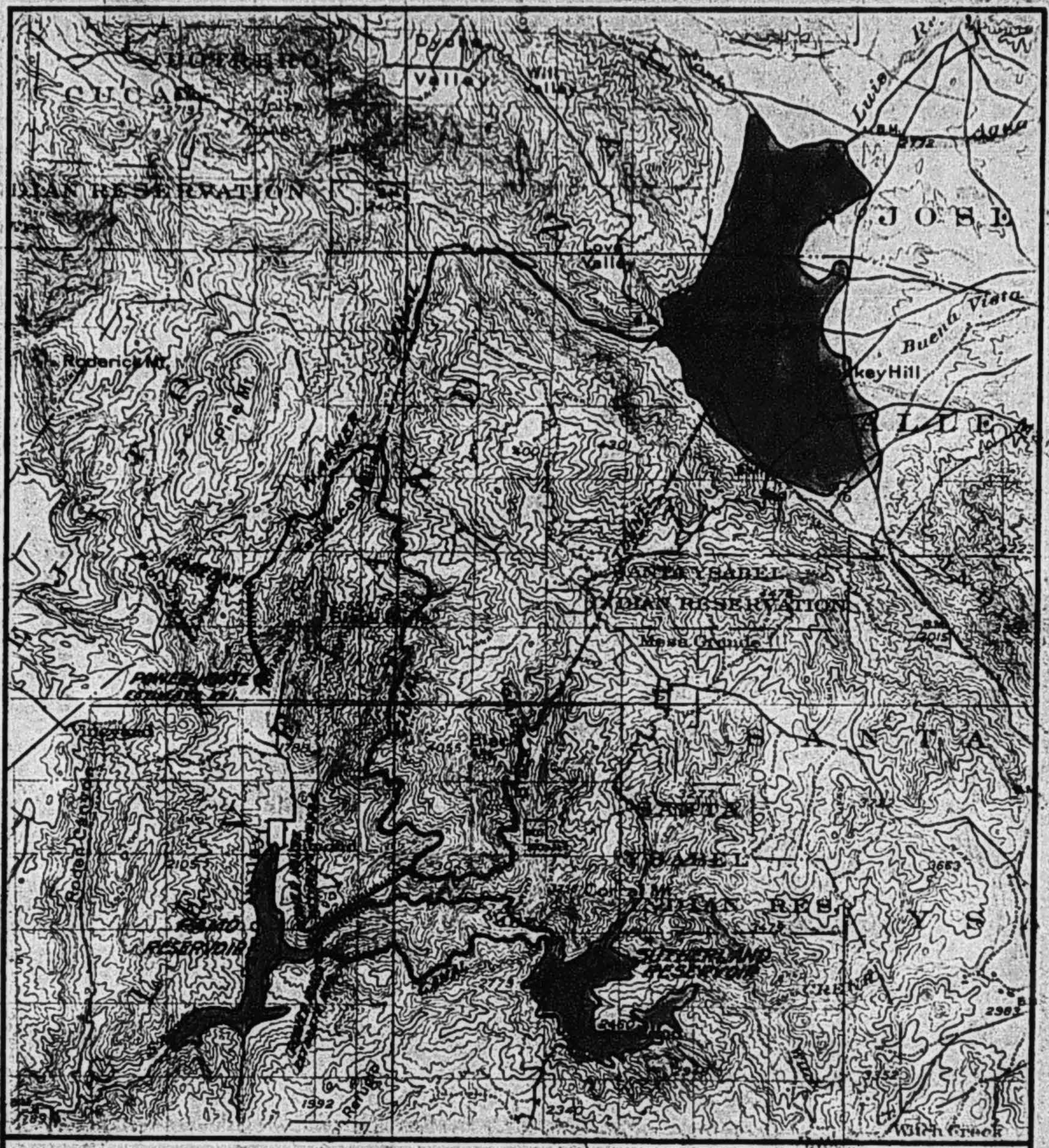

MAP SHOWING
COMPARATIVE PLANS FOR DEVELOPMENT OF POWER
FROM WATER FROM
WARNER AND SUTHERLAND RESERVOIRS

TO ACCOMPANY REPORT OF POST & SELLEW
FEBRUARY 6, 1917.

