite, while hard, would not be suitable after being shot, as it would be porous and would soon disintegrate under alternate wetting and drying, and freezing weather.

The triangular upstream crib of each abutment will be filled with earth instead of rock, as it will be cheaper, and will aid in making the structure waterproof.

The headgate will be placed in the south abutment, and the water

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carried thru the abutment in a wooden or corrugated iron culvert into the ditch. The crest of the dam for six feet in front of the gate has been lowered to form a sluiceway, as there will be considerable mud and silt settle in front of the gate after floods. This will be closed with flashboards, which may be removed after the subsidence of the flood and the silt in front of the gate washed away.

Plate IV is a large scale sketch of the headgate and details of connections, showing alternate method of construction using a wooden gate and also a circular iron gate with a 76" corrugated iron culvert. The iron culvert will probably cost about $75 more than a wooden one, but should have a much longer life.

Plate V is a profile of the diversion ditch, and the outlet ditch from the reservoir. The ditch is designed to carry the normal flow of Laguna Creek-6 second feet, with all of the water in cut. There is enough material in the excavation to allow a bank over a foot in height to be placed on either side, and the crest of the dam has been built so as to allow for a 6" increased depth of water, about doubling the capacity of the ditch for small rises of the Creek. It will not be possible to utilize large flood flows of the Creek on account of the silt content. The normal flow contains about 5% of very fine silt in suspension. The section of the ditch for the first 1200' has been given a gradual increase, to allow this silt to be deposited thru the retardation of the velocity. At about Stat. 12 the ditch runs thru sandstone for a ways, and a sandbox and wasteway will be placed here.

Plate VI shows this structure. Should the ditch become silted up between it and the headgate, the lower gates can be opened, and with the steep bottom gradient the ditch cleaned. Grooves have been provided for flashboards in case it is desired to turn all of the water out at this place. The water will waste over rock down to the Creek.

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A spillway 6'in length has been provided in the wasteway,to take care of any water from side drainage that is not carried off thru the culverts at Stats.10 and 23.

Plate VII is a contour map of the reservoir site.As stated in my pr previous report,this is an old lake bed lying in a natural depression,and usually contains several feet of water after heavy rains.It is surrounded by three ridges,one of sandstone on the north ,and two of alluvial earth on the southwest and east.By making a cut thru the ridge on the east,and providing suitable means for controlling the water impounded,it may be used as a storage reservoir.The capacity and area of the water surface at difference depths of water are shown on Plate VII.It will be seen that with the reservoir full of water,i.e.the water 9'deep,the capacity will be 1180 acre feet with an area of water surface of 218 acres.Evaporation is likely to be heavy as there is little humidity,and very high winds in the spring.Water could be stored during the ~~XXX~~ fall and winter,tho,and used to supplement the normal flow of the Creek,and the evaporation loss would not be so great.

There is a saddle occurring a short distance south of the place where the outlet ditch will be placed,and this will be ~~XXX~~ used as a spillway.It should be riprapped,to elevation 98.0,and a dike 2'high built as shown.Any water coming over the spillway will flow down the dry wash which carries the water to the irrigable land.

Plate VIII shows the outlet for the reservoir.It will be made thru a 24"corrugated iron pipe with a gate and bridge .A stilling box,either built of concrete as shown or made as a pool lined with grouted riprap will be placed at the lower end of the culvert.

After leaving the reservoir the water will be carried down the dry arroyo to just above the present site of the school.This arroyo or dry wash has a rock bottom for the greater part of the way,and this will

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prevent any great loss of water thru seepage.

As the arroyo only carries water for a short time after rains a small rock and brush dam, riprapped on the downstream side to allow for overflow will be sufficient to get the water into the ditch. A wooden head-gate will be placed in the ditch just above the dam.

As shown on Plate I, the soil of the land between the ditch and the rise in light red blow sand, not suitable for cultivation. The rock is about a foot below the surface around the site of the school, and for these two reasons, the ditch was not taken out of the wash at a higher point. In its present location it skirts the upper edge of the flat upon which the best soil occurs.

The section of the distribution ditch is the same as that of the diversion ditch, designed to carry about 6 second feet of water all in cut, with sufficient freeboard to about double the capacity. At Stat. 79 a small chute or drop will be placed, about 1.6' in height. Takeouts can only be placed after it is decided in what manner the irrigable land will betaken up and cultivated.

There is a small gully at Stat. 104 which can be used to waste the water, in case the ditch is carried no farther.

The two miles of ditch as shown will be sufficient about 600 acres, and 400-500 acres additional can be covered by another mile of ditch, at a cost of about $ 500.

In my previous report I stated that the normal flow of the Creek would be sufficient to irrigate about 600 acres. Assuming a flow of 6 second feet thruout the year, the total annual runoff would be about 4300 acre feet. Deducting 1300 acre feet for losses thru evaporation, low stages of flow, etc., would leave 3000 acre feet available for irrigation, and by using the reservoir wisely for regulation and storage it should be pobbible to irrigate 1000 acres

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of land.Allowing 100 acres for the school farm,this would leave 900 acres for use by the Indians,sufficient for 50 families.

I think that the Indians would eagerly take up any land that might be given to them,and I would advise that the land be allotted,from 15 to 20 acres per family.

The new boarding school which opened this year has 30 children at present,and they have had to turn away a great many on account of lack of accomodations. When I was there in April the Indians seemed to be very much interested in the prospect of a ditch being built and were anxious for work to start soon.

