Report to the

City of San Diego, California

on the

Proposed BARRETT and LOWER OTAY DAMS

by

M. M. O'SHAUGHNESSY, Hydraulic Engineer.

Copies of O'Shaughnessy-
Leppmcott Report. issued.

~~Bro~~ Edition by Leppmcott 4 copies -

No 1 Fletcher
" 2 Henshaw.
" 3 ?
" 4 Post.
Edition by our office.
" 5- Brown.
" 6 Cromwell -
" 7 Faude -
" 8
" 9
" 10- Carbon backed Kept in files for blue printing.

Report to the

City of San Diego, California

on the

Proposed BARRETT and LOWER OTAY DAMS

by

M. M. O'SHAUGHNESSY, Hydraulic Engineer

-O-

1. Letter of transmittal.
2. Details of Cost Estimate, BARRETT DAM.
3. Details of Cost Estimate, LOWER OTAY DAM.
4. Specifications, Barrett Dam
5. Specifications, Lower Otay Dam.

M. M. O'SHAUGHNESSY
City Engineer
San Francisco.

July 10, 1916.

To the Honorable

MAYOR and Common Council,

of the City of San Diego, California.

Gentlemen:-

In accordance with your Resolution No 21436 and Ordinance No. 6596 of your Body, I herewith submit the following plans and specifications of dams for your approval:-

Sites Available and Advisable.

An adequate water supply is essential to the solid growth of any community and it will therefore be desirable and necessary for the needs of the future Greater City of San Diego to ultimately build dams and to conserve the waters on every watershed in San Diego County. The City of San Diego should therefore direct its development policy with this end kept constantly in mind. At present the City owns in fee simple two excellent dam sites, available for immediate occupation and use, namely, Barrett and Lower Otay, and I recommend that work on these sites be immediately undertaken.

A reservoir at Barrett, with seven billion (7,000,000,000) gallons capacity, will more than conserve seven million (7,000,000) gallons daily average waste now taking place at that point from lack of adequate storage and is the cheapest stored water that can be added to San Diego's supply. The dam at Lower Otay, besides collecting water from its adjacent watershed, can also be used to hold such overflow from Cottonwood Creek as may be diverted by the Dulzura Conduit, and conserve the same in a balancing reservoir within 20 miles of San Diego.

There has been a substantial amount of preliminary work finished for the two above named sites, such as roads, which make the work readily accessible; diversion tunnel; partial foundation explorations; the Dulzura Conduit from Barrett; and the pipe line and distributing branches from the Lower Otay. Should the City of San Diego attempt to initially utilize some of the other available sites, of which there are several in the County, practically all of the above mentioned work or its equivalent would have to be duplicated; water rights and rights of way would have to be obtained either by direct purchase or condemnation proceedings, with the consequent legal entanglements, etc.,; all of which would entail unnecessary expense and delay at this time.

The City should therefore realize the importance of immediately beginning and diligently prosecuting the work on the Barrett and Lower Otay Dams in order to meet the needs of the rapidly increasing population.

The most desirable program of construction would be to carry on both dams simultaneously. However, should the City decide to build only one dam immediately, I recommend that Barrett dam be given preference.

The Barrett reservoir would act not only as a balancing unit for the Lower Otay Reservoir, but would also make full use of the completed Dulzura conduit and bring into immediate service the water now wasting at Cottonwood, thus supplying a very desirable link in the ultimate plan of development.

It is clearly evident from the location and physical characteristics of these two watersheds, and from measurements heretofore made, that the runoff from Barrett is, in normal years, much

more than that from the Lower Otay shed, while exactly the reverse is true of the available economic storage at the two dam sites - fifteen billion (15,000,000,000) gallons at Lower Otay and seven billion (7,000,000,000) gallons at Barrett. This condition demands that the excess waters of Barrett reservoir be transmitted by means of the Dulzura Conduit and stored in the Lower Otay. This in turn will make available more storage space for waters from the Cottonwood shed.

With these two dams built a much more complete utilization of the waters from the two sheds now in City ownership will be possible, and the available City supply will be increased in average years by approximately ten million (10,000,000) gallons per day.

If Barrett dam alone be built at present, the stored water from the same can be passed down to the Upper Otay and the lower smaller City reservoirs near San Diego and practically directly into City distributing system by the direct connection to the Dulzura conduit.

Types of Dams.

With the recent flood experiences in San Diego from unprecedented runoffs which caused a train of destruction along each streambed in the County, it is only wise to anticipate any future recurrence of such conditions by now building dams of such strength and magnitude as to resist floods of even greater volume than any heretofore encountered.

You will note from the accompanying plans that the greatest care has been taken in development of designs which, if properly executed, will render the community immune for all time from any future disasters. To accomplish this object it has been necessary to make some what more expensive works than preliminarily estimated but I am

firmly convinced that no cheapening of type will be justifiable when the vital purpose for which these structures have to serve in the life of the community is considered.

The type of dam proposed for both the Barrett and Lower Otay sheds is the "Arched Gravity, Cyclopean Concrete." Previous exploration work at the two sheds (for the original dam in the case of Lower Otay) has proven that the foundations are amply able to withstand all the pressures and thrusts which may develop. These pressures will not exceed 10 or 11 tons per square foot for either structure.

For both dams there is a central portion made lower than the remainder in order to pass the flood waters. This portion of the dams will be of the "overflow type".

BARRETT DAM

Height of overflow section, 140 feet above streambed.

Height of non-overflow section, 152 feet above streambed.