LEGEND

CANAL
TUNNEL
PRESSURE PIPE

San Diego, California,

February 6, 1917.

Col. Ed Fletcher,
Mgr V L & W Co.

Dear Sir:-

Replying to your communication of 31st ult. regarding power development from Warners and from Sutherland Reservoirs, we have to advise as follows:

The net safe yield of Warners as determined in the Board Report is 34 sec. feet continuous flow. The drop into Pamo is 1500 feet, giving a continuous flow energy on the switchboard of 3,250 K.W. This assumes a combined hydraulic and electrical efficiency of 75%.

At Sutherland the net safe yield is 15.5 sec. ft. and the available fall 890 feet giving on the switchboard 890 K.W. The total energy available is therefore 3,250 + 890 = 4,140 K.W.

This is the amount which may be developed with a uniform load throughout the entire 24 hours during which period there would be a total output of 99,360 K.W. hours.

The above is dependent upon the construction of independent plants for each source of power and you have asked how this volume would be affected should the water from Warner and Sutherland be brought to a common point from which the drop to Pamo could be made in one line. Such an arrangement, because of the difference in available head, will involve two plants; one to utilize the fall from Warners above the junction of the two conduits, and the other using the energy below the junction. It might be more economical to keep both pressure lines independent and combine

the installation under one roof as a "two head" plant. Whatever arrangement is adopted, there can be no material difference in the volume of power for this is governed by the amount of water and the available fall, which factors will not vary sensibly in either scheme.

Should there be any economy in the combination suggested, it will consist of a saving in the construction costs of conduits and power houses plus a reduction in the cost of operation. A determination of this phase of the matter will require estimates of the cost of these structures; also assumptions as to peak loads upon which the dimensions of the structures are mainly dependent.

As a case in point: the total energy of the plant, if uniformly distributed throughout the entire 24 hours, will require development dependent upon the continuous output of 4,140 K.W. Such a plant will probably be ill-advised as practically all commercial purposes require peak load provisions when the power required for short periods may be 100% above the normal.

Peak load conditions may be met by (1) increasing the capacity of the conduit in order that it may deliver sufficient water to meet the maximum requirements; or (2) storage in the forebay immediately above the plant, impounding the conduit flow during periods of low requirement for use under peak conditions. In the absence of specific information as to the destination of this power and other data from which the magnitude of the peak could be determined, we have assumed:

(1) That generation will be confined to 16 hours per day.

(2) That the peak will be 8 hours duration and its requirements met by the storage of the conduit discharge during the eight hours when the plant is idle.

Such provisions allow the employment of minimum conduit dimensions - that is, one which will deliver only the net safe yield in terms of continuous flow. Upon this general basis the following estimates have been prepared except as otherwise noted. The amount of power being the same for each scheme, the installations are omitted from estimate.

Estimate No. 1.

Warner's - Pamo Conduit and Pressure Pipe.

Conduit

From Warner's Dam to south end Lusardi Tunnel 33,200 lin. ft. (See Post report October 8, 1914) ----------	$259,207	
South end Lusardi tunnel to forebay, 13,650 feet at $4.00 ----------	54,600	
Forebay (Post March 16, 1912) ---------	18,400	
Overhead 15% ----------	49,830	$382,037

* **Pressure Pipe 6,500 lin. ft.**

See Post Report - March 16, 1912 ------	$124,050	
Overhead 15% ----------	18,607	142,657
		$524,694

* Steel 1.500.000 lbs. @ 7 c. delivered and erected based upon market price of plate 4 cts lbs. War prices have increased this 3 ¢ a total increase of $45000

Cement $2.00 per bbl. F.O.B. San Diego.

Estimate No. 2

Sutherland - Pamo Conduit and Pressure Pipe - Based on Post's Report - August 1,1916

This scheme proposes an installation of 3,000 theoretical H.P. substantially the same as that now under consideration.

