# HUGH FENDALL CONSULTANTS LTD

Civil and Structural Engineering

Dr. H.D.W. FENDALL Director
B.E. (Civil) Hons., Ph.D. M.IPENZ
R.N. McLEAN Director
B.E. (Civil) Hons., M.IPENZ

6A Montel Avenue,
Henderson,
AUCKLAND, 8.
Ph. & Fax 09-836-1853


Ref: 99122/oc2
23 November 2001

Mr & Mrs J. Davidson,
1 Landing Road,
LAINGHOLM.



Dear Sir,

**PROPOSED BASEMENT DEVELOPMENT**
**AT 1 LANDING ROAD, LAINGHOLM**

**BUILDING CONSENT NO. ABA 2001/2815**

**CONSTRUCTION OBSERVATION**

Prior to the issue of the above Building Consent, our firm carried out a Geotechnical Appraisal and prepared Structural Design Calculations for the building work. Conditions 7, 8 and 19 of the Consent require inspections by the geotechnical engineer and designer, to confirm satisfactory construction of the foundations, as well as the Grade B masonry walls.

Accordingly, at the request of yourself and the Builder, Mr Mike Abernethy, the following inspections were carried out by representatives of our firm:

**29 October 2001, 2 pm**

At the time of this inspection, virtually all the bulk earthworks for the basement development had been completed, as well as excavation of the strip footings / piles along the lower edge. It was noted that the piles were 300 mm diameter x 2.0 metres deep as specified and that the reinforcement comprised 2/D12 bars with R6 links at 600 mm centres in both the piles and the footing.

The use of polystyrene to ensure fill depths are no greater than 0.5 metres was discussed with the Builder, who was advised that the next engineering inspection should be to view the reinforcement in the masonry retaining wall footings.

**13 November 2001, 3 pm**

Inspection of footings and associated reinforcement for the masonry retaining walls. At the time of the inspection, the footing excavations were completed, the polythene DPC laid, and all the footing reinforcement placed. Final placing of the floor mesh reinforcement was under way.

1/2/02

It was noted that the footing dimensions and reinforcement complied with our design specifications. Site staff were advised that the mesh reinforcement should extend to within about 100 mm of the vertical starter bars (D16's at 400 mm / 600 mm centres).

It was confirmed that the retaining wall footings were being constructed in accordance with our design specifications, and hence placement of concrete could proceed.

I advised that my next inspection would be prior to grouting of the wall – this being due for 22 November. The Builder advised that the masonry would be constructed as one unit with clean-outs at the vertical bars.

**22 November 2001, 3.30 pm**

Masonry retaining wall blocks all installed ready for grout placement. Reinforcement all as per design calculations. Clean-outs at all vertical bars and have all been well cleaned out.

Confirmed to builder that placement of grout could proceed.

**Summary**

In summary, as a result of our inspections as outlined above, it is our opinion that the foundations and masonry retaining wall have been constructed in accordance with our design specifications.

Yours faithfully,

Dr H.D.W. Fendall
Director
HUGH FENDALL CONSULTANTS LIMITED

HUGH FENDALL CONSULTANTS LTD
Civil and Structural Engineering

Dr. H.D.W. FENDALL Director
B.E. (Civil) Hons., Ph.D, M.IPENZ
D.G. Bishop
B.E. (Civil), N.Z.C.E. Civil, M.IPENZ

6A Montel Avenue,
Henderson,
AUCKLAND, 8.
Ph. & Fax 09-836-1853

Ref: 99122/r2
10 September 2001

Mr & Mrs J & J. Davidson,
1 Landing Road,
Laingholm,
WAITAKERE CITY.

Dear Sir & Madam,

**PROPOSED BASEMENT DEVELOPMENT**
**AT 1 LANDING ROAD, LAINGHOLM**

**GEOTECHNICAL APPRAISAL**

## 1. INTRODUCTION

This report has been prepared to accompany a Building Consent Application for the proposed basement development beneath the existing dwelling.

Our investigations for this report have included a visual appraisal of the site and inspection of soils exposed in existing cut faces. We have also reviewed the 1997 Geotechnical Report prepared by Ormiston Associates Limited for the existing dwelling, as well as a 1999 report previously prepared by our firm for the garage, deck and driveway retaining wall at the north-western end of the dwelling.

