DEPARTMENT OF MINES

SOUTH AUSTRALIA

REPORT ON SITE INVESTIGATION
MULTI-STOREY HOTEL
O'CONNEL ST., NORTH ADELAIDE
HD. YATALA

by

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SOILS GEOLOGY SECTION

GEOLOGICAL SURVEY

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Department of Mines
South Australia

REPORT ON SITE INVESTIGATION
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I SUMMARY

One percussion hole was put down to a depth of 90'. A total of 16 sealed tube samples was taken at selected intervals, and forwarded to Mr. T. A. Farrent, University of Adelaide.

The soil profile consists of 13'6" of calcareous material, 13'6" of clay, 32' of silt grading to sands and gravels with depth, 10' of fine sands and 21' of Tertiary marine fossiliferous limestone. Water was encountered at 10' below the surface, and again at 82' below the surface. Materials below 13'6" have been preconsolidated due to overburden of the order of 140 ft. thick which has been subsequently eroded.

From the surface to a depth of 13'6", foundation conditions are poor, the calcareous material having a low strength and subject to loss of strength with increase in moisture content. At 13'6" the material is stable, and the bearing capacity although not high, improves consistently with depth.

It is recommended that the calcareous zone be avoided, and that foundations be located at 14' below the surface. This can best be accomplished by incorporating a basement into the design of the building. Accurate strength data will be available from Mr. T. A. Farrent.

The upper groundwater has a low sulphate content and normal concrete can be used in foundations.

II INTRODUCTION

This investigation was carried out following a request by Lucas Parker and Partners, Architects of King William Street, Adelaide.

Allanda Ltd. propose to erect a multi-storey hotel on the site, and Lucas Parker and Partners are acting as consulting architects. Mr. T. A. Farrent, Civil Engineering Department, University of Adelaide is the consulting engineer.

The site is situated on the north-west corner of the intersection of O'Connel Street and Brougham Place, North Adelaide.

III TEST DRILLING

One percussion hole was put down to a depth of 90 feet using a Ruston Bucyrus Plant. The sealed tube attachement was used throughout, and wherever sealed tube samples were not required the core was extruded and retained for identification.

A total of 16 sealed tube samples were taken at the following depths:- 6'-7'6"; 7'6"-9'; 12'-13'6"; 13'6"-15'; 19'6"-21'; 21'-22'6"; 24'-25'6"; 25'6"-27', 30'-31'6"; 31'6"-33'; 37'-38'6"; 38'6"-40', 47'-48'6"; 48'6"-50'; 73'-74'6"; 74'6"-76'.

The depths for these samples were selected by Mr. T. A. Farrent, University of Adelaide, and the samples were forwarded to him for laboratory determinations.

It was necessary to use casing for a considerable portion of the drill hole. Initially 9'3" of casing was used as a stand-pipe at the top of the hole until a depth of 58 feet was reached. Thereafter the hole was fully cased to a depth of 72 feet. From 72 feet to 90 feet the material was relatively firm and no casing was necessary.

Blows per foot were recorded throughout, and a detailed log containing penetration data and the nature of the material is included as an appendix to this report.

IV GEOLOGY

The profile exposed by the test drilling can be divided into six approximate zones. These zones are (1) Calcareous zone (2) Clay zone (3) A fine grained silty and sandy zone (4) Gravel (5) Sand (6) Fossiliferous marine limestone. These zones are discussed in further detail below.

(1) Calcareous Zone 0-13'6": This consists of a shallow topsoil overlying a soft travertine limestone layer.

The travertine grades into a sandy marl which continues to a depth of 9 feet. Below 9 feet there is a sandy clay with large limey pockets. This latter material is water bearing, the water being contained in the limey pockets which are more permeable than the surrounding clay. Only small quantities of free water are involved.

