REPORT OF

ENGINEERING CONTROL OF COMPACTED FILL

TWO EARTH DAMS

LORD'S LAKE DEVELOPMENT

JEFFERSON COUNTY, WASHINGTON

for the

CROWN ZELLERBACH CORPORATION

SCOPE

We present in this report the results of the Engineering Control maintained by our firm over a portion of the fill placement for two earth dams constructed at Lord's Lake in Jefferson County, Washington, for the Crown Zellerbach Corporation. The dams are known as the East Dam and the North Dam. Control of the fill placement was maintained during the summer and fall months of 1956, at which time operations were suspended for the winter. During this period the fill placement at the East Dam was completed, and the North Dam was filled to approximately Elevation 892. Subsequent to the suspension of filling operations on November 8, 1956, no further control was maintained by our firm.

The purpose of the engineering control of the compacted fill was (1) to examine the soils brought to the site for fill placement to determine that they were in compliance with the specifications, (2) to determine the compaction characteristics of the fill soils, (3) to determine the moisture content at which the soils were being placed, (4) to determine the density of the fill as placed, and (5) to make recommendations for proper placement in the event that the moisture content and density of the fill material as placed were not in accordance with the specifications. Specifications required that all soils be placed to 90 per cent of the maximum dry density as determined by the Modified A.A.S.H.O. Compaction Test Procedure to provide adequate strength for stability of the dams.

The locations of the two dams, with respect to surrounding features, are shown on Plate 1, Map of Area. The fill area for the East Dam and the locations of all field density tests run in this area are shown on Plate 2, Plot Plan, East Dam. The fill area for the North Dam and the locations of the field density tests run in this area prior to November 8, 1956, are shown on Plate 3, Plot Plan, North Dam.

EAST DAM

On July 27, 1956, our field engineer began a continuous control of the filling operations on the East Dam at Lord's Lake. Prior to and during the course of this control nine compaction tests were performed to provide control curves with which the results of field density tests could be compared to determine whether or not the fill was being placed satisfactorily. The results of these tests are tabulated in Table I, Compaction Test Data. Where the soils contained gravel, a standard CBR cylinder was substituted for the 1/30 cubic foot cylinder specified in the Modified A.A.S.H.O. Compaction Test Procedure, and the number of blows per layer was increased from 25 to 55. This substitution was made in four of the compaction tests. The method used in performing these tests is described on page A-1.

During the placing of the compacted fill in the East Dam, 70 field density tests were performed to determine the moisture content and degree of compaction being obtained. The results of these tests are tabulated in Table II, Field Density Test Data, East Dam. The percent compaction obtained, based on a comparison of the dry density of the soil as determined by the field density test and the maximum dry density of the same soil as determined by the compaction test is shown on the table for each test. For those tests containing gravel, corrections were made to take into account the effect of the gravel

on the density. Where tests indicated compaction of less than 90 per cent of maximum dry density, the fill received additional compaction, or was removed and replaced with adequately compacted material.

Placement of the compacted fill for the East Dam was completed on approximately October 19, 1956. A final inspection of the fill was made on November 6, 1956. The results of the field density tests and observations by our field engineer indicate that the fill has been placed satisfactorily and in accordance with the specifications.

NORTH DAM

The first fill was placed in the North Dam on September 21, 1956. Fill was placed whenever weather conditions were satisfactory until November 8, 1956, when all work was halted for the remainder of the fall and winter season. During the placement of the fill in the North Dam, 13 field density tests were made to determine the degree of compaction being obtained. The results of the tests are tabulated in Table III, Field Density Test Data, North Dam. The data are presented in this table in the same manner as the data presented in Table II. Between September 21 and October 8 the fill was placed and compacted to meet a strength requirement based upon the results of direct shear tests performed on samples of compacted fill. The results of these tests were summarized on Plate B-1 in our "Report of Supplementary Consultation and Soils Investigation, North Dam, Lord's Lake Development, Jefferson County, Washington", dated October 31, 1956. Tests 67 through 69 and 74 through 79 were performed

during this period, and are denoted as being satisfactory or unsatisfactory based on a comparison between the dry density of the field tests and the average dry density of the laboratory shear test samples.