It is the conclusion of this report that the proposed basement development as described on drawings by Mr M. Saunders (Reference 69901, dated 9/01) can be satisfactorily constructed in terms of the ground strength and stability. Note that this conclusion assumes that all the recommendations in Section 5 herein are implemented. These recommendations include the need for specific foundation design for all proposed foundations and retaining walls. Recommendations are also made with regard to minimum foundation depths and allowable soil bearing pressures.

Please note that this report only considers only the issues of the soil strength and stability in relation to the proposed basement area construction, and not to any other aspect of the proposed development.

## 2. SITE DESCRIPTION

### 2.1 GENERAL

The legal description of the property is Lot 2, DP 140604 and it is located to the south of the intersection of Laingholm Drive and Landing Road. Vehicle access to the site is via a common accessway off Laingholm Drive approximately 85 metres north-east of Landing Road. The property has a irregular shape with a road frontage to Laingholm Drive of 74.1 metres and an area of 3,298 square metres.

The existing dwelling is located near the centre of the site and the existing garage is located at the north-western end of the dwelling.

The ground surface in the vicinity is characterised by a large east-west trending ridge to the south of the site. The site is located at the north-western end of a broad crested side spur extending off the main ridge. The spur falls down towards the north with average ground slopes of around 15 - 20 degrees with some steeper areas also present.

Most of the slopes have a uniform, stable appearance although past slumping of the road cutting along the eastern side of Laingholm Drive is apparent. In addition, down hill soil creep in the form of curved and leaning trunks of the vegetation is apparent on most of the moderate to steeper sloped areas.

### 2.2 GEOLOGY

The New Zealand Industrial Series Geological Map for the Cornwallis Area (Sheet N 42/7 - 1:25,000 scale), indicates that the proposed building area is underlain by a residual soil ($sz_3$) which has been derived from in-situ weathering of the underlying Waitemata Formation rocks. The soils are described as greyish white to yellowish brown, soft to very stiff, clays and silts which grade down into the underlying sandstones and mudstones within around 8 metres of the ground surface. The underlying Waitemata Formation sandstones and mudstones were laid down in a sea floor environment during the early Miocene Period (around 19 - 24 million years ago). Subsequent uplifting has occurred and the normal forces of erosion have produced the topography now evident.

The clays and silts derived from in-situ weathering of the Waitemata Formation normally have a safe allowable bearing capacity of at least 100 kPa for the support of standard, shallow dwelling foundations. However, the near surface clays in particular can be subject to significant shrinkage and swelling movements as a result of seasonal moisture content variations. This can detrimentally affect shallow footings and can result in cracking of brittle veneers, etc.

In addition, downhill creep of the near surface soils can occur on slopes greater than around 15 - 20 degrees and slumping can occur on slopes greater than around 20 degrees, depending upon groundwater conditions, vegetative cover, etc.

On steeper slopes such as this, adequate protection must be provided against the risk of soil slumping, and pile foundations that are specifically designed to resist lateral pressures caused by downhill soil creep are often required.

## 3. PREVIOUS REPORTS

### 3.1 ORMISTON ASSOCIATES LIMITED REPORT, MARCH 1997

This report was prepared for the original dwelling construction. The investigations included the drilling of four test boreholes and the carrying out of Scala Penetrometer tests.

The report concluded that the proposed building site is suitable in terms of the ground strength and stability provided that the foundations were specifically designed in accordance with the report recommendations. These recommendations included the use of 3.0 metre deep drilled and concreted pile foundations with allowance for creep pressures over the upper 1.0 metres of soil depth. Recommendations were also made with regard to the design of masonry retaining walls as follows:

Design Parameters

| | | | |
|---|---|---|---|
| (i) | Soil Friction Angle (assumed) | $\phi$ | = 30 degrees |
| (ii) | Active Earth Pressure ($K_o$ conditions) | $K_o$ | = 0.5 |
| (iii) | Soil Density | $\gamma$ | = 18 kN/m$^3$ |
| (iv) | Surcharge Loadings from the slope above the proposed wall | | |
| (v) | Factors of safety as outlined ......... | | |

Recommendations were also made with regard to possible basement development. The report notes:

"*Where the proposed basement is to be founded on a level cut platform rather than on the existing sloping ground, then it will be possible to found all or part of the load-bearing walls of the structure on either conventional near surface pad or strip footings. Conventional shallow foundations on cut natural ground should be embedded a minimum depth of 0.45 m below the finished ground level into firm natural ground.*

*Where footings come within 2 m of the downslope edge of any cut bench, the embedment depth should be increased to 0.6 m minimum below the final ground level. Refer drawing 388/503-3 for schematic foundation layout. Piles 2.5 m minimum depth should be used to support the basement foundations along the downslope perimeter. These piles are not intended as load bearing piles, merely as a precaution to protect the strip footing against the detrimental effects of seasonal shrinkage and swelling of the site soils and soil creep .*"

A copy of the drawing 388/503-3 taken from the report is included herewith.