The upper portion of the calcareous zone is typical of the Mallee Soil Type profile. This soil type is believed to have been formed following the deposition of aeolian lime dust during the Pleistocene glacial periods when large areas of the continental shelf were exposed. The loessial material has been subjected to the action of meteoric waters, which usually contain carbonic acid, and the lime has been taken into solution and re-deposited at a lower depth as calcium carbonate. The depth to which the lime is carried is dependent on the permeability of the underlying material, and the base of the calcareous zone is, as in this particular case, not usually clearly defined.

(2) Clay Zone 13'6"-27': The zone consists of a greenish-grey clay with some reddish-brown mottling, the mottling increasing with depth. It is a very fine grained clay, especially at the top of the zone, and the silt and sand content is very low. Some slight evidence of fissuring was present, but the polyhedral structure is not well developed, and the clay is usually structureless.

(3) Silt and sand zone 27'-52': This zone contains an increasing amount of silt and sand. It commences at the top of the zone as a silty clay grading to a clayey silt and fine sand with depth. It is cohesive at the top but becomes friable with depth. It is generally slightly micaceous.

(4) Gravel Horizon 52'-59': This consists of siliceous waterworn gravel with interstitial grit to fine sand. The horizon is slightly damp but no free water is present.

(5) Fine sand zone 59'-69': This consists of a brownish-yellow fine grained sand with some patches of ironstaining.

(6) Fossiliferous Marine Limestone 69'-70': This consists of a soft greenish-grey and off-white fossiliferous limestone. Glauconite is generally present, and there are frequent patches of yellow-brown ironstaining. The age of this formation has not yet been determined, but a palaeontological examination is being carried out. The horizon is water bearing.

Groundwater was encountered at two levels in the above profile. The upper water was encountered at a depth of 10 feet below the surface, with a static water level of 9 feet 9 inches. This water was not present in the percussion hole, but was detected in several hand auger holes which were put down in close proximity to the percussion hole. Apparently in the percussion method the sampler shoe attachment seals off the walls of the hole, particularly in clayey material. This prevents the relatively small amounts of water from entering the hole, as the hydrostatic pressure of the water, which is usually low for these shallow waters, is insufficient to break the seal. The hand auger does not seal the sides of the hole and hence the water can move freely. This effect has also been noticed at other sites, and apparently the percussion method will only detect relatively large amounts of water if the aquifer is at all clayey.

The upper water has been analysed and the results are included as an appendix of this report.

The lower water is present in the marine limestone, and was encountered at a depth of 86 feet, with a static level of 82 feet 3 inches. This water is too deep to have any effect on foundations, but has been analysed for Departmental records.

V FOUNDATIONS CONDITIONS:

With the exception of the upper calcareous zone, foundation conditions are relatively good below a depth of

13 feet 6 inches from the surface. The bearing capacity is not high, but there is a consistent increase in strength with depth.

From the surface to a depth of 13 feet 6 inches, which is the calcareous zone of this profile, foundation conditions are not good. This type of calcareous material has a moderately high strength when dry, but loses strength rapidly with increase in moisture content. This creates a problem of differential settlement, as during the winter months it is difficult to prevent an increase in moisture content within this zone. The area around the proposed building may be sealed and drained, but lateral movement of water from other sources still occurs. There is a strong possibility therefore, that certain areas beneath the building may become more saturated than others. This is further aggravated by the fact that calcareous material of this nature generally has a considerable lateral variation in composition, and physical characterisitcs, due in part to its mode of origin. This causes a variation in permeability, allowing irregular distribution of water. Also some of the material is less sensitive to moisture changes.

Because of the variability of this horizon it is extremely difficult to accurately assessthe effect of change in moisture content within the zone. Consequently the loading which safely can be used on such a material is low, and for a large multi-storey building this can create difficulties. The stability of such a building on this material would therefore be suspect.