While at Marsh Pass I took a trip over to Tuba Canon,where the Indians have had a small ditch for over 30 years,constructed entirely by themselves.The ditch covers from 75 to 100 acres,and had been washed out by high water.Mr.Robertson,the Farmer at Marsh Pass tells me that the Indians have to rebuild the ditch every two or three years,and do it by hand,using boards and sticks to dig with,as they have no shovels or other implements.I re-ran the ditch,and showed them where to put in protection work against further high water.This illustrates their desire for land to cultivate.

The Farmer at Marsh Pass is well liked by the Indians,and takes a great interest in them,and I am sure that after four or five years the showing made by the Indians would amply justify the expense incurred in developing the water and the land.

The estimate in my previous report was based upon obtaining hand labor at $ 1.00 to $ 1.25 per day,and teams at from $ 2.25 to $ 2.50.Since making it,The trading store has been allowing $ 1.50 per day for hand labor, and $ 2.50 for teams,and I have made the following estimate upon this basis, and upon data secured on the work on the diversion dam in the Moencopi Wash. From all reports from people familar with the Indians at Tuba and at Marsh

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Pass, those of the latter place are by far the better workmen, and with no misfortunes occuring, I think that the work can be done well within the estimate. The Indians are very hard up for tools, harness, wagons, etc., and if some provision could be made whereby a number of the above articles could be issued to them shortly it would greatly facilitate obtaining labor.

Due to the greater increase in the price of hand labor, which will be used on the diversion dam principally, I have assumed a dam with a crest at elev. 93.0, making it about 13.5 high at the maximum. The present estimate exceeds the one of my previous report on account of the increased cost of labor and also from the fact that I did not include the cost of the distribution dit ditch in the latter, for reasons stated.

Should work be commenced this year in the late summer or fall, it should be possible to complete it in six months at the most, if labor was not too difficult to obtain, the logs being cut and stripped and work on the ditch being done before the freezing and cold weather sets in, and work on the diversion dam being done during the winter months, when there is some snow.

ESTIMATE FOR CONSTRUCTION MARSH PASS PROJECT

Diversion Dam		Quantity	Unit price	Cost	Total
Logs for cribs	no.	645	@ 90¢	$ 580.50	
Drift bolts	"	1300	15¢	195.00	
Anchor bolts	"	105	30¢	31.50	
Dimension lumber	'B.M.	18000	$ 95/M	1710.00	
Steel gate and lift	no.	1	$100	100.00	
Rock for cribs	C.Y.	1350	2.50	3375.00	
Earth for dike	"	2500	27½	687.50	
Riprap for dike					
Dolomite	"	160	2.50	400.00	
	Carried forward			7079.50	

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Diversion Dam-Cont.-		Quantity	Unit price	Cost	Total
Brot forward				7079.50	
Rubble stone	C.Y.	116	$ 1.50	172.50	
Total					7252.00
Diversion ditch.					
Excavation-Rock	"	250	1.15	287.50	
Earth	"	8660	27½¢	2381.50	
Waste way and headbox					
Concrete	"	1.6	27.50	44.00	
Rock Exc.	"	20	1.15	23.00	
Hardware, etc.,				1.00	
Corr. iron culverts					
24"	lin. ft.	46	22.25	103.50	
Masy. walls	C.Y.	2	15.00	30.00	
Total					2872.50
Outlet from Reservoir.					
Excavation-Earth	"	4727	27¼¢	1299.93	
Backfill	"	"	500	30¢	150.00
Culvert-24" Corr. iron-lin. ft.			34	$ 2.25	76.50
Gate and lift	no.		1	75.00	75.00
Inlet-concrete	C.Y.		1.25	27.50	34.50
Outlet- "	"		1.75	27.50	47.50
Tower and bridge					
Lumber	B.M.		400	95/M	38.00
Piles	no.		3	4.00	12.00
Total					1683.43
Distribution ditch.					
Rock and brush diversion dam					

Distribution Ditch, Cont.	Quantity	Unit Price	Cost	Total
Rock and Brush Diversion Dam, Cont.				
Brot forward			0	$11827.93
Rock C.Y.	6.5	$3.00	19.50	
Brush Cords	1.5	8.00	12.00	
Wooden Headgate No.	1	25.00	25.00	
Excavation-earth C.Y.	2305	27½¢	633.88	
Borrow " "	620	27½¢	170.50	
Metallic Flumes lin. ft.				
54	70	5.00	350.00	
Inlet & Outlet No.	4.	10.00	40.00	
Chute & Stat.79				
Concrete C.Y.	1.3	27.50	33.75	
Riprap "	6	2.50	15.00	
1 mile additional ditch		500.00	500.00	
Total				1801.63
Grand Total				13629.56
Contingencies 10%				1362.96
Engineering and Superintendence				1200.00
Total cost of project				$16192.52

Subtracting from this total cost the cost of the distribution ditch — $1801.63 it will be seen that the cost is about 25% greater than that of my previous estimate, due to the increase in rate of wages.

In case work is started soon, it might be possible to get workmen for $1.25, before they have become accustomed to the higer wage.

Basing this estimate upon the irrigation of 1000 acres, the cost per acre will be $16.00 which is very reasonable.

Very respectfully yours,

Donald W. Baker.

Assistant Engineer.

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