### 3.2 REPORT BY HUGH FENDALL CONSULTANTS LTD. DATED 18 JUNE 1999

This report was prepared to assess the ground conditions within the proposed garage and driveway areas so as to determine what slope stabilisation measures and foundation types would be appropriate. Three test boreholes were drilled and the report recommended the installation of subsoil and surface drainage measures, as well as the use of specifically designed deep pile foundations.

## 4. DISCUSSION

### 4.1 SLOPE STABILITY

The Ormiston Report concluded that the proposed dwelling site was sufficiently stable for residential development provided that certain foundation recommendations were implemented. The ground slopes within and below the dwelling area are around 16 degrees (1:3.5) with slightly steeper gradients up-slope (around 20 degrees, 1:2.75) which extend for a significant distance. A concrete driveway traverses these slopes approximately 15 metres above the dwelling and this is acting as a surface water diversion drain to reduce runoff flowing across the building area.

This stormwater diversion would be improving the stability of the dwelling site and given the moderate slopes, combined with the generally firm soil strength, it is considered that the conclusion of the Ormiston Report with regard to the satisfactory stability of the area was, and still is, appropriate. Note that the proposed basement development will not extend beyond the existing building platform area, and hence the above conclusion is applicable to the basement area.

It is further considered that the Ormiston recommendations with regard to the basement development foundations are also satisfactory and should be implemented.

The steeper slopes adjacent to Laingholm Drive (to the west of the garage / driveway) are considered to be sufficiently clear of the proposed basement area, and in any event, the stability of these slopes has been improved by the installation of the subsoil drainage measures which were specified in our 1999 report and have since been installed.

It will be important that the proposed basement development does not include any actions that would significantly reduce the existing slope stability. Hence, all excavations must be fully retained with walls designed for "at rest" pressures, and the placement of fill should be avoided as far as possible. The proposed underslab filling must be limited to a maximum depth of 0.5 metres if normal density fill is used (eg. GAP 40), and 0.8 metres if low density scoria is used. Greater depth "fills" should use either polystyrene fill or a suspended slab system.

### 4.2 SOIL BEARING CAPACITY

The existing cut faces beneath the dwelling reveal generally firm, orange – grey, silty clays, which are consistent with those derived from in-situ weathering of the underlying Waitemata Group rocks. These soils have a peak, "undrained" shear strength of 90 kPa or greater, and hence a safe allowable bearing capacity of 100 kPa can be used for foundation design.

Note that pile foundations extending to a depth of 2.5 metres below the existing ground surface will be required along the lower edge of the basement area to provide some assurance against the effect of downhill soil creep and near surface shrinkage / swelling movements.

All the proposed basement foundations must be specifically designed by a Registered Engineer experienced in Geomechanics who is familiar with the site and this report.

## 5. SUMMARY AND RECOMMENDATIONS

Outlined above are our findings regarding the soil strength and stability which have been based on a visual assessment of the property together with previous survey and subsoil investigations. As a result, it is our professional opinion, not to be construed as a guarantee, that the site is sufficiently stable for the proposed basement development. This conclusion is based on the assumption that the following recommendations will be implemented:

A. The proposed basement development must be constructed in accordance with the drawings provided to us - by Mr M. Saunders – Ref 69901.

B. No actions must be undertaken which would significantly reduce the existing ground stability. In particular:

- All cut faces must be fully retained with walls designed for "at rest" pressures ($K_o = 0.5$),
- The placement of filling on or adjacent to the slopes should be avoided as far as practicable, and in any event, the proposed underslab filling must be limited to a maximum depth of 0.5 metres if normal density fill is used (eg. GAP 40), and 0.8 metres if low density scoria is used.
- Stormwater control measures must be adequately maintained to ensure that no concentrated discharges of stormwater occur onto the ground surface. All runoff from roofed and paved areas must continue to be collected and piped to the stormwater disposal system.

C. The basement area foundations must be specifically designed by a Registered Engineer who is familiar with the site and this report. A safe allowable bearing capacity of 100 kPa is considered appropriate for working load design, with shallow (450 mm depth) footings within level, excavated areas. Along the lower side of the basement, the footings should comprise 2.5 metre deep piles which can be designed for a safe allowable end bearing pressure of 150 kPa.

