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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

SOIL INVESTIGATION
UPPER PORT REACH TIDAL BASIN
(S.A. HARBOURS BOARD)

SECOND REPORT

by

P.R.G. Dunlop, B.Sc.
Geologist

Rept. Bk. No. 51/86
G.S. No. 1837
D.M. 802/60

21st October, 1960.

51/86

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RIB 51/86

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ABSTRACT

Particle size analyses of typical clays, silty and sandy clays, sands and silts have been used to make an estimate of the probable size characteristics of the average remoulded material to be expected from dredging, and reclamation of adjoining swamp lands. This remoulded material is expected to resemble a fine grained sand, with a small fraction only of clay and silt size particles. Physical properties cannot be predicted with certainty, but will be governed largely by the effectiveness of drainage from the reclaimed areas.

INTRODUCTION

At the request of Mr. R.F. Beverly of the S.A. Harbours Board, a number of samples were selected from the sludges obtained from the 33 test bores recently drilled in the proposed Tidal Basin area (See Report 51/65, 27/9/60). These represented clays, silty clays, sandy clays, sands and silts as logged in the bores. Twenty samples were taken, four of each type, and submitted to the Australian Mineral Development Laboratories for particle size analysis.

These analyses were carried out by screening of the coarser fractions down to + 200 BSS, (+ 76 microns) then by sedimentation to - 3 microns. Comments on the screen fractions to + 200 mesh were supplied by Mr. D.M. Read, Chief Metallurgist, A.M.D.L. Cumulative curves were constructed to illustrate the particle size distribution in each sample. No mineral determinations were made on the fine (-76 micron) fraction of any samples.

RESULTS

Clays

P 497/60 (Bore 31, 1-2 feet). Top size, mainly shell and organic material. Other fractions sand with organic matter.

This sample contains a proportion of well graded sand, 47 percent being + 100 B.S.Screen size. The remainder is poorly graded, with about 10 percent in the clay particle size range.

P 498/60 (Bore 25, 1-2 feet). Top size, mainly organic. Traces of organic matter in all other fractions.

The cumulative curve shows this to be a clay, with only a small proportion of sand. Grading is poor, and 39 percent of the total sample is in the clay particle size range.

P 499/60 (Bore 17, 1-2 feet). Shell fragments in top size. Other fractions sandy with no organic matter.

P 500/60 (Bore 9, 1-2 feet). All fractions very dark, probably organic.

These two clays are rather similar, being poorly graded throughout, and with a small proportion only of clay size particles.

Silty Clays

P 501/60 (Bore 3, 1-3 feet). Top size, mainly shell and organic material. Other fractions sand with organic matter but becoming cleaner in lower fractions to + 200.

This consists of a fairly well graded fine sand, passing through poorly graded silt to clay size particles. Only 3.5 percen lies in the clay particle size range.

P 502/60 (Bore 8, 0-2 feet). Approximately 2% plus 6 mesh. Fractions comprise sand with organic matter, becoming cleaner in bottom fractions.

P 503/60 (Bore 24, 0-2 feet). Sand with organic matter in all fractions - very closely sized fractions.

These two samples comprise very similar material, poorly graded through all size ranges. Less than 8 per cent of

each is in the clay particle size range.

P 504/60 (Bore 15, 1-3 feet). Fractions similar to P 501/60.

This silty clay corresponds closely to the silt samples, P 513-516/60. It contains only 3.5 per cent smaller than silt size particles (below - 20 microns).

Sandy Clays

P 505/60 (Bore 33, 2-4 feet). Top size, mainly shell and organic matter. Other fractions sand with organic matter but becoming cleaner in lower fractions to + 200.

This sample contains about 3% fairly well graded sand down to + 150 B.S.S., but from there down, it is poorly graded. 36% by weight was finer than 20 microns, 20% was minus 3 microns.

P 506/60 (Bore 25, 2-4 feet). Very little organic matter above 150 mesh. 200 mesh fraction contains slightly more.

Size distribution was very similar to P 505/60 to 14 microns. Beyond this point there was an abrupt increase in silt size particles. Less than 3% of the total sample was of clay size particles (minus 3 microns diameter).

P 507/60 (Bore 17, 2-5 feet). Plus 52 fraction full of hair like organic material. Plus 72 fraction black with probable carbonaceous matter. Bottom fractions grey sand with much less organic matter.

This was a poorly graded material with a large fraction within the fine sand range. The proportion of silt was small, and clay sized particles, less than 2%.

P 508/60 (Bore 19, 2-5 feet). Top size coarse aggregate with 1% plus ¼". Organic matter in all fractions.