Available storage at 140 foot depth, 6.75 billion gallons

(This can be increased to 7 billion gallons by means of low flash boards if desirable.)

Length of crest, 640 feet.

Length of effective spillway crest, 242 feet.

Width of crest and roadway, 15 feet.

Outlet tower reinforced concrete, dry.

Depth of overflow, 12 feet.

Capacity of spillway with 12 foot overflow, about 30,000 cu. ft. per second.

Volume of Dam approximately 89,000 cu. yds.

Cost, approximately $690,400.

LOWER OTAY DAM

Height of overflow section, 137.5 feet above streambed

Height of non-overflow section, 145 feet above streambed.

Available storage 137.5 foot depth, 15 billion gallons

(This can be increased to 15.5 billion gallons by means of low flash boards if desirable.)

Length of crest, 750 feet.

Length of effective spillway crest, 212 feet.

Width of crest, and roadway, 15 feet.

Outlet tower reinforced concrete, dry.

Depty of overflow, 7½ feet.

Capacity of spillway with 7½ foot overflow, about 13,000 cu. ft. per second. There is also an additional spillway provided which discharges into the present spillway, enlarged at upper end. This will also have a capacity of approximately 13,000 cubic feet per second, bringing the total available combined spillway capacity up to 26,000 cubic feet per second.

Volume of Dam, approximately 86,000 cu. yds.

Cost, approximately $682,200.

General Plans and Specifications, showing the type, heights of dams at Barrett and Otay, are enclosed under separate cover, together with their cost estimates.

Time Required for Construction.

The probable time which will be required for constructing these dams will be about 15 to 18 months if the construction of both is carried on simultaneously. If the dams are built in sequence the time of construction will be from 30 to 36 months.

Respectfully submitted,

M.M. O'Shaughnessy,

Hydraulic Engineer.

DETAILS OF COST ESTIMATE

For

BARRETT DAM

COST ESTIMATE - BARRETT DAM.

34,700	cu. yds. of 1:2½:5 concrete at $6.30 per cu. yd.,	$218,600.
30,000	cu. yds. of 1:3½:7 concrete at $5.00 " " "	150,000.
115	cu. yds. of 1: 2:4 concrete at $7.30 " " "	850.
	(above concrete costs are exclusive of quarrying rock for crushing for concrete)	
21,600	cu. yds. of rock plums at $2.25 per cu. yd.	48,600.
34,600	cu. yds. of rock for crushing for concrete at $1.75 per cu. yd.	60,550.
13,000	cu. yds. of stripping (mostly rock) at $2.70 per cu. yd.	35,100.
Say 4,200	lin. ft. of holes for grouting foundation (this will depend upon the nature of the foundation when stripped) at $1.35 per lin. ft. grouted	5,700.
380	cu. yds. of 1:2½:5 concrete in outlet tower, at $10.25 per cu. yd.	3,900.
200	cu. yds. of rock for crushing for concrete at $1.75 per cu. yd.	350.
15	tons of steel reinforcement for tower and roadway, at $100. per ton,	1,500.
10	tons of steel pipe,ladders,screens,valve stems, gratings, etc., at $140. per ton,	1,400.
45	feet of 15.5 feet diameter shaft for outlet tower, at $55.75 per foot,	2,500.
3	Valves, 24 inch and 30 inch	1,350.
400	lin. ft. 12" x 1/16" copper water stops at $1.25 per ft.	500.
	Painting 18,000 square feet of expansion joint with P. & B. No. 2 mixture, at $.03 per sq. ft.	550.
	Camps, buildings, sheds, water supply,sewerage, etc.	7,500.
	Camp maintenance and repairs,	1,400.
	Plant (allowing 40% salvage value	30,000.
	Plant maintenance and repairs	4,000.

Engineering and Superintendence at 4%	$ 22,950.
Contractors' profit 12½% of above (except 4% engineering and superintendence)	71,800.
Interest during construction at 4½% on one-half the above amount for 17 months	21,300.
TOTAL	$690,400.

DETAILS OF COST ESTIMATE

for

LOWER OTAY DAM

COST ESTIMATE - LOWER OTAY DAM

37,000	cu. yds. of 1:2½:5 concrete (this includes spillway changes,	at $5.50 per cu.yd.	$203,500.
30,800	cu. yds. of 1:3½:7 concrete	at $4.45 per cu.yd.	137,000.
157	cu. yds. of 1:2:4 concrete	at $6.35 per cu.Yd	1,000.
	(above concrete costs are exclusive of quarrying rock for crushing for concrete)		
22,400	cu. yds. of rock plums	at $2.25 per cu. yd.	50,400.
36,000	cu. yds. of rock for crushing for concrete,	at $1.75 per cu. yd.	63,000.
11,000	cu. yds. of rock (with some earth), stripping and excavating	at $2.70 per cu. yd	29,700.
6,250	cu. yds excavation for spillway alterations,	at $2.50 per cu. yd.	15,625.
Say 7,500	lin. ft. of hole for grouting foundation, (this will depend on the nature of foundation when stripped)	at $1.25 per lin. ft. grouted	9,375.
440	cu. yds. of 1:2½:5 concrete for tower and connection to tunnel	at $9.50 per cu.yd.	4,175.
270	cu. yds. of 1:2½:5 concrete for lining tunnel,	at $12.00 per cubic yd.	3,250.
400	cu. yds. of rock for crushing for concrete,	at $1.75 per cu. yd.	700.
18	tons of steel reinforcement of tower and roadway	at $95.00 per ton	1,700.
	Wrecking old tower and enlarging tunnel entrance		750.
	Road change owing to new spillway, say		2,000.
9,500	ft. B.M. in bridge over spillway, at $47.30 per M., including all bolts, etc.		450.
19½	tons of steel pipe, ladders, screens, valve stems, gratings, etc.	at $133.00 per ton	2,600.
9	valves, 24 inch and 30 inch		2,400.
500	lin. ft. of 12" x 1/16" copper water stops at	$1.25 per ft.	625.
		Forwarded	$528,250.