From 13 feet 6 inches to 27 feet a fine grained clay is present. This material, although it does not have a high bearing capacity, would not suffer from lateral variations. Foundation conditions would therefore, be uniform throughout the area of the proposed building if foundations were seated in this zone. The clay is impervious, and is not subject to seasonal moisture changes. The estimated bearing capacity at the top of the zone is 1½ tons per square foot maximum safe, increasing with depth to 2-2½ tons per square foot maximum safe at a depth of 27 feet. These figures are however only based on the penetration rate of the sampling tube, and must be regarded as approximate. Accurate strength figures will be obtained from the laboratory tests and in situ testing carried out by Mr. Farrent.

From 27 feet to 52 feet the grain size increases with depth, the material grading from a silty clay to a clayey silt and fine sand. This material is stable, and has a moderately high bearing capacity. It is well drained and from the cores obtained in the bore the moisture content is low.

From 52 feet to 59 feet a siliceous gravel is present. This material is stable and has a very high bearing capacity. It is very well drained, and the zone would be ideally suited for internal drainage disposal if so required.

Below 59 feet fine sands and Tertiary marine limestone are present. These are stable and have a high bearing capacity.

The site is located on the upthrust Para Fault Block. Results from bores elsewhere in the area, on both sides of the Para Faults suggest that some 140 ft. of overburden has been removed from this elevated block since uplift. Hence all of the above materials, excepting the upper calcareous material, have been preconsolidated. Preconsolidation of this order is to be expected in the results of the laboratory tests on the sealed tube samples.

CONCLUSIONS

Foundation conditions may be summarized as follows:-

0'0" - 13'6"	Calcareous Zone: Low bearing capacity and subject to loss of strength with increased moisture content. Laterally variable.
13'6" - 27'	Clay: Low bearing capacity but strength increases with depth. The material is stable and can be assumed to have little or no lateral variation.
27' - 52'	Coarser grained material becoming non cohesive with depth. Stable, with a high bearing capacity
52' - 90'	Material with a high bearing capacity. The depth however is too great to have any effect on foundations located in the upper zone.

All materials below 13'6" probably have been subjected to preconsolidation equivalent to that due to 140' of overburden.

From the above conditions it would appear that it is desirable to avoid the upper calcareous zone, and to have all foundations located in the underlying clay. This would best be accomplished by incorporating a basement into the design of the building, so that the unstable calcareous material is removed and the whole of the footings are seated on the clay.

The bearing capacity and other necessary strength figures for the material below the calcareous zone will be obtainable from Mr. T. A. Farrent.

The upper water table present at a depth of approximately 10 feet below the surface, may cause some inconvenience during excavation. However the amount of water contained in this type of material is not great, and the rate of flow is generally very small. It should be possible to adequately drain the site whilst the excavation is open, either by pumping out the water, or by sealing off the water bearing layers.

Analyses of the upper water show that the SO_3 radicle content is 0.028%. This figure is well below 0.1% SO_3 radicle which has been determined from research to be the upper limit of sulphate content for which normal concrete can be used. Consequently it may be assumed that the groundwater will have no deleterious effect on normal concrete used in the foundation.

PGM:CERF
30/6/59

P.G. Miller
P. G. MILLER
GEOLOGIST

APPENDIX

NORTH ADELAIDE PERCUSSION BORE NO. 1

Bore Serial No: P.D. 764/59 **Location:** O'Connel Street, North Adelaide.

Purpose: Foundation testing for proposed multi-storey hotel

Plant: Ruston No. 4. **Driller:** W. D. Wilson

Date commenced: 6/4/59 **Date completed:** 13/4/59

Depth: 90 feet **Diam:** 4 in.