Respectfully submitted,

DAMES & MOORE

By William Enkeboll

November 12, 1957

William Enkeboll

TABLE I

COMPACTION TEST DATA

TEST NO.	SOIL TYPE	PERCENT PASSING $\frac{1}{4}$" SCREEN	OPTIMUM MOISTURE CONTENT IN PERCENT	MAXIMUM DRY DENSITY IN LBS/CU. FT.
A	Dark brown sandy loam with gravel	49	13.5	118*
B	Gray sandy loam with gravel	72	11.5	131*
C	Brown sandy loam with gravel	60	11.5	124*
D	Brown silty loam	100	19.0	102
E	Gray sandy loam	100	10.5	129
F	Brown loam with organic matter	100	22.5	98
G	Gray sandy loam	100	12.5	118
H	Brown sandy clay loam	100	10.4	128
I	Brown sandy loam with gravel	--	11.0	122*

* These tests were performed on material passing 3/4" screen using a CBR cylinder and compacting soil in five layers with 55 blows per layer.

TABLE II

FIELD DENSITY TEST DATA

EAST DAM

TEST NO.	ELEVATION IN FEET	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN LBS/CU.FT.	PERCENT GRAVEL	APPLICABLE COMPACTION CURVE	PERCENT COMPACTION
1	886	21.0	113	0	A	96
2	885	15.7	107	0	A	91
3	884	16.5	109	0	A	92
4	885	15.1	106	0	A	90
5	888	13.6	119	0	B	91
6	888	13.3	114	0	A	97
7	885	18.9	100	0	A	85
8	883	19.7	106	0	A	90
9	883	13.4	122	0	A & B	98
10	883	13.9	118	0	A	100
11	883	13.8	113	0	A	96
12	886	16.3	105	0	A	89
13	886	18.9	109	0	A	92
14	886	19.9	105	0	A	89
15	887	19.5	99	0	A	84
16	887	17.5	108	0	A	92
17	888	21.6	83	0	A	70
18	888	22.6	96	0	A	81
19	889	26.0	102	0	A	86
20	890	26.6	93	0	A	79
21	890	25.2	102	0	A	87
22	890	31.2	94	0	A	80
23	916	23.7	104	0	A	88

TABLE II (Continued)

TEST NO.	ELEVATION IN FEET	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN LBS/CU.FT.	PERCENT GRAVEL	APPLICABLE COMPACTION CURVE	PERCENT COMPACTION
24	919	12.5	119	0	A	96
25	920	17.5	124	0	A & B	95
26	888	18.6	116	0	A	98
27	888	Erratic Test				
28	888	18.4	104	0	A	89
29	889	22.7	112	2	A & B	89
30	894	18.3	114	38	C	91
31	894	28.5	92	27	D	81
32	893	25.2	100	28	D	88
33	894	24.8	100	29	D	88
34	893	12.3	100	19	D	91
35	894	17.7	112	28	C	92
36	896	16.5	122	31	B	93
37	897	15.2	123	0	B	94
38	900	21.5	104	32	D	90
39	896	13.0	120	0	B & E	91
40	896	Erratic Test				
41	903	11.5	126	38	E	90
42	901	16.0	129	43	E	90
43	903	13.9	127	39	E	91
44	902	15.6	128	37	E	91
45	904	22.1	107	0	A & B	87
46	906	17.1	117	0	B	88
47	906	13.1	122	41	B	93
48	905	12.8	124	43	B	95
49	904	5.7	136	42	E	96

TABLE II (Continued)

TEST NO.	ELEVATION IN FEET	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN LBS/CU.FT.	PERCENT GRAVEL	APPLICABLE COMPACTION CURVE	PERCENT COMPACTION
50	906	14.9	121	46	B	92
51	904	Erratic Test				
52	908	12.2	129	35	E	92
53	899	8.4	139	55	E	94
54	903	7.1	127	39	E	90
55	905	7.3	135	55	E	92
56	907	9.5	110	55	A	92
57	905	9.4	133	57	E	91
58	905	5.6	133	66	B & E	94
59	907	8.3	128	42	E	90
60	911	Erratic Test				
61	912	8.1	134	44	E	93
62	912	7.8	137	52	E	95
63	912	9.7	136	55	E	92
64	914	10.7	129	44	E	90
65	913	10.5	134	54	E	91
66	907	7.6	129	42	E	95
67						
68	Tests 67 to 69 were located at site of North Dam. See Table III					
69						
70	917	11.6	123	40	C	96
71	916	5.8	127	50	C	96
72	923	9.4	138	50	E	95
73	922	9.0	136	52	E	92