Brought Forward	$528,250.
Painting 30,000 sq. ft. of expansion joints, at $ .03 per sq.ft.	900.
Camp buildings, sheds, water supply, sewerage, etc.	6,000.
Camp maintenance and repairs	1,200.
Plant (allowing 40% salvage value)	27,500.
Plant maintenance and repairs	3,600.
Engineering and superintendence at 4%	22,700..
Contractor's profit 12½% of above (except 4% engineering and superintendence	71,000.
Interest during construction at 4½% on one-half the above amount for 17 months	21,050.
TOTAL.	$682,200.

PLANS AND SPECIFICATIONS

for

BARRETT DAM

S P E C I F I C A T I O N S

1. GENERAL DESCRIPTION:

The work to be done under these specifications is the construction of a storage dam and its appurtenant features at the Barrett Dam Site, San Diego County, California.

This dam will form a reservoir having a capacity of Seven Billion Gallons (6.75 billion gallons usable) of water. The dam will be of the gravity type, arched in plan, the central portion being used as a spillway for discharging flood waters. It will be built of concrete in which will be imbedded large rough stones of various sizes up to about four (4) cubic yards each.

(a) The section of the dam will be in accordance with drawing No.

(b) The top of the overflow portion of the dam will be one hundred and forty (140) feet above the streambed, the top of the non-overflow portion being twelve (12) feet higher, that is, at elevation one hundred and fifty-two (152) feet. It will be about six hundred forty (640) feet in length with a roadway along the top. The width of crest will be fifteen (15) feet.

(c) The faces of the dam below the coping will be of concrete built in place with the use of sectional forms.

2. ROCK EXCAVATION FOR FOUNDATION:

Excavation shall be made to a sufficient depth to secure a foundation on sound ledge rock, free from open seams or other objectionable defects.

It is the intention to build the cyclopean concrete masonry against the side of this rock excavation. To preserve the rock outside the lines of the excavation in the soundest possible condition and to obtain over the whole foundation a rock surface, free from open seams or cracks, unusual precaution will be required in excavating. Blasting may be done to the extent directed by the Engineer in charge with explosives of such moderate power and in such positions as will neither crack nor damage the rock outside the prescribed limits of excavation, and whenever, in the opinion of the Engineers, further blasting is liable to injure the rock upon or against which the masonry is to be built, the use of explosives shall be discontinued and the excavation of the rock continued by wedging and barring or other approved methods.

(a) A cutoff trench will be required near the heel of the dam, practically for its entire length. This cutoff trench will have nearly vertical sides and be of dimensions shown on plans.

3. PREPARATION OF ROCK FOUNDATION:

The surfaces of the rock foundation shall be left sufficiently rough to bond well with the masonry and shall be cut to rough benches or steps unless naturally so stepped. Care must be taken not to open or break the ledge rock unnecessarily.

Before laying the masonry on or against the ledge rock the latter shall be scrupulously free from all dirt, gravel, scale, loose fragments, and other objectionable substances. Streams of water, air, or steam under sufficient pressure, stiff broom, hammers, and other effective means shall be used to accomplish this cleaning. Should any springs be encountered they shall be piped and grouted or carried outside the dam. After cleaning and before concrete is laid on or against the foundation, the water shall be removed from all depressions so that the surface can be inspected to determine whether seams or other defects exist.

(a) Small seams and cavities showing on the base or the face of excavation where masonry is to be placed, shall be carefully scraped and cleaned out and filled with rich concrete or mortar rammed in under pressure.

(b) All holes that may be drilled in riverbed at the time when borings shall be made shall be thoroughly grouted under pressure.

(c) In the center of the cutoff trench a row of holes shall be drilled as shown on the drawing, which holes shall be grouted after the concrete above shall have been carried up to a convenient elevation, not less than twenty (20) feet above the base of the dam. There may be three (3) or more lines of such holes required, depending upon the nature of the foundation.

(d) Along the bottom of the cutoff trench there shall be laid a porous sub-drain composed of porous concrete blocks or tile, and connected at intervals by riser galleries to the main inspection and drainage gallery, as shown upon the plans. In building up the riser care shall be taken to place large rocks imbedded in the concrete between them in order to prevent the formation of any line of weakness.

(e) Whenever in excavating the foundation or abutments, thick strata of earth or other material, which is liable to decompose from exposure to the air, are encountered, drifts generally parallel to the axis of the dam shall be driven along these seams or strata until a safe distance from points of possible exposure is reached. These drifts shall be at once thoroughly washed and cleaned and immediately refilled with concrete. Grout should be pumped in, especially around the top, so as to entirely fill the opening.

4. CEMENT:

All cement shall be first quality Portland cement of a brand which has been in continuous and successful use in the State of California for three (3) years.

(a) It shall be furnished in original packages, bearing the original labels.

(b) The cement shall have a specific gravity of not less than three and one-tenth (3.1) nor more than three and twenty-five hundredths (3.25), after being thoroughly dried at a temperature of two hundred and twelve (212) degrees Fahrenheit.