D Note that normal inspection of the soils at the base of all excavated foundation holes must be undertaken prior to the placing of concrete to ensure that sufficient depth has been achieved and that sufficient soil bearing capacity is available.

## 6. LIMITATIONS

This Report has been prepared for the purpose of assessing the ground strength and stability in relation to the proposed basement development, so as to ascertain appropriate foundation types / depths. The Report shall not be relied upon for any other purpose.

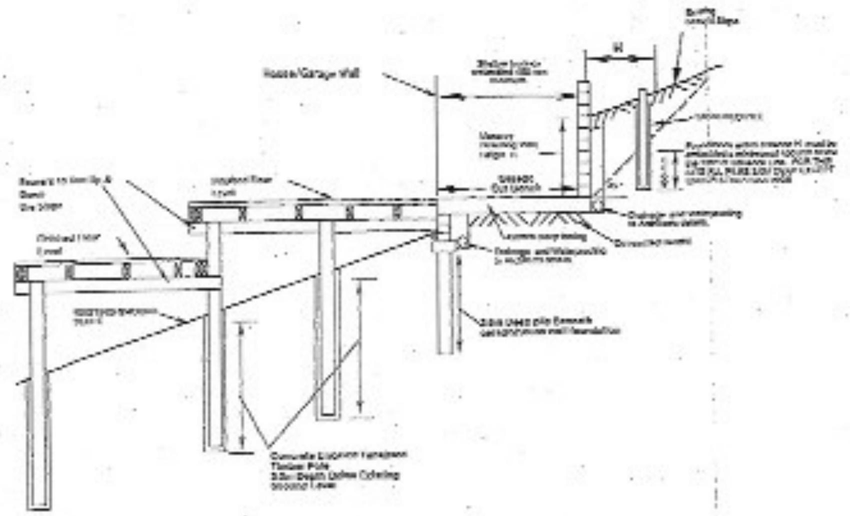
During excavation and construction the site should be examined by an Engineer or Engineering Geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based upon this Report.

This report has been prepared solely for the benefit of Mr and Mrs Davidson as our client with respect to the brief, and for the Local Territorial Authority to assess compliance with the Building Act. The reliance by other parties on the information or opinions contained in the Report shall, without our prior review and agreement in writing, be at such parties sole risk.

Yours faithfully,

HDW Fendall

Dr H.D.W. Fendall
Director
HUGH FENDALL CONSULTANTS LIMITED




SCHEMATIC DRAWING FOR
GENERAL FOUNDATION
REQUIREMENTS
FOR BENCHES ON SLOPES GREATER
THAN 15°.

| | | | |
|---|---|---|---|
| **ORMISTON ASSOCIATES LTD** | CLIENT : MADDREN HOMES<br>LOCATION : 1 LANDING ROAD, LAINGHOLM<br>TITLE : FOUNDATIONS ON BENCHES - TYPICAL DETAILS | SCALES Not To Scale<br>DRAWN LGD<br>DATE 12 MAR 1997<br>CHECKED LGD | DRAWING NO<br>388/503-3<br>SHEET 3 OF 3 |

BRANZ
THE RESOURCE CENTRE FOR BUILDING EXCELLENCE

**Sheet A**

**Name of Applicant:** J+J Davidson.

**Site Address**

City/Town or District: Langholm.

Street and Number: 1 Landing Road.

or

Lot and D.P. Number: ______

**BOX 1**

**LOCATION OF STOREY BEING ASSESSED**

| FOUNDATION | SINGLE STOREY or UPPER STOREY | LOWER STOREY |
|---|---|---|

Use 1 sheet for each storey and circle the appropriate location

**Box 2** For Earthquake (from Table 4.7A for foundations or Table 6.1 at other levels).

| | | |
|---|---|---|
| Weight of Roof: | light / heavy | E = 5.0 B.U.'s/sq m |
| Average Roof Slope: | 20° | |
| Weight of Wall Cladding: | light / heavy | |
| Storey in Roof Space: | ~~yes~~ / no | |
| Earthquake Zone (Fig 2.2, Table 2.3): | A / B / C | |

**Box 3** For Wind (from Table 4.7B for foundation or Table 6.2 at other levels).

| | | |
|---|---|---|
| Building Height: | m 7.0 | |
| Roof Height: | m 1.0 | W along = 80 B.U.'s/m |
| Stud Height: | m 2.4 | W across = 72 B.U.'s/m |
| Building Wind Zone (Table 2.4): | low / medium high / very high | |