Logged by A. A. Gibson & P. G. Miller

Depth From	Depth To	Description	Penetration From	Penetration To	Blows
0'	6"	Fill material: Fine gravel			
6"	2'	Mainly fill material composed of grey-brown finely sandy clay loam with numerous lime nodules and small lime pockets. Soft and moist.	6" 1'	1' 2'	14 11
2'	2'6"	Soft dark grey-brown finely sandy clay with occasional travertine nodules.	2'	3'	8
2'6"	3'	Soft travertine limestone.			
3'	6'	Off-white to pale brown finely sandy marl.	3' 4' 5'	4' 5' 6'	8 8 8
6'	7'6"	Sealed tube sample: Pale reddish-brown and off white mottled finely sandy marl with numerous small limestone nodules. Soft and moist.	6'	7'6	12
7'6"	9'	Sealed tube sample: As above.	7'6	9'	18
9'	11'	Red-brown finely sandy and somewhat limey clay with pale brown to off-white limey pockets containing some hard nodules. Sparse flecks of organic matter and occasional rootlets Stiff and moist.	9' 10'	10' 11'	12 12
11'	12'	As above with large earthy lime pockets containing abundant small nodules. Medium and moist.	11'	12'	18
12'	13'6"	Sealed tube sample: As above	12'	13'6	15
13'6"	15'	Sealed tube sample: Light greenish grey fatty clay with frequent small yellow-brown mottling. Numerous small black specks (probably organic) for the top 3'. Stiff and moist.	13'6	15'	14
15'	18'	As above.	15' 16' 17'	16' 17' 18'	11 9 9
18'	19'6"	Light greenish-grey clay with sparse dark red and some yellow-brown mottling. Stiff and moist.	18'	19'6	23

Depth From	Depth To	Description	Penetration From	Penetration To	Blows
19'6"	21'	Sealed tube sample: As above.	19'6	21'	25
21'	22'6"	Sealed tube sample: As above.	21'	22'6	23
22'6"	24'	Light greenish-grey and dark red mottled clay. Stiff and moist.	22'6	24'	23
24'	25'6"	Sealed tube sample: As above	24'	25'6	20
25'6"	27'	Sealed tube sample: As above	25'6	27'	23
27'	30'	Brownish yellow, brick red finely mottled very silty clay with the silt content increasing with depth. Occasional small light-grey pockets of clay. Stiff and moist at the top becoming damp with depth.	27' 28' 29'	28' 29' 30'	15 18 20
30'	31'6"	Sealed tube sample: As above	30'	31'6	25
31'6"	33'	Sealed tube sample: Brownish-yellow, brick red, and pale grey finely mottled clayey silt and fine sand, slightly micaceous. Stiff and damp.	31'6	33'	30
33'	37'	Light brownish-yellow, brick red and pale grey mottled slightly clayey fine sand and silt. Clay content decreasing with depth. Slightly micaceous. Stiff and slightly damp at the top becoming friable with depth.	33' 34' 35' 36'	34' 35' 36' 37'	17 19 23 25
37'	38'6"	Sealed tube sample: As above.	37'	38'6	37
38'6"	40'	Sealed tube sample: Pale brownish-yellow and light red-brown compact fine sand and silt. Slightly micaceous. Damp.	38'6	40'	26
40'	41'	As above but slightly clayey.	40'	41'	18
41'	45'3"	Light red-brown, lighty yellow-brown and pale grey mottled clayey silt and fine sand, (silt predominating). Micaceous. Stiff and moist. at the top becoming damp and friable with depth.	41' 42' 43' 44' 45'	42' 43' 44' 45' 46'	20 22 19 17 14
45'3"	47'	Yellow-brown and pale grey mottled very silty clay. Firm and moist and friable.	46'	47'	16
47'	48'6"	Sealed tube sample: Lightyyellow-brown and pale grey mottled slightly clayey fine sand and silt.			
48'6"	50'	As above but sample lost.			
50'	51'6"	Sealed tube sample: As above.			
51'6"	52'	As above but becoming more sandy	51'6	52'6	25
52'	59'3"	Siliceous gravel with interstitial grit to fine sand. Slightly damp.	52'6 53' 53'6 54' 55' 55'6 56'	53' 53'6 54' 55' 55'6 56' 63'	20 20 18 25 20 22 Not recorded