(c) Its color shall be uniform bluish-gray, free from yellow or brown particles.

(d) At least ninety-two (92) per cent of the cement by weight shall pass through a sieve of ten thousand (10,000) meshes to the square inch and at least seventy-seven (77) per cent shall pass through a sieve of forty thousand (40,000) meshes to the square inch.

(e) Brickettes made from neat cement, after being kept one (1) day in moist air and the remainder of the time in water must develop a tensile strength per square inch as follows:-
After seven (7) days five hundred (500) pounds
After Twenty-eight (28) days six hundred (600) pounds.

(f) Brickettes made with one (1) part of cement and three (3) parts of sand and exposed in the same way as above must develop a tensile strength per square inch as follows:-

After seven (7) days two hundred (200) pounds.
After Twenty eight (28) days three hundred (300) pounds.

The sand used in this test shall be clean sharp quartz sand and must pass a twenty (20) mesh and be rejected by a thirty (30) mesh sieve.

(g) Cement failing to meet the seven (7) day requirements may be held awaiting the results of the twenty-eight (28) day tests before final rejection.

(h) Pats of neat cement about three (3) inches in diameter and one-half ($\frac{1}{2}$) inch in thickness at center, tapering to a thin edge being kept in moist air at a normal temperature for twenty-four (24) hours and then placed in water and raised to a temperature of two hundred and twelve (212) degrees Fahrenheit in one (1) hour, and maintained at such temperature for five (5) hours; and other pats kept, one in open air and one in water, at a temperature of about sixty-five (65) degrees Fahrenheit, for twenty-eight (28) days, shall show no signs of distortion, blotching, cracking, or disintegration.

(i) The cement shall not contain more than one and seventy-five hundredths (1.75) per cent of anhydrous sulphuric acid (SO3), nor more than four (4) per cent of magnesia (MgO).

(j) In determining the proportion of cement to be used in concrete and mortar ninety-four (94) pounds of cement will be considered a cubic foot.

5. SAND:

(a) The sand must be clean river or be ach sand and the grains shall be composed of hard, siliceous material. It shall not show more than three (3) per cent by volume of fine material, such as silt, mica, clay, or other injurious material after being shaken in water and allowed to settle.

(b) The mesh composition of all sand shall be such than ten (10) per cent shall be retained on a No.20 mesh screen and seventy (70) per cent shall be retained on a No.50 mesh screen.

6. CRUSHED ROCK:

The crushed rock shall be a good quality of altered sandstone, limestone, basalt, granite, quartzite, or porphyry, close grained and sound. It shall be clean and free from loam, clay, soil, or other inferior material. All crushed rock must be capable of passing through a two and one-half ($2\frac{1}{2}$) inch ring.

7. CONCRETE IN BODY OF DAM:

Concrete shall consist of an intimate mixture of sand, run of crusher rock, and cement.

(a) The interior or heart portion of the dam shall be constructed of concrete approximately of a 1:$3\frac{1}{2}$:7 mixture.

(b) The outside or skin eight (8) or ten (10) feet thick on the upstream face and about four (4) feet thick on the downstream face, shall be constructed of concrete approximately of a 1:$2\frac{1}{2}$:5. mixture. Care shall be taken to make this skin mixture as dense and impermeable as possible.

(c) Concrete composing the slabs of the roadway over the spillway portion of the dam shall be constructed of a 1:2:4 mixture.

(d) The above proportions may be changed slightly from time to time as determined by frequent mechanical analyses of the ingredients available and by experiments and tests on samples taken from large batches.

(e) All classes of concrete and mortar shall be machine mixed in batch mixer. Hand mixing will not be permitted except for special reasons and then only in small quantities.

8. STONES FOR MASONRY:

Stones for imbedding in concrete shall be sound, free from seams and cracks, clean, hard, of irregular shapes, without long thin projections, and of various sizes up to the largest which can be economically quarried, transported and handled (approximately four (4) cubic yards). They shall be thoroughly cleaned before being brought onto the dam by washing with water under pressure, or by the use of brushes or otherwise, and shall be cleaned and placed in the concrete. Hammers or other tools shall be used if necessary to remove objectionable material adhering to any stone. Stones shall be wet at the time of placing in the concrete.

9. PLACING OF MASONRY:

Wet concrete in sufficient quantities shall be deposited in low places in the work and large stones shall be lowered into it immediately as close together as desirable, but not closer than six (6) inches, leaving room to thoroughly fill the spaces between them with concrete. This concrete shall be carried to the work in bottom-dumping buckets or by other approved appliances, as directed by the Engineer. The stones, after being placed in the concrete, shall be jostled with a bar so as to settle them well into the mass, and the concrete shall be worked with suitable tools to force the filling with concrete of all spaces around the large stones. In placing large stones care shall be taken to secure as good bonding both horizontal and vertical, as is practicable with this class of massonry. Whenever convenient smaller stones shall be imbedded in the concrete between the large stones. The object is to obtain a monolithic mass of stone and concrete containing as large a proportion of stone as is economical (probably 20 to 25 per cent.)

When ever the concrete surface must be left long enough to permit the concrete to set this surface must be left as rough as possible by means of large rocks partially imbedded in the concrete.

No material shall be placed in the dam except in the presence of an authorized inspector.

10. JOINING NEW TO OLD MASONRY:

Before laying masonry of any class the masonry previously laid shall be wire brushed and thoroughly cleaned by a jet of water or other approved methods.