Although logged as a sandy clay, this would be more correctly described as a clayey sand. It is well graded in the sand size range -36#0 + 150 B.S.S. but poorly graded beyond. The proportion of clay size particles is less than 1% minus 3 microns.

Sands

P 509/60 (Bore 27, 4-9 feet). Top sizes contain organic matter; very little below 52 mesh.

P 510/60 (Bore 18, 1-4 feet). Very clean sand with small amount of organics in plus 36 fraction.

Calcareous Sands

P 511/60 (Bore 6, 4-12 feet). Plus 10 mesh, mostly shell fragments. Small amount of organics in other fractions, but mostly clean sand.

P 512/60 (Bore 22, 9-16 feet). Similar to P 511/60

The sands are all similar in character, as shown by their cumulative curves. They are well graded, with size range lying principally between - 52 and + 100 B.S.S. Sand P 511/60 was somewhat finer, ranging from - 72 to + 150 B.S.S. These size ranges lie between coarse and fine sands in the Atterberg size classification. The sands, being free of all but traces of organic matter or colloid size particles, are not expected to present any problems after reclamation and drainage of excess water.

Silts

P 513/60 (Bore 29, 8-12 feet). Plus 10 mesh - shell; Plus 36 mesh - shell and sand; other fractions clean sand.

P 514/60 (Bore 23, 15-16 feet). Screen fractions similar to P 513/60.

P 515/60 (Bore 7, 3-5 feet). Screen fractions similar to P 513/60, but with organic material in all fractions below 72 mesh.

P 516/60 (Bore 1, 1-2 feet). Screen fractions similar to P 515/60.

The silts, like the sands, are very similar in size range. All four have a coarse fraction, consisting mostly of

shells, but the principal size range is from - 52 to + 150 B.S.S. The proportion of fines is somewhat greater than in the sands, but the silt fraction (- 20 microns) is surprisingly small. It is considered probable that the soft nature of these "silts" is due to organic material present in the minus 76 micron fractions.

The special interest in these samples lay in the clays. The analyses have shown that these are clays in the stratigraphic sense only. That is, they are sediments of mixed grades, only a proportion of which is of clay size, and the proportion may be quite small. In this they differ from aggregates of the clay minerals such as kaolin or montmorillonite, where the bulk of the material is of clay size particles.

The materials sampled in the Upper Port Reach are to be dredged, and used for reclamation of tidal swamps. They will then constitute remoulded sediments, and their properties will be subject to the proportions of coarse and finergrained particles settling in them. In order to arrive at some estimate of the size composition of the remoulded sediments, typical sand and clay type sample analyses were combined in the proportions indicated by the overall sampling. The resultant composite analysis was then plotted as a cumulative curve.

The samples combined were -

P 512/60 - a calcareous sand from Bore 22, 9-16 feet.

P 503/60 - a silty clay from Bore 24, 0-2 feet.

Size fractions were combined in the proportion 84.4% sand and 15.6% clay. The composite sample would then have the size composition as set out below.

Composite analysis - P 512/60 and P 503/60

B.S.S. Mesh	Per Cent Weight retained	Cumulative percent
+ 10	1.5	1.5
- 10 + 36	5.0	6.5
- 36 + 52	7.8	14.3
- 52 + 72	18.8	33.2
- 72 + 100	27.2	60.3
- 100 + 150	18.6	78.9
- 150 + 200	6.2	85.2
- 76 + 50 microns	6.1	91.2

B.S.S. Mesh	Per Cent Weight retained	Cumulative per cent
- 40 + 28 microns	2.1	93.2
- 28 + 20 "	1.4	94.7
- 20 + 14 "	1.4	96.1
- 14 + 10 "	1.0	97.1
- 10 + 7 "	1.2	97.4
- 7 + 5 "	0.5	97.9
- 5 + 3 "	0.8	98.7
- 3 "	1.3	100.0

This corresponds to a well graded sand with size range principally minus 52 to plus 200 B.S.S. mesh, which lies between the Atterberg classification of course and fine sands. About 5 per cent of the composite sample is in the silt range and less than 2 per cent is of clay sizeparticles.

The physical properties of remoulded material of this composition could only be determined reliably by laboratory and field tests.

CONCLUSIONS

Particle size analyses have been used to show the size characteristics of the various materials sampled. A composite analysis made up of an average sand and an average clay sample, combined in the proportions indicated by the overall sampling programme in 33 bores, shows the size characteristics of the Upper Port Reach sediments as may be expected after thorough mixing and remoulding. It is concluded that the sediments, after dredging and reclamation of adjoining swamp lands, may be expected to resemble a fine grained sand, with only a small proportion of silt and clay size particles. The effect of these fine particles, which may include organic colloidal material, on the physical properties of the remoulded material, cannot be predicted with certainty from the information available. As these properties will be largely a factor of the moisture content, the effective drainage of the reclaimed area should be carefully planned.