Depth From	Depth To	Description	Penetration From	Penetration To	Penetration Blows
59'3"	60'	Pale brownish-yellow very fine sand.			
60'	60'6"	As above but containing some thin iron cemented dark brown to black bands. Very slightly damp.			
60'6"	63'6"	Greyish-yellow very fine grained sand with some iron cemented lumps, alternating with brownish-yellow sand containing off-white lumps. Very slightly damp.			
63'6"	64'6"	Off-white very fine sand.	63' 63'6	63'6 64'6	22 40
64'6"	65'	Yellowish-brown and grey very fine iron stained sand. Loosely cemented.	64'6	65'	21
65'	65'6"	Heavily ironstained and semi cemented fine grained sand.	65'	65'6	30
65'6"	67'6"	Light yellowish-brown slightly clayey fine sand and silt with some dark grey-brown staining in patches.	65'6 66' 66'6 67'	66' 66'6 67' 67'6"	31 37 35 28
67'6"	68'	Yellow-brown fine sand and silt slightly clayey with some limey patches.	67'6 68'6	68'6 69'3	36 26
68'	69'3"	Pale greenish-grey to off-white fossiliferous limestone with abundant small glauconite grains.			
69'3"	72'	Off-white soft fossiliferous limestone with sparse glauconite.	69'3 70' 70'6 71' 71'6	70 70'6 71 71'6 72'	22 31 30 24 17
72'	73'	Pale greenish-grey and off-white fossiliferous limestone with abundant glauconite. Soft.	72'	73'	25
73'	74'6"	Sealed tube sample. Off white very fossiliferous limestone with slight ironstaining in places.	73'	74'6	47
74'6"	76'	Sealed tube sample. As above.	74'6	76'	29
76'	90'	Off-white and pale greenish-grey soft fossiliferous limestone. with abundant glauconite and frequent yellow-brown ironstained patches. Becoming moist at 82' with water at 86'. Static water level after 2 days 82'3".	76' 77' 78' 79' 80' 81' 82' 83' 84' 85' 86' 87' 88' 89'	77' 78' 79' 80' 81' 82' 83' 84' 85' 86' 87' 88' 89' 90'	20 21 17 13 10 15 16 17 28 52 40 28 15 19

END OF HOLE

W1025/59

RDA413/59
A159/3

SOUTH AUSTRALIA

DEPARTMENT OF MINES

RESEARCH AND DEVELOPMENT BRANCH

Flemington Street, Parkside, S.A.

27th May, 1959.

Director of Mines,
Government Offices,
Rundle Street,
ADELAIDE

Sample of water marked W1025/59 yielded on analysis as unde

	Grains per Gallon
Chlorine, Cl	63.6
Sulphuric acid (radicle), SO_4	23.3 (0.028% SO_3)
Carbonic acid (radicle) CO_3	46.1
Nitric acid (radicle) NO_3	10.9
Sodium, Na	84.8
Potassium, K.	-
Calcium, Ca	1.4
Magnesium, Mg	2.9
Iron, Fe	-
Silica, SiO_2	-
Total Saline matter, Grains per gallon	233.0
Total Saline matter, Ounces per gallon	0.53
Suspended matter	-
Organic matter	-

Name: Lucas Parker & Partners

Address: 408 King William Street, Adelaide.

Hundred: Yatala
Section: -
Sample Collected by: P. G. Miller
Bore No. Foundation
Water Cut: 10'
Water Level: 9(9"
Supply: -
Depth Bore 90'
Date Collected 30/4/59.

Remarks

ASSUMED COMPOSITION OF SALTS

Calcium carbonate	3.5
Calcium sulphate	-
Calcium chloride	-
Magnesium carbonate	10.1
Magnesium sulphate	-
Magnesium chloride	-
Sodium carbonate	65.0
Sodium sulphate	34.5
Sodium chloride	104.9
Sodium nitrate	15.0
Potassium chloride	-
Silica	-

HARDNESS Degrees	(English)
Total	15.4
Temporary	15.4
Permanent	-
Due to Calcium	3.5
Due to Magnesium	11.9

Thomas R. Frost
CHIEF ANALYST