11. EXPANSION JOINTS:

At such intervals and depths as shown on the drawings or directed, expansion joints normal to the axis of the dam shall be formed of masonry built against forms.

Each such face shall be ~~xx~~ coated with an acceptable material to prevent adhesion to the masonry on the other side of the joints. Copper water stops shall be placed across the expansion joints upstream from the line of drainage galleries as shown on the plans. The expansion joints will divide the dam into sections and as the work progresses alternate sections shall be carried ahead of the intervening ones.

Derricks or other hoisting and conveying apparatus may, when the masonry is of acceptable strength, be placed on such higher sections for use in placing masonry in the lower sections. One or more of these sections may be maintained at a lower elevation than the adjacent ones, as an additional safeguard against damage by floods.

12. RACKING:

The top of the masonry under construction shall be kept at all times approximately level between expansion joints or such other limits as required, except that the downstream side shall be generally higher thanthe upstream side.

Pinnacles for landing platforms and similar purposes shall not be built unless they be made of individual first class concrete piers with platforms on top, these piers to be built in and become a part of the masonry of the main dam. Where racking is permitted the slope shall not be steeper than one to one and the face shall be as irregular as possible.

Small spall dams shall be built to prevent the concrete from running down the face of the rack. The trowel work on the spall dams is the only trowel work which will be required or expected in connection with the cyclopean part of the masonry. When trowel work is necessary it shall be done with mortar of such consistency as to give a tight joint.

13. WORK IN FREEZING WEATHER:

Should it become necessary to lay masonry during freezing weather, precaution shall be taken for removing ice and frost from all materials, for protecting the newly laid masonry from freezing, and for heating the materials when necessary to prevent freezing. The water, stone, sand and gravel, shall be heated to a sufficient temperature to insure its being deposited in the forms at a temperature not lower than seventy-five (75) degrees Fahrenheit. The cement shall not be heated.

Covering for the newly laid masonry and such additional appliances and materials as may be required therefor, including steam pipes for keeping the air warm beneath the covering, shall be provided.

14. PROTECTION OF MASONRY.

Until a sufficient time has elapsed for the setting of the concrete it will not be permitted to erect derricks or other machinery upon the surfaces of the masonry nor to build centering or forms, nor to land or store stones or other heavy objects, nor to walk or work on such surfaces. Care shall be exercised to avoid disturbing stones in any way after they have been set.

15. DEFECTIVE MASONRY:

Masonry damaged by freezing or alternate freezing and thawing, or from any other cause, or any masonry which shall be found defective at any time before the completion of the dam, shall be removed and rebuilt. Whenever a stone has been set and its bond broken, it shall be taken up and reset.

16. PROTECTING EXPOSED FACES:

The facing of the dam and all other masonry which is permanently exposed to view shall be effectively protected from injury or disfigurement by the falling of stones, tools, motar or other objects until the completion of this work.

17. MASONRY TO BE KEPT MOIST:

Concrete or other masonry shall be kept moist for at least two (2) weeks or until covered)

18. MIXING AND USING GROUT:

Apparatus for mixing and placing grout shall be of a type that has been successfully used and shall be equal in efficiency to a machine having for its essential part an airtight chamber in which the grount is mechanically stirred and from which it is forced by air pressure into the holes and voids.

Whenever it is known in advance that grout is to be used in any place, pipes through which the grout may be forced shall be set as the work progresses. In other cases, suitable holes shall be drilled. Holes to test the efficiency of the filling shall be made if necessary.

If it is discovered that any voids have not been thoroughly filled with the first application of the grout, the process shall be repeated until satisfactory results are obtained.

19. SPECIAL SURFACES OF FORMS:

In order to secure the smoothest practicable finished surfaces wherever the concrete is a part of a waterway and elsewhere if required, the centering, if not entirely of metal construction, shall be faced with sheet steel not lighter than No. 23 gauge or with other suitable material. In case sheet steel is used the plates should be carefully selected, and should be put on the forms without wrinkles.

The surface of the forms against which concrete is to be deposited shall be cleaned and coated with soap, mineral oil or other suitable substance to prevent adhesion of the concrete. Where the forms are built of separate panels and sheet metal is used the metal shall be carried over all straight edges having been bent to a sharp corner over a straight steel edge. Suitable and effective devices shall be used to hold adjacent edges or ends of panels or other forms tight together and in accurate alignment.

Metal covering need not be used on any special forms which are to be used but once. The surfaces of all such special forms, however, shall be tight and smooth, and if used on any portion of the waterway, shall make a surface equal to that made upon metal forms.

20. SUPPORTS FOR FORMS:

Small rods to hold the forms in place will be allowed in the structure, provided proper means be used to take out a portion of each of the rods nearest the surface at least 6 inches in length. All holes left after the removal of such rods shall be filled immediately and completely with cement mortar and the surface left smooth and in good condition.

21. WETTING AND PLACING FORMS:

Wooden forms shall be wetted throughly just before placing concrete so as to prevent injurious drying of the surface of the concrete by absorption. Where forms are placed in successive units for continuous surfaces, care shall be exercised to fit the forms tightly over completed surfaces so as to prevent leakage from the concrete.

22. REMOVING FORMS:

Forms shall not be removed or disturbed for at least seven (7) days and when removed great care shall be exercised so as to avoid any injury to the concrete.

23. METAL REINFORCEMENT:

Portions of the concrete and other masonry shall, wherever shown on the drawings, and in other places if required, be strenghtened by imbedding in them pieces of steel or iron of the number, sizes and shapes directed.

24. BUILDING METAL INTO MASONRY.

There shall be built into or set in or attached to the masonry wherever directed, the sluice gates, valves, pipes, stop grooves, frames and manhole covers, bolts, metal strips, bronze supports, or other metal objects shown on the drawings, or else recesses, holes or projections necessary therefor shall be left or made in the masonry. All necessary precautions shall be taken to prevent this metal work from being displaced, broken or deformed Rich concrete or mortar shall be packed tightly around pipes and other metal work so as to prevent leakage and secure perfect adhesion.

PLANS AND SPECIFICATIONS

for

LOWER OTAY DAM

SPECIFICATIONS

1. GENERAL DESCRIPTION:

The work to be done under these specifications is the construction of a storage dam and its appurtenant features at the Lower Otay Damsite, San Diego County, California.

This dam will form a reservoir having a capacity of Fifteen Billion Gallons (15,billion gallons usable) of water. The dam will be of the gravity type, arched in plan, the central portion being used as a spillway for discharging flood waters. It will be built of concrete in which will be imbedded large rough stones in various sizes up to about four (4) cubic yards each.

(a) The section of the dam will be in accordance with drawing No.

(b) The top of the overflow portion of the dam will be one hundred and thirty-seven and five tenths (137.5) feet above the Streambed, the top of the non-overflow portion being seven and one-half (7½) feet higher, that is, at elevation one hundred forty-five (145) feet. It will be about seven hundred and fifty (750) feet in length with a roadway along the top. The width of crest will be fifteen (15) feet.

(c) The faces of the dam below the coping will be of concrete built in place with the use of sectional forms.

2. ROCK EXCAVATION FOR FOUNDATION:

Excavation shall be made to a sufficient depth to secure a foundation on sound ledge rock, free from open seams or other objectionable defects.

It is the intention to build the cyclopean concrete masonry against the side of this rock excavation. To preserve the rock outside the lines of the excavation in the soundest possible condition and to obtain over the whole foundation a rock surface, free from open seams or cracks, unusual precaution will be required in excavating. Blasting may be done to the extent directed by the Engineer in charge with explosives of such moderate power and in such positions as will neither crack nor damage the rock outside the prescribed limits of excavation, and whenever, in the opinion of the Engineer, further blasting is liable to injure the rock upon or against which the masonry is to be built, the use of explosives shall be discontinued and the excavation of the rock continued by wedging and barring or other approved methods.

(a) A cutoff trench will be required near the heel of the dam, practically for its entire length. This cutoff trench will have nearly vertical sides and be of dimensions shown on plans.

3. PREPARATION OF ROCK FOUNDATION:

The surfaces of the rock foundation shall be left sufficiently rough to bond well with the masonry and shall be cut to rough benches or steps unless naturally so stepped. Care must be taken not to open or break the ledge rock unnecessarily.

Before laying the masonry on or against the ledge rock the latter shall be scrupulously free from all dirt, gravel, scale, loose fragments, and other objectionable substances. Streams of water, air, or steam under sufficient pressure, stiff broom, hammers, and other effective means shall be used to accomplish this cleaning. Should any springs be encountered they shall be piped and grouted or carried outside the dam. After cleaning and before concrete is laid on or against the foundation, the water shall be removed from all depressions so that the surface can be inspected to determine whether seams or other defects exist.

(a) Small seams and cavities showing on the base or the face of excavation where masonry is to be placed, shall be carefully scraped and cleaned out and filled with rich concrete or mortar rammed in under pressure.

(b) All holes that may be drilled in riverbed at the time when borings shall be made shall be thoroughly grouted under pressure.

(c) In the center of the cutoff trench a row of holes shall be drilled as shown on the drawing, which holes shall be grouted after the concrete above shall have been carried up to a convenient elevation, not less than twenty(20) feet above the base of the dam. There may be three (3) or more lines of such holes required, depending upon the nature of the foundation.

(d) Along the bottom of the cutoff trench there shall be laid a porous sub-drain composed of porous concrete blocks or tile, and connected at intervals by riser galleries to the main inspection and drainage gallery, as shown upon the plans. In building up the risers care shall be taken to place large rocks imbedded in the concrete between them in order to prevent the formation of any line of weakness.

(e) Whenever in excavating the foundation or abutment, thick strata of earth or other material, which is liable to decompose from exposure to the air, are encountered, drifts generally parallel to the axis of the dam shall be driven along these seams or strata until a safe distance from points of possible exposure is reached. These drifts shall be at once thoroughly washed and cleaned and immediately refilled with concrete. Grout should be pumped in, especially around the top, so as to entirely fill the opening.

4. CEMENT:

All cement shall be first quality Portland cement of a brand which has been in continuous and successful use in the State of California for three (3) years.

(a) It shall be furnished in original packages, bearing the original labels.

(b) The cement shall have a specific gravity of not less than three and one-tenth (3.1) nor more than three and Twenty-five hundredths (3.25), after being thoroughly dried at a temperature of two hundred and twelve (212) degrees Fahrenheit.

(c) Its color shall be uniform bluish-gray, free from yellow or brown particles.

(d) At least ninety-two (92) per cent of the cement by weight shall pass through a sieve of ten thousand (10,000) meshes to the square inch, and at least seventy-seven(77) per cent shall pass through a sieve of forty thousand (40,000) meshes to the square inch.

(e) Brickettes made from neat cement, after being kept one (1) day in moist air and the remainder of the time in water must develop a tensile strength per square inch as follows:

After seven (7) days five Hundred (500) pounds
After twenty-eight (28) days six hundred (600) pounds.