**Box 4**

| | | | |
|---|---|---|---|
| Gross Roof or Building Plan Area | GPA = | 75.10 | sq m |
| Roof or Building Width | BW = | 9.0 | m |
| Roof or Building Length | BL = | 13.90 | m |

**Box 5**

| | | | | | | |
|---|---|---|---|---|---|---|
| Earthquake Load (Across and Along) | E x GPA | = 5 | x 75.10 | = 375.5 | B.U.'s | ✓ |
| Wind Load Along: | W x BW | = 80 | x 9.0 | = 720 | B.U.'s | ✓ |
| Wind Load Across: | W x BL | = 72 | x 13.90 | = 1000.8 | B.U.'s | ✓ |

Sheet B

LOCATION OF STOREY BEING ASSESSED

FOUNDATION SINGLE STOREY or UPPER STOREY LOWER STOREY

Use 1 sheet for each storey and circle the appropriate location

BRANZ
THE RESOURCE CENTRE FOR BUILDING EXCELLENCE

## ALONG

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Wind | | | | Earthquake | | |
| Wall or Bracing Line | Bracing Element Identification | Bracing Type | Length of Element (m) | B.U.'s/m (Wind) | B.U.'s Achieved | Total for Bracing Line | Minimum Bracing Required | B.U.'s/m (Earthquake) | B.U.'s Achieved | Total for Bracing Line |
| A Ext | 1 | HF1 | 1·2 | 117 | 140·4 | 257·4 | 58x 10 | 97.5 | 117 | 234 |
| | 2. | HT2 | 0·9 | 130 | 117·0 | | 58 | 130 | 117 | |
| B INT | 3 | HF2 | 2·4 | 123.5 | 296.4 | 296·4 | 70 | 104 | 249.6 | 249·6 |
| C Ext | 4 | BR9 | 0·8 | 110 | 88 | 253 | 139x 10 | 95 | 76 | 218·5 |
| | 5 | BR9 | 0·6 | 110 | 66 | | 139 | 95 | 57 | |
| | 6 | BR9 | 0·9 | 110 | 99 | | | 95 | 85.5 | |
| D | | | | | | | | | | |
| E | | | | | | | | | | |
| | | | | Total Bracing Achieved | | 806·8 | 267 | Total Bracing Achieved | | 702·1 |
| | | | | Total Bracing Required for Wind Along | | 720 | | Total Bracing Required for Earthquake | | 376 |

## ACROSS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Wind | | | | Earthquake | | |
| Wall or Bracing Line | Bracing Element Identification | Bracing Type | Length of Element (m) | B.U.'s/m (Wind) | B.U.'s Achieved | Total for Bracing Line | Minimum Bracing Required | B.U.'s/m (Earthquake) | B.U.'s Achieved | Total for Bracing Line |
| M Ext | 7 | BR4 | 1·2 | 100 | 120 | 120 | 3.7x10 37 | 85 | 102 | 102 |
| N INT | 8 | BR5 | 1·8 | 115 | 207 | 347·4 | 70 | 85 | 153 | 270 |
| | 9 | HF1 | 1·2 | 117 | 140·4 | | | 97.5 | 117 | |
| O INT | 10 | HF1 | 1·7 | 117 | 198·9 | 468·9 | 70 | 97.5 | 165.7 | 363·7 |
| | 11 | BR6 | 1·8 | 150 | 270 | | | 110 | 198 | |
| P Ext | Bract. | GIB.1 | 1·8 | 55 | 99 | 99 | 90x 10 90 | 50 | 90 | 90 |
| Q | | | | | | | | | | |
| | | | | Total Bracing Achieved | | 1035·3 | | Total Bracing Achieved | | 825·7 |
| | | | | Total Bracing Required for Wind Across | | 1001 | | Total Bracing Required for Earthquake | | 376 |

# HUGH FENDALL CONSULTANTS LTD

Civil and Structural Engineering

Dr. H.D.W. FENDALL Directer
B.E. (Civil) Hons., Ph.D, M.IPENZ
D.G. Bishop
B.E. (Civil), N.Z.C.E. Civil, M.IPENZ

6A Montel Avenue,
Henderson,
AUCKLAND, 8.
Ph. & Fax 09-836-1853

Ref: 99122/ds2
11 September 2001

**PROPOSED BASEMENT DEVELOPMENT**
**AT 1 LANDING ROAD, LAINