

1985/59. Water table investigation at Heathfield Street, Norwood

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Abstract

A dispute arose between the contractors installing a floor heating system and the owner of a new house in Norwood, Launceston. The installers claimed that because of the type of ground on which the house was built, groundwater was under the concrete slab in which the heating pipes were situated. This floor was 0.2-0.8 m above ground surface, with plastic sheeting and sand above the ground level. The owner wished to prove the type of materials on which his house was situated, the level of the water table, and if it was conceivable that the water table could rise above the ground to the concrete slab. Two auger holes were drilled near the house foundations and intersected a sequence of thin silty sand (Sm) soil, a sandy clay transitional layer, and clay. A piezometer was placed in one hole in the clay, and samples were tested for moisture content, Atterberg limits, linear shrinkage etc.

Over the three months in which measurements were made, the water table never reached the surface soil layer. The foundation materials are not unusual for Launceston and because the clay was not fissured there is unlikely to be a water table at the site. Any water present beneath the slab is not likely to be groundwater.

INTRODUCTION

Mr F. Bearup was having serious problems with the under-floor heating system in his recently built two-storied house at 18 Heathfield Street, Norwood [EQ144099]. The system has an external, wood-fired boiler, with hot water circulating in pipes within the concrete floor slab. After testing the system for water leakages the installers of the heating system stated the reason for the systems poor performance was that water was present beneath the concrete slab. The concrete slab was conventional, with sand filling and plastic sheeting above ground level and with foundation walls and concrete footings around the perimeter. The installers of the heating system claimed the 'water' was the result of the type of ground on which the house was situated, and was not just a mere dampness in the sand filling from condensation beneath the slab.

In discussion on 30 July, Mr Bearup stated to Messrs Moore and Stevenson that he wished to know on what material his house was sited, the water table level, and if it was conceivable that the water table could rise to the level of the concrete slab if the impermeable plastic sheeting had been holed during construction.

The block's location indicates that the house foundations are on clay, and the surface sandy soil is only a thin superficial deposit. As clay is an aquaclude (it absorbs water), there would be no continuous water table as such with free water present unless the clay was highly fissured. There was more likely to be a moist zone in the top section of the clay and the thickness of this moist zone would fluctuate seasonally. Any free water would be confined to the thin surface sandy soil layer above the clay, and it was unlikely to occur here as the layer appears so permeable that any water would drain rapidly down the slope. It was difficult to see how any free water could be associated with groundwater, particularly as the water was reported to be above the plastic sheeting and in the sand filling below the concrete. There was a slight possibility

that if the clay was highly expansive, subsurface soil movements had caused the house to move and caused the rupture of the heating pipes. This appeared unlikely, as no cracks were visible in the foundations or walls of the house. The lack of cracks indicated that no differential vertical movements had occurred at Bearups.

TOPOGRAPHY AND SURFACE GEOLOGY

The block has a low slope of 2°-3° to the north-west towards Heathfield Street. A low bank along the back (south-west) boundary near the house exposes silty sand surface soil (Sm) overlying yellow clay (CH). From soil heaps around the house, it appeared that the foundations and drains had been dug below the surface soil into the reddish-brown clay. This clay was highly expansive, as shown by surface shrinkage cracks present on the bank and ground surface.

INVESTIGATION

Two auger holes were drilled as near as possible to the house foundations using the Triefus trailer mounted drill. Both holes were drilled to a depth of 3.3 m and their lithological logs are given in Appendix 1. Because the bottom of the concrete slab was only 0.2 m above the ground at the rear of the house, compared with 0.8 m at the front, a piezometer was placed in Hole 1 at the rear of the house near the slab's lowest point. This piezometer was placed in the clay and sealed off from the surface water and any groundwater in the surface silty sand. The water level was checked regularly by the owner during the wet months of July to October and was measured by the Department three times.