TABLE III

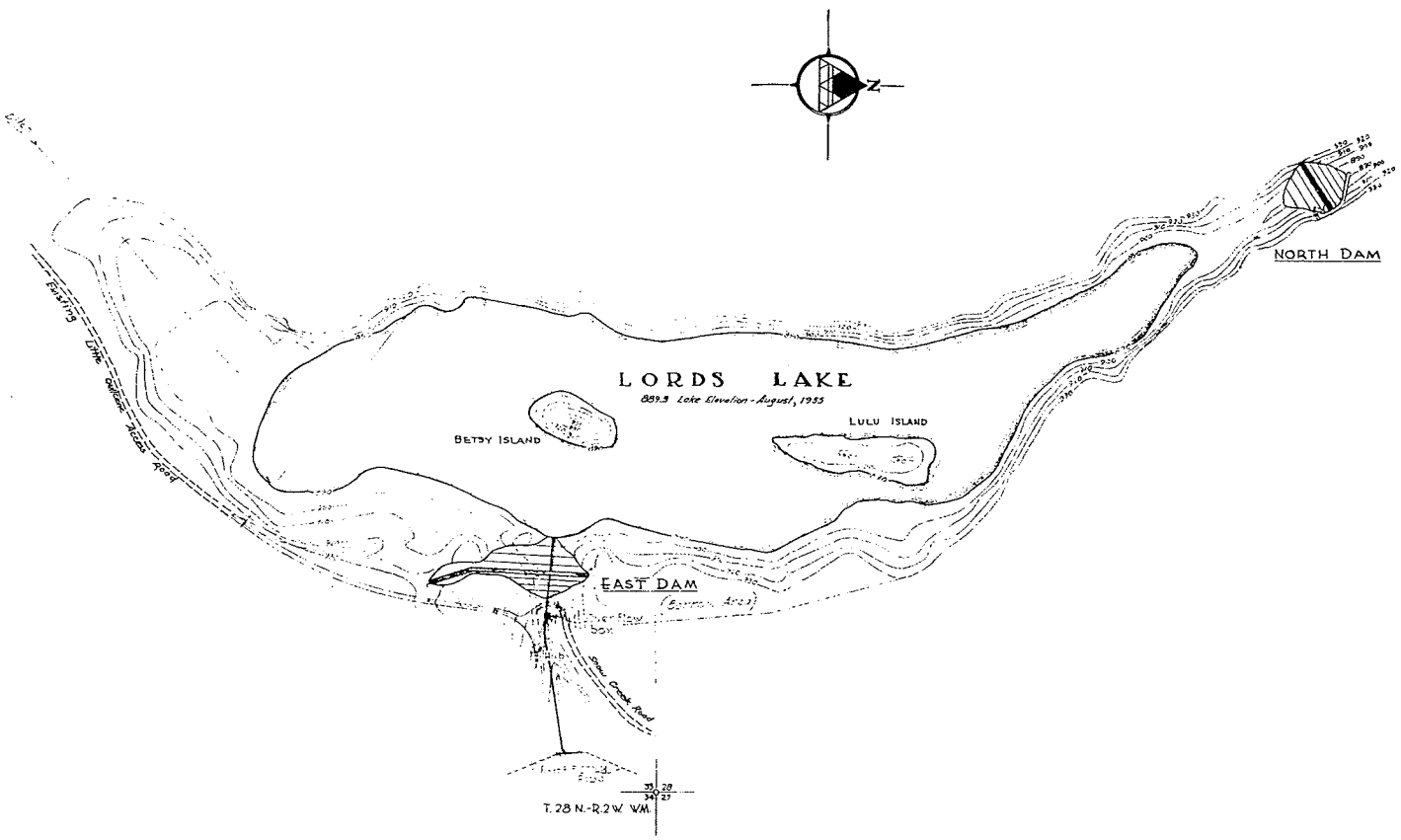
FIELD DENSITY TEST DATA

NORTH DAM

TEST NO.	ELEVATION IN FEET	FILL MOISTURE IN PERCENT	FILL DRY DENSITY IN LBS/CU.FT.	PERCENT GRAVEL	APPLICABLE COMPACTION CURVE	PERCENT COMPACTION
67	875	19.1	129	43		Satisfactory
68	880	11.0	126	44		Satisfactory
69	879	16.8	121	52		Unsatisfactory
74	883	16.2	129	59		Satisfactory
75	883	11.1	126	52		Satisfactory
76	891	11.8	119	54		Unsatisfactory
77	895	12.1	123	41		Satisfactory
78	891	13.0	120	25		Satisfactory
79	892	12.7	112	35		Unsatisfactory
80	891	10.1	129	23	E	95
81	889	12.6	125	27	H	92
82	892	12.8	122	20	H	91
83	892	13.2	120	26	H	89

Note:

Tests 67-69 and 74-79 were determined to be satisfactory or unsatisfactory on the basis of comparisons between the dry density of the fill determined by these tests and the dry density of samples of similar fill soils compacted and subjected to laboratory shear tests. See discussion in text.