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PRD/AGK
21/10/60.

APPENDIX

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

S.A. HARBOURS BOARD - UPPER PORT REACH

PARTICLE SIZE ANALYSES

B.S.S. Mesh	Sample Nos.	P 497/60		P 498/60		P 499/60		P 500/60		P 501/60		P 502/60	
		Per cent. Weight Retained, and Cumulative Per cent. Weight Retained											
	+ 10 ...												
	- 10 + 36 ...	1.8	1.8	0.2	0.2	3.5	3.5	15.5	15.4	0.5	0.5	15.8	15.8
	- 36 + 52 ...	8.2	10.0	0.5	0.7	3.8	6.3	5.9	21.4	0.6	1.1	4.5	20.3
	- 52 + 72 ...	19.7	29.7	1.1	1.8	3.1	9.4	5.5	26.9	1.5	2.6	4.2	24.5
	- 72 + 100 ...	17.8	47.5	1.9	3.7	3.6	13.0	3.6	30.5	4.1	6.7	4.1	28.6
	- 100 + 150 ...	5.9	53.4	2.0	5.7	3.4	16.4	2.1	32.6	14.0	20.7	6.1	34.7
	- 150 + 200 ...	2.2	55.6	3.2	8.9	5.3	21.7	3.0	35.6	21.5	42.2	6.7	41.4

Sedimentation	Sample Nos.	Per cent. Weight Retained, and Cumulative Per cent. Weight Retained											
		P 497/60		P 498/60		P 499/60		P 500/60		P 501/60		P 502/60	
	- 76 + 40 Microns	8.0	63.6	14.6	23.5	18.0	39.7	16.1	51.7	30.6	72.8	21.7	63.1
	- 40 + 28 "	1.8	65.4	5.5	29.0	7.8	47.5	5.2	56.9	5.8	78.6	5.3	68.4
	- 28 + 20 "	2.2	67.6	4.5	33.5	7.9	55.4	5.8	62.7	4.1	82.7	5.8	74.2
	- 20 + 14 "	2.7	70.3	4.6	38.1	8.6	64.0	7.7	70.4	4.0	86.7	5.3	79.5
	- 14 + 10 "	3.5	73.8	4.5	42.6	8.6	72.6	9.3	89.7	3.5	90.2	2.9	82.4
	- 10 + 7 "	4.0	77.8	3.7	46.3	7.2	82.8	5.8	95.5	1.7	91.9	4.7	87.1
	- 7 + 5 "	5.3	83.1	5.4	51.7	4.5	87.5	0.6	96.1	2.3	94.2	1.8	88.9
	- 5 + 3 "	7.1	90.2	9.1	60.8	4.7	92.2	1.3	97.4	2.3	96.5	3.5	92.4
	- 3 + "	9.8	100.0	39.2	100.0	7.8	100.0	2.6	100.0	3.5	100.0	7.6	100.0

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AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

S.A. HARBOURS BOARD - UPPER PORT REACH

PARTICLE SIZE ANALYSES

B.S.S. Mesh	Sample No's.	Per cent. Weight Retained, and Cumulative Per cent. Weight Retained											
		P 503/60		P 504/60		P 505/60		P 506/60		P 507/60		P 508/60	
	+ 10 ...												
	- 10 + 36 ...	8.0	8.0	2.1	2.1	2.5	2.5	2.5	2.5	14.8	14.8	29.5	29.5
	- 36 + 52 ...	5.4	13.4	2.5	4.6	2.9	5.4	8.4	10.9	7.6	22.4	8.3	37.8
	- 52 + 72 ...	6.9	20.3	10.2	14.8	12.3	17.7	13.1	24.0	9.0	31.4	10.4	48.2
	- 72 + 100 ...	6.9	27.2	33.4	48.2	15.9	33.6	18.7	42.7	11.8	43.2	24.2	72.4
	- 100 + 150 ..	6.8	34.0	28.3	76.5	10.0	43.6	5.8	48.5	14.1	57.3	7.5	79.9
	- 150 + 200 ..	8.0	42.0	5.5	82.0	3.8	47.4	1.8	50.3	4.5	61.8	2.8	82.7

Sedimentation	Sample No's.	Per cent. Weight Retained, and Cumulative Per cent. Weight Retained											
		P 503/60		P 504/60		P 505/60		P 506/30		P 507/60		P 508/60	
	- 76 + 40 Microns	18.0	60.0	10.8	92.8	10.5	57.9	9.9	60.2	14.1	75.9	5.2	81.9
	- 40 + 28 "	8.7	68.7	2.3	95.1	3.2	61.1	3.5	63.7	3.9	79.8	2.8	90.7
	- 28 + 20 "	4.6	73.3	1.3	96.4	2.6	63.7	4.0	67.7	4.2	84.0	2.0	92.7
	- 20 + 14 "	5.8	79.1	1.1	97.5	3.2	66.9	3.5	71.2	3.4	87.4	1.8	94.5
	- 14 + 10 "	3.5	82.6	1.2	98.7	1.5	68.4	13.8	85.0	7.3	94.7	2.1	96.6
	- 10 + 7 "	4.1	86.7	0.6	99.3	3.2	71.6	8.1	93.1	1.9	96.6	1.2	97.8
	- 7 + 5 "	2.3	89.0	0.3	99.6	2.1	73.6	1.4	94.5	0.7	97.3	0.5	98.3
	- 5 + 3 "	4.0	93.0	0.4	100.0	6.3	80.0	2.5	97.0	0.4	97.7	0.7	99.0
	- 3 + "	7.0	100.0	-	-	20.0	100.0	3.0	100.0	2.3	100.0	1.0	100.0

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AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

S.A. HARBOURS BOARD - UPPER PORT REACH

PARTICLE SIZE ANALYSES

B.S.S. Mesh	Sample No's.	Per cent. Weight Retained, and Cumulative Per cent. Weight Retained							
		P 509/60	P 510/60	P 511/60	P 512/60	P 513/60	P 514/60	P 515/60	P 516/60
+ 10 ...				0.9 0.9	1.8 1.8	3.2 3.2	6.1 6.1	12.4 12.4	3.8 3.8
- 10+ 36 ...		6.1 6.1	0.9 0.9	1.7 2.6	4.4 6.2	3.4 6.6	8.3 14.4	6.7 19.1	2.4 6.2
- 36 + 52 ...		9.7 15.8	6.8 7.7	2.1 4.7	8.2 14.4	5.3 11.9	8.9 23.3	4.3 23.4	3.8 10.0
- 52 + 72 ...		26.0 41.8	53.5 61.2	8.0 12.7	21.0 35.4	22.8 34.7	23.1 46.4	14.3 37.7	27.8 37.8
- 72 + 100 ...		38.4 80.2	23.0 84.2	22.5 35.2	30.1 65.5	32.4 67.1	14.6 61.0	16.4 54.1	33.8 71.6
- 100 + 150 ..		13.3 93.5	10.9 95.1	39.8 75.0	20.4 85.9	19.2 86.3	14.3 75.3	19.6 73.7	14.7 86.3
- 150 + 200 ..		1.6 95.1	2.2 97.3	11.1 86.1	5.9 91.8	4.1 90.4	7.0 82.3	6.8 80.5	4.8 91.1

Sedimentation	Sample Nos.	Per cent. Weight Retained, and Cumulative Per cent. Weight Retained							
		P 509/60	P 510/60	P 511/60	P 512/60	P 513/60	P 514/60	P 515/60	P 516/60
	- 76 + 40 Microns	4.9 100.0	2.7 100.0	5.8 91.9	3.9 95.7	3.8 94.2	6.6 88.9	7.4 87.9	4.5 95.6
	- 40 + 28 "			3.2 95.1	0.9 96.6	1.1 95.3	1.7 90.6	3.3 91.2	1.2 96.8
	- 28 + 20 "			1.0 96.1	0.9 97.5	1.1 96.4	1.1 91.7	2.6 93.8	0.8 97.6
	- 20 + 14 "			0.9 97.0	0.6 98.1	1.5 97.9	1.2 92.9	2.5 96.3	0.6 98.2
	- 14 + 10 "			0.4 97.4	0.5 98.6	1.1 99.0	0.7 93.6	1.2 97.5	0.6 98.8
	- 10 + 7 "			0.4 97.8	0.7 99.3	0.5 99.5	0.9 94.5	1.1 98.6	0.3 99.1
	- 7 + 5 "			0.7 98.5	0.2 99.5	0.2 99.7	1.1 95.6	0.8 99.4	0.1 99.2
	- 5 + 3 "			0.7 99.2	0.2 99.7	0.1 99.8	1.2 96.8	0.3 99.7	0.3 99.5
	- 3 + "			0.8 100.0	0.3 100.0	0.2 100.0	3.2 100.0	0.3 100.0	0.5 100.0