(f) Brickettes made with one (1) part of cement and three (3) parts of sand and exposed in the same way as above must develop a tensile strength per square inch as follows:-

After seven (7) days two hundred (200) pounds
After twenty-eight (28) days three hundred (300) pounds.

The sand used in this test shall be clean sharp quartz sand and must pass a twenty (20) mesh and be rejected by a thirty (30) mesh sieve.

(g) Cement failing to meet the seven (7) day requirements may be held awaiting the results of the twenty-eight (28) day tests before final rejection.

(h) Pats of neat cement about three (3) inches in diameter and one-half (½) inch in thickness at center, tapering to a think edge, being kept in moist air at a normal temperature for twenty-four (24) hours and then placed in water and raised to a temperature of two hundred and twelve (212) degrees Fahrenheit in one (1) hour, and maintained at such temperature for five (5) hours; and other pats kept, one in open air and one in water, at a temperature of about sixty-five (65) degrees Fahrenheit, for twenty-eight (28) days, shall show no signs of distortion, blotching, cracking, or disintegration.

(i) The cement shall not contain more than one and seventy-five hundredths (.75) per cent of anhydrous sulphuric acid (SO3), nor more than four (4) per cent of magnesia (MgO).

(j) In determining the proportion of cement to be used in concrete and mortar ninety-four (94) pounds of cement will be consider a cubic foot.

5. SAND:

(a) The sand must be clean river or beach sand and the grains shall be composed of hard, siliceous material. It shall not show more than three (3) per cent by volume of fine material such as silt, mica, clay or other injurious material after being shaken in water and allowed to settle.

(b) The mesh composition of all sand shall be such that ten (10) per cent shall be retained on a No. 20 mesh screen and seventy (70) per cent shall be retained on a No 50 mesh screen.

6. CRUSHED ROCK:

The crushed rock shall be a good quality of altered sandstone, limestone, basalt, granite, quartzite, or porphyry, close grained and sound. It shall be clean and free from loam, clay, soil, or other inferior material. All crushed rock must be capable of passing through a two and one-half (2½) inch ring.

7. CONCRETE IN BODY OF DAM:

Concrete shall consist of an intimate mixture of sand run of crusher rock and cement.

(a) The interior or heart portion of the dam shall be constructed of concrete approximately of a 1:3½:7 mixture.

(b) The outside or skin eight (8) or ten (10) feet thick on the upstream face and about four (4) feet thick on the downstream face, shall be constructed of concrete approximately of a 1:2½:5 mixture. Care shall be taken to make this skin mixture as dense and impermeable as possible.

(c) Concrete composing the slabs of the roadway over the spillway portion of the dam shall be constructed of a 1:2:4 mixture.

(d) The above proportions may be changed slightly from time to time as determined by frequent mechanical analyses of the ingredients available and by experiments and tests on samples taken from large batches.

(e) All classes of concrete and mortar shall be machine mixed in batch mixer. Hand mixing will not be permitted except for special reasons and then only in small quantities.

8. STONES FOR MASONRY:

Stones for imbedding in concrete shall be sound, free from seams and cracks, clean, hard, of irregular shapes, without long thin projections, and of various sizes up to the largest which can be economically quarried, transported and handled (approximately four (4) cubic yards). They shall be thoroughly cleaned before being brought onto the dam by washing with water under pressure, or by the use of brushes or otherwise, and shall be cleaned and placed in the concrete. Hammers or other tools shall be used if necessary to remove objectionable material adhering to any stone. Stones shall be wet at the time of placing in the concrete.

9. PLACING OF MASONRY:

Wet concrete in sufficient quantities shall be deposited in low places in the work and large stones shall be lowered into it immediately as close together as desirable, but not closer than six (6) inches, leaving room to thoroughly fill the spaces between them with concrete. This concrete shall be carried to the work in bottom-dumping buckets or by other approved appliances, as directed by the Engineer. The stones, after being placed in the concrete, shall be jostled with a bar so as to settle them well into the mass, and the concrete shall be worked with suitable tools to force the filling with concrete of all spaces around the large stones. In placing large stones care shall be taken to secure as good bonding both horizontal and vertical as is practicable with this class of masonry Whenever convenient smaller stones shall be imbedded in the concrete between the large stones. The object is to obtain a monolithic mass of stone and concrete containing as large a proportion of stone as is economical (probably 20 to 25 per cent)

Whenever the concrete surface must be left long enough to permit the concrete to set this surface must be left as rough as possible by means of large rocks partially imbedded in the concrete.

No material shall be placed in the dam except in the presence of an authorized inspector.

10. JOINING NEW TO OLD MASONRY:

Before laying masonry of any class the masonry previously laid shall be wired brushed and thoroughly cleaned by a jet of water or other approved method.

11. EXPANSION JOINTS:

At such intervals and depths as shown on the drawings or directed, expansion joints normal to the axis of the dam shall be formed of masonry built against forms. Each such face shall be coated with an acceptable material to prevent adhesion to the masonry on the other side of the joints. Copper water stops shall be placed across the expansion joints upstream from the line of drainage galleries as shown on the plans. The expansion joints will divide the dam into sections and as the work progresses alternate sections shall be carried ahead of the intervening ones.

Derrick or other hoisting and conveying apparatus may, when the masonry is of acceptable strength, be placed on such higher sections for use in placing masonry in the lower sections. One or more of these sections may be maintained at a lower elevation than the adjacent ones, as an additional safeguard against damage by floods.