Conduit

Concrete Pipe Line 36" diameter, 3 miles at $15,000 ----------	$45,000	
Steel pipe light heads 36" diam., 1.6 miles at $25,000 ----------	40,000	
Overhead 15% ----------	12,750	$97,750
Pressure line 20" diam., 2500 lin. ft. at $10.00 ----------	$25,000	
Overhead ----------	3,750	28,750
		$126,500

Cost of Development With Independent Units

Warner - Pamo ----------	$524,694
Sutherland - Pamo ----------	126,500
	$651,194

Estimate No. 3.

Warner - Sutherland - Pamo - Combined.

Conduit

Warners Dam to south end of Lusardi tunnel 33,200 lin. ft. - See Estimate No. 1 -----		$ 259,207
Lusardi tunnel to head of pressure pipe 3 miles south of Sutherland, 10½ miles = 55,780 feet at $3.50 ----------		195,230
Sutherland Reservoir to pressure pipe from Warners, 3 miles at $15,000 ----------		45,000
Overhead 15% ----------	75,000	$ 574,437

Pressure Pipes

From Warners 5,300 lin. ft. at $19.00 ----	$ 100,700	
From Sutherland 2,500 lin. ft. at $10.00--	25,000	
Overhead 15% ----------	29,000	154,700
		$ 729,137

In this study opportunity for forebay storage is not apparent and estimates are based upon larger conduits.

Estimate No. 4.

Warner - Sutherland - Pamo - Combined.

Alternate Scheme

This plan considers a tunnel 22,000 feet in length from Warners to upper end of Black Canyon - a conduit to upper end of pressure pipe in Estimate No. 3; the remainder being identical with No. 3.

Conduit

Tunnel from Warners Dam to upper end Black Canyon, 22,000 lin. ft. at $16.00 ----------		$352,000
Conduit from end of tunnel to Pressure Pipe 22,000 ft. at $3.50 ----------	77,000	
Conduit from Sutherland, 3 miles at $15,000	45,000	
Overhead 15% ----------	71,000	$545,000

Pressure Pipes

From Warners, 5,300 ft. at $19.00 ----------		$100,700
From Sutherland, 2,500 ft. at $10.00 ------	25,000	
Overhead 15% ----------	29,000	154,700
		$699,700

No opportunity for forebay development, estimates based on larger conduits.

Table No. 1.

Comparative Estimates of Power Development.

Warner's - Sutherland - Pamo.

Scheme	Length of Conduit	Length of Pressure Pipe	Estimated Cost	Departure from No. 1
No. 1				
Estimates No. 1 and 2 Independent Plants	62,850 ft.	9,000 ft.	$ 651,194	
No. 2				
Estimate No. 3 Combined Plants	104,980 ft.	7,800 ft.	729,137	$ 77,943
No. 3				
Combined Plants with long tunnel	60,000 ft.	7,800 ft.	699,700	48,506

These various schemes are exhibited in Table I which indicates that the most economic arrangement is that with independent plants covered by Estimate No. 1 and No. 2. These estimates have been prepared from an inspection of topographic maps and the use of such previous estimates as appear to fit the case. On portions of the route where no surveys exist, approximations of cost have been made by comparison with those surveyed routes which appear to have similar characteristics. Therefore, the above results must be considered as comparative rather than absolute.

Particular attention is drawn to the fact that these comparisons are based upon the assumption that it is desirable to bring the water from Warner's and Sutherland to the Pamo Reservoir, extracting on the way so much of its potential energy as is commercially available. This is the proposition put up in your letter of January 31st, 1917. We are, however, unable to state definitely that such a plan embraces the most economic development of the resources of the Volcan System. Water has a far greater value for domestic and agricultural purposes than for power and in order that the full possibilities of the system may be realized, the creation of hydro-electric energy should be secondary and in conjunction with a carefully considered development for higher uses.

An examination of the feasibility of devoting this water to domestic and agricultural use, having regard for the future growth of communities within reach and the irrigation of the best

areas available, should be in hand before a definite program is outlined.

It is respectfully recommended that careful attention be given this matter before the Company is committed to any scheme of power development.

Francis P. Sellew.
William S. Post.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 42 Folder: 5

Business Records - Reports - Sellew, Francis [and Post, W.S.] - "Report on Power Development of Volcan System"