Samples were collected from Hole 1 at depths shown on the log. The samples were tested for moisture content, Atterberg limits and linear shrinkage. The soil testing results are given in Table 1 and are shown diagrammatically in Figure 1. No samples were collected from Hole 2 at the front of the house, as the lithological differences between Holes 1 and 2 are minor.

RESULTS

- (1) The surface silty sand layer is thin, being 0.5 m thick at the rear of the house and 0.6 m at the front of the house.
- (2) A thin, sandy clay transitional layer is present between the surface sand and underlying clay. It is thicker in the front (0.8 m) than at the rear of the house (0.4 m).
- (3) Both of the above layers are underlain by clay of the Launceston Beds of Tertiary age. Such clay underlies large areas of Launceston City and the Tamar Valley.
- (4) The surface sandy soil is well drained with a low moisture content (19%) compared with the high moisture contents of the sandy clay (47%) and underlying clay (41% and 32%). The moist layer is only 0.4 m thick, occurring at depths of 1.5 m and 1.8 m in the two holes drilled.
- (5) The sandy clay and underlying clay are highly plastic with plastic indices of 45, and 91 and 95 respectively.

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Table 1. SOIL TESTING RESULTS

| Sample No. | Depth (m) | MC (%) | PL | LL | PI | LS (%) | XRD of clay fines (%) | Quartz in total sample (%) | Field lithology | Laboratory classification |
|------------|-----------|--------|----|-----|----|--------|--|----------------------------|------------------------|---------------------------|
| 1 | 0.6 | 19 | - | - | - | - | - | - | Silty sand with gravel | Sm |
| 2 | 0.9 | 47 | 19 | 60 | 45 | 16 | Montmorillonite 10-15 Kaolinite 80-85 Goethite 5-10 | Whole quartz 15-20 | Sandy clay | CH |
| 3 | 1.5 | 41 | 31 | 126 | 95 | 25 | Montmorillonite 15-20 Kaolinite 70-75 Goethite 10-15 | Whole quartz 5-10 | Highly plastic clay | CH |
| 4 | 3.4 | 32 | 30 | 121 | 91 | 24 | Montmorillonite 15-20 Kaolinite 75-80 Goethite 0-5 | Whole quartz 10-15 | Highly plastic clay | CH |

MC = moisture content; PL = plastic limit; LL = liquid limit; PI = plasticity index; LS = linear shrinkage.