12. RACKING:

The top of the masonry under construction shall be kept at all times approximately level between expansion joints or such other limits as required, except that the downstream side shall be generally higher than the upstream side.

Pinnacles for landing platforms and similar purposes shall not be built unless they be made of individual first class concrete piers with platforms on top, these piers to be built in and become a part of the masonry of the main dam. Where racking is permitted the slope shall not be steeper than one to one and the face shall be as irregular as possible.

Small spall dams shall be built to prevent the concrete from running down the face of the rack. The trowel work on the spall dam is the only trowel work which will be required or expected in connection with cyclopean part of the masonry. When trowel work is necessary it shall be done with mortar of such consistency as to give a tight joint.

13. WORK IN FREEZING WEATHER:

Should it become necessary to lay masonry during freezing weather, precautions shall be taken for removing ice and frost from all materials, for protecting the newly laid masonry from freezing, and for heating the materials when necessary to prevent freezing. The water, stone, sand and gravel shall be heated to a sufficient temperature to insure its being deposited in the forms at a temperature not lower than seventy-five (75) degrees Fahrenheit. The cement shall not be heated.

Covering for the newly laid masonry and such additional appliances and materials as may be required therefor, including steam pipes for keeping the air warm beneath the covering, shall be provided.

14. PROTECTION OF MASONRY:

Until a sufficient time has elapsed for the setting of the concrete it will not be permitted to erect derricks or other machinery upon the surface of the masonry nor to build centering or forms, nor to land or store stones or other heavy objects, nor to walk or work on such surfaces. Care shall be exercised to avoid disturbing stones in any way after they have been set.

15. DEFECTIVE MASONRY:

Masonry damaged by freezing or alternate freezing and thawing, or from any other cause, or any masonry which shall be found defective at any time before the completion of the dam, shall be removed and rebuilt. Whenever a stone has been set and its bond broken, it shall be taken up and reset.

16. PROTECTING EXPOSED FACES:

The facing of the dam and all other masonry which is permanently exposed to view shall be effectively protected from injury or disfigurement by the falling of stones, tools, mortar or other objects until the completion of the work.

17. MASONRY TO BE KEPT MOIST:

Concrete or other masonry shall be kept moist for at least two (2) weeks or until covered.

18. MIXING AND USING GROUT:

Apparatus for mixing and placing grout shall be of a type that has been sucessefully used and shall be equal in effeicency to a machine having for its essential part an airtight chamber in which the grout is mechanically stirred and from which it is forced by air pressure into the holes and voids.

Whenever it is known in advance that grout is to be used in any place, pipes through which the grout may be forced shall be set as the work progresses. In other cases, suitable holes shall be drilled. Holes to test the efficiency of the filling shall be made if necessary.

If it is discovered that any voids have not been thoroughly filled with the first application of the grout the process shall be repeated until satisfactory results are obtained.

19. SPECIAL SURFACES OF FORMS:

In order to secure the smoothest practicable finished surface wherever the concrete is a part of a waterway and elsewhere if required, the centering, if not entirely of metal construction shall be faced with sheet steel not lighter than No.23 gauge or with other suitable material. In case sheet steel is used the plates should be carefully selected, and should be put on the forms without wrinkles.

The surface of the forms against which concrete is to be dsposited shall be cleaned and coated with soap, mineral oil or other suitable substance to prevent adhesion of the concrete. Where the forms are built of separate panels and sheet metal is used the metal shall be carried over all straight edges having been bent

to a sharp corner over a straight steel edge. Suitable and effective devices shall be used to hold adjacent edges or ends of panels or other forms tight together and in accurate alignment.

Metal covering need not be used on any special forms which are to be used but once. The surfaces of all such special forms however, shall be tight and smooth, and if used on any portion of the waterway, shall make a surface equal to that made upon metal forms.

20. **SUPPORTS FOR FORMS:**

Small rods to hold the forms in place will be allowed in the structure, provided proper means be used to take out a portion of each of the rods nearest the surface at least 6 inches in length. All holes left after the removal of such rods shall be filled immediately and completely with cement mortar and the surface left smooth and in good condition.

21. WETTING AND PLACING FORMS:

Wooden forms shall be wetted thoroughly just before placing concrete so as to prevent injurious drying of the surface of the concrete by absorption. Where forms are placed in successive units for continuous surfaces, care shall be exercised to fit the forms tightly over completed surfaces so as to prevent leakage from the concrete.

22. REMOVING FORMS:

Forms shall not be removed or disturbed for at least seven (7) days and when removed great care shall be exercised so as to avoid any injury to the concrete.

23. METAL REINFORCEMENT:

Portions of the concrete and other masonry shall, wherever shown on the drawings, and in other places if required, be strengthened by imbedding in them pieces of steel or iron of the number, sizes and shapes directed.

24. BUILDING METAL INTO MASONRY:

There shall be built into or set in or attached to the masonry wherever directed, the sluice gates, valves, pipes, stop grooves, frames and manhole covers, bolts, metal strips, bronze supports, or other metal objects shown on the drawings, or else recesses holes or projections necessary therefor shall be left or made in the masonry. All necessary precautions shall be taken to prevent this metal work from being displaced, broken or deformed. Rich concrete or mortar shall be packed tightly around pipes and other metal work so as to prevent leakage and secure perfect adhesion.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 40 Folder: 6

Business Records - Reports - O'Shaughnessy, M.M - "Report to the City of San Diego, California on the Proposed Barrett and Lower Otay Dams"