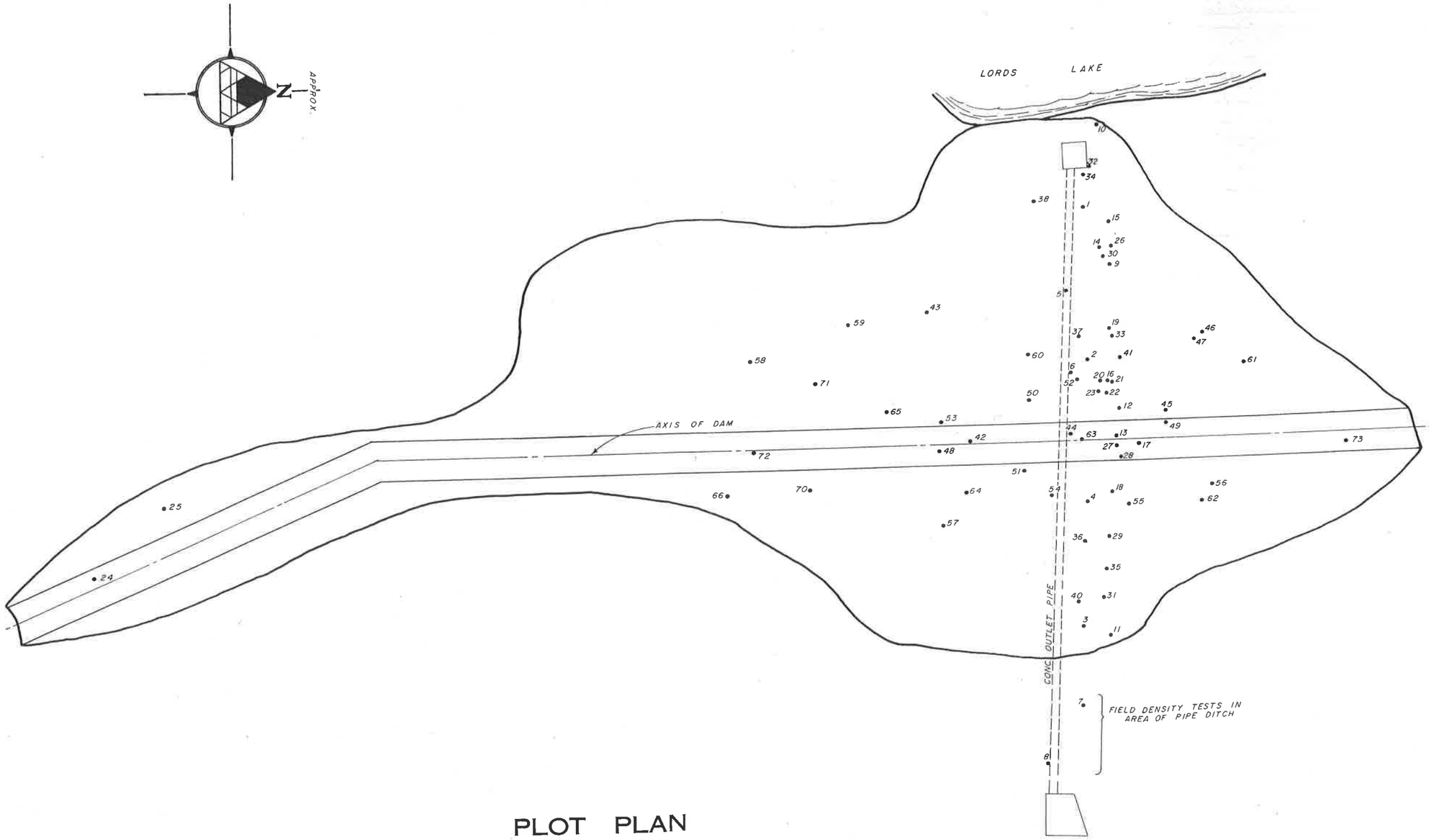
MAP OF AREA

FEET
100 0 100 200 300 400 500

REFERENCE DWG. NO. 670-A-2N/3961, ENTITLED "GENERAL LAYOUT" BY JOHN W. CUNNINGHAM & ASSOCIATES, DATED JAN. 1956.

DAMES & MOORE
SOIL MECHANICS ENGINEERS

PLATE 1



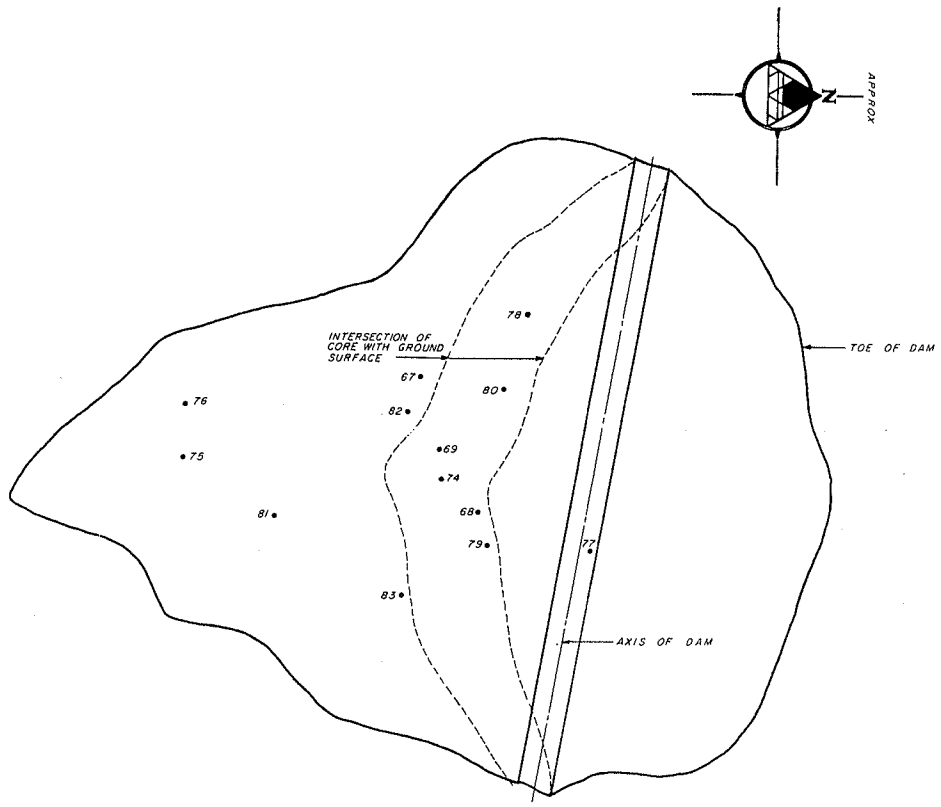
PLOT PLAN
EAST DAM

FEET
10 5 0 10 20 30 40 50

REFERENCE: PORTION OF JOHN W. CUNNINGHAM & ASSOC. DWG. NO. 20F5, 670-A-3/3962, ENTITLED "LORDS LAKE RESERVOIR PROJECT, EAST DAM," DATED JAN. 1956.

DAMES & MOORE
SOIL MECHANICS ENGINEERS

PLATE 2



PLOT PLAN

NORTH DAM

FEET

10 5 0 10 20 30 40 50

REFERENCE: PORTION OF CROWN ZELLERBACH DWG. ENTITLED "NORTH DAM LAYOUT" DATED 9-20-56

DAMES & MOORE
SOIL MECHANICS ENGINEERS

PLATE 3