Soil testing by R.N. Woolley, Department of Mines, Hobart

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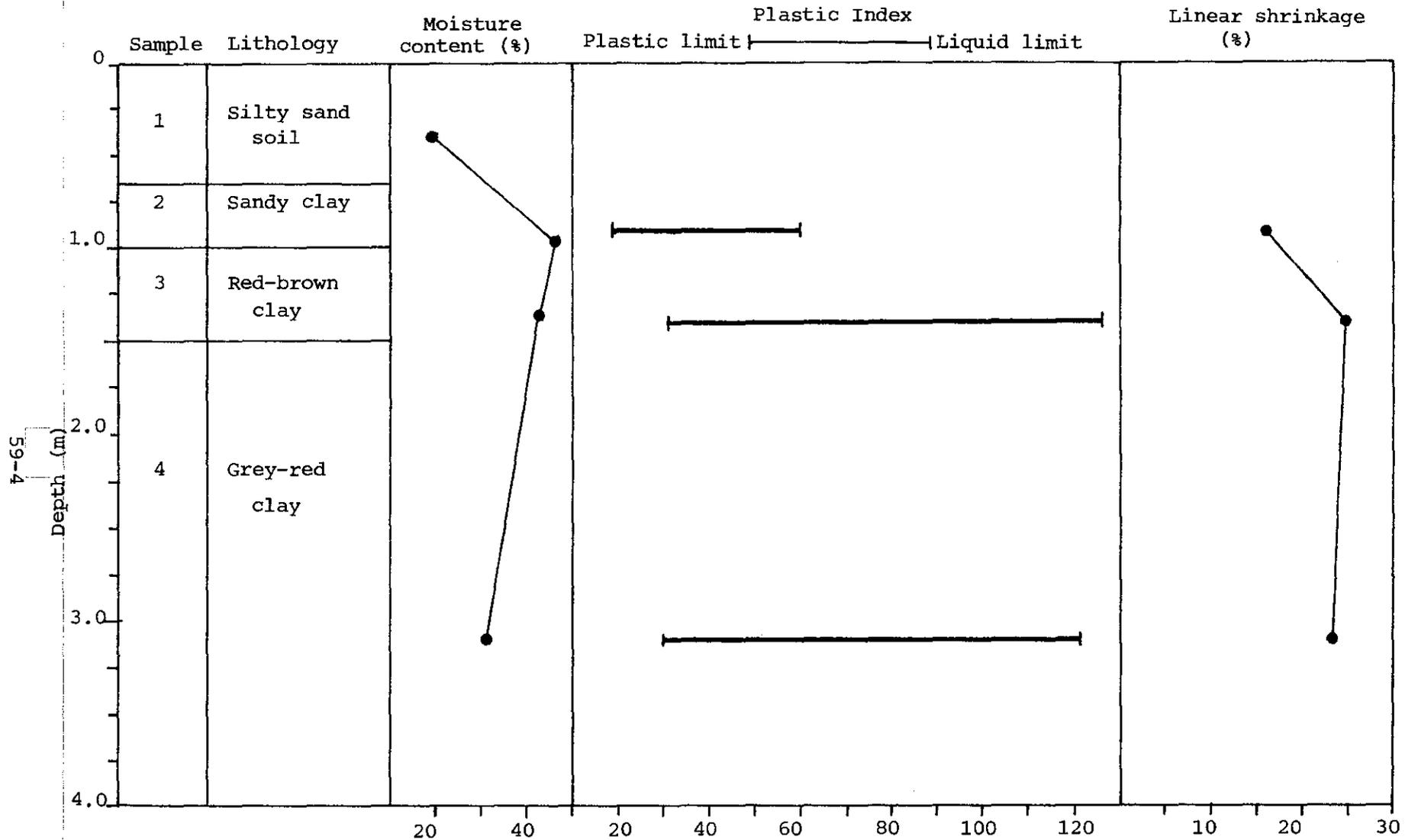


Figure 1. Soil testing results of samples, Hole 1.

5 cm

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- (6) Both the sandy clay and underlying clay have high linear shrinkages of 16% and 24-25%.
- (7) Neither of the two holes made any water when drilled on 14 August. In Hole 1, the piezometer water level was 1.8 m on 27 August, 0.94 m on 9 September, and 0.91 m on 19 October. From the levels measured by the Department or observed by the owner, at no time did the water level rise above the sandy clay into the surface silty sand layer.
- (8) No fissured clay was observed from the clay samples recovered from the auger drilling.

CONCLUSIONS

- (1) There is unlikely to be any lithological difference between the area under the house and the two holes drilled at the front and rear of the house. No evidence of any fissured clay was found.
- (2) With the foundations of the house and surface drains dug in the clay, it is unlikely that any groundwater will occur in the surface silty sand layer, particularly as the soil appears to be free draining downslope. A conventional water table does not appear possible, with subsurface investigation showing a shallow surface layer of silty sand, a thin transitional layer of sandy clay, and finally clay.
- (3) The piezometer measurements to date indicate that the clay and silty sand clay layers, even if highly fissured, are not likely to produce a water table which reaches the surface silty sand. Therefore it appears highly improbable that the water above the ground surface (reported below the concrete slab at Bearups) is connected with groundwater.
- (4) The underlying clay has the potential for vertical seasonal movements, as indicated by the high plastic indices and linear shrinkages. These movements are generally differential and would show as cracking on this type of house. No such cracking was seen on the outside of the house or reported inside by the owner.
- (5) The sedimentary sequence present beneath the house foundation is very common in Launceston and the Tamar Valley.

A general conclusion is that the source of free water, if present, beneath the concrete slab of Bearup's house is not groundwater. A continuous water table is unlikely, given the subsurface geology present. Differential movement in the expansive clay beneath the house foundations does not appear to be a cause of this water accumulation through the cracking of either the water heating or other pipes. There is nothing unique in the foundation soil beneath the house.

RECOMMENDATIONS

- (1) The piezometer water level still be monitored.
- (2) The water heating pipes and any other plumbing pipes beneath the concrete floor slab be checked for leakage by some form of pressure testing.

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- (3) The presence of the water be verified. It should be established if the 'water' is moist sand or wet sand with water in the interstices as implied strongly to date in the dispute. A more accurate instrument should be used to check the moisture or 'water' beneath the slab.

[1 November 1985]

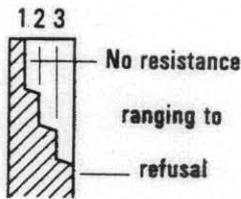
APPENDIX 1

Logs of boreholes

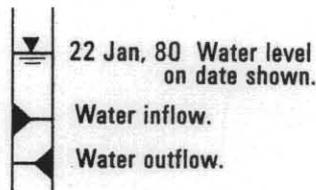
EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water



Notes - samples and tests

- U50 Undisturbed sample 50mm diameter.
- D Disturbed sample.
- N Standard penetrometer blow count for 300mm.
- N* SPT + sample.

Material classification

Based on Unified Soil Classification System.
In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

- D Dry, looks and feel dry.
 - M Moist, no free water on hand when remoulding.
 - W Wet, free water on hand when remoulding.
 - LL Liquid limit.
 - PL Plastic limit.
 - PI Plasticity Index.
- eg. M > PL - Moist, moisture content greater than the plastic limit.

Consistency

- | Consistency | hand penetrometer (kPa) |
|-----------------|-------------------------|
| VS Very soft. | < 25 |
| S Soft. | 25 - 50 |
| F Firm. | 50 - 100 |
| St Stiff. | 100 - 200 |
| VSt Very stiff. | 200 - 400 |
| H Hard. | > 400 |
| Fb Friable. | |

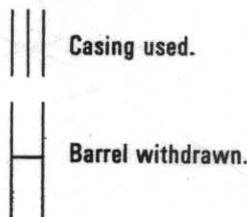
Notes: X on log is test result
— is range of results.

Density index

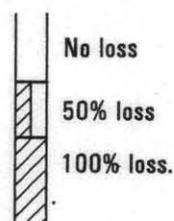
- | Density index | % |
|------------------|----------|
| VL Very loose. | 0 - 15 |
| L Loose. | 15 - 35 |
| MD Medium dense. | 35 - 65 |
| D Dense. | 65 - 85 |
| VD Very Dense | 85 - 100 |

Cored borehole log

Case - lift



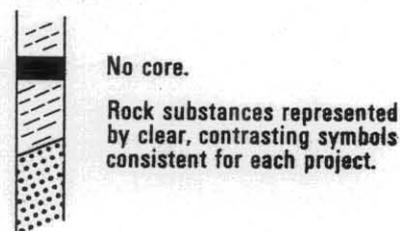
Fluid loss



Lugeons

Lugeon units (μL) are a measure of rock mass permeability. For a 48 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log



Weathering

- Fr Fresh.
- SW Slightly weathered.
- HW Highly weathered.
- EW Extremely weathered.

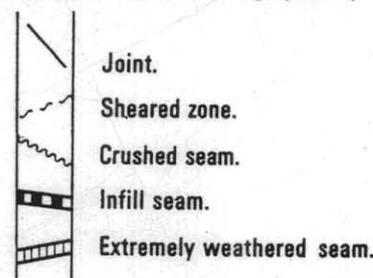
Strength

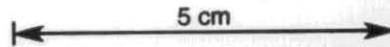
- | Strength | point load strength index $I_{5(50)}$ (MPa) |
|--------------------|---|
| EL Extremely low. | < 0.03 |
| VL Very low. | 0.03 - 0.1 |
| L Low. | 0.1 - 0.3 |
| M Medium. | 0.3 - 1 |
| H High | 1 - 3 |
| VH Very high. | 3 - 10 |
| EH Extremely high. | > 10 |

Note: X on log is test result.

Significant defects

Significant defects shown graphically.



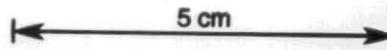


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ENGINEERING LOG - BOREHOLE

| | | | | | |
|--------------|-----------------------------|--------------|----------|---|----------|
| project | Foundation study, F. Bearup | | location | 18 Heathfield Street, Norwood (back of house) | |
| co-ordinates | EQ144409 | drill type | Triefus | hole commenced | 14.8.85 |
| R.L. | 65 m (approximate) | drill method | Auger | hole completed | 14.8.85 |
| inclination | v | drill fluid | None | drilled by | B.E. Cox |
| bearing | - | | | logged by | W.R.M. |
| | | | | checked by | R.C.D. |

| penetration 1 2 3 | support water | notes samples, tests | metres R.L. depth | graphic log | classification symbol | material soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency density index | hand penetr- ometer kPa 25 50 100 200 400 | structure, geology |
|---|------------------|----------------------------|-------------------------|-------------|--------------------------|---|---------------------------------|------------------------------|---|----------------------|
| | | | | | | | | | | |
| | None | S1 | | [Symbol] | Sm | Sand: Grey, fine with silt and occasional small quartz pebbles. | M | VL | | Surface sandy soil |
| | None | S2 | 1.0 | [Symbol] | Sc | Sandy clay: Grey-red clay. Highly plastic. Sand <10%, fine, poorly graded. | M | VS | | Transitional zone |
| | None | S3 | | [Symbol] | CH | | Clay: Red-brown, highly plastic | | PL | |
| | None | S4 | 2.0 | [Symbol] | CH | Clay: Grey-red, mottled. Highly plastic. | M < PL | F | | Launceston Beds Clay |
| | | | 3.0 | | | | | | | |
| <p>Drill stopped at required depth. Piezometer inserted - pipe diameter = 50 mm. Hole diameter = 100 mm Depth = 3.3 m Slots = 1.2 - 3.3 m</p> | | | | | | | | | | |



borehole no. 2
sheet 1 of 1

ENGINEERING LOG - BOREHOLE

| | | | | | |
|--------------|-----------------------------|--------------|----------|--|----------|
| project | Foundation study, F. Bearup | | location | 18 Heathfield Street, Norwood (front of house) | |
| co-ordinates | EQ144409 | drill type | Triefus | hole commenced | 14.8.85 |
| R.L. | 65 m (approximate) | drill method | Auger | hole completed | 14.8.85 |
| inclination | V | drill fluid | None | drilled by | B.E. Cox |
| bearing | - | | | logged by | W.R.M. |
| | | | | checked by | R.C.D. |

| penetration 1 2 3 | support water | notes samples, tests | metres R.L. depth | graphic log | classification symbol | material soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency density index | hand penetr- ometer kPa | structure, geology |
|----------------------|------------------|----------------------------|-------------------------|-------------|--------------------------|---|-----------------------|------------------------------|----------------------------------|------------------------|
| | | | | | | | | | 25 50 100 200 400 | |
| | | | | | Sm | Sand: Grey fine, some organic matter. | D | VL | | Soil |
| | | | 1.0 | | Sc ↓ CH | Sandy clay: Brown-yellow, changing to clay with sand at base. | M > PL | S | | Transitional layer |
| | | | 2.0 | | CH | Clay: Orange. Some sand (<10%). Highly plastic. | M | F | | Clay |
| | | | 3.0 | | CH | Clay: Red-orange, mottled. Highly plastic. | M < PL | F | | Clay - Launceston Beds |
| | | | | | | Hole stopped. Required depth reached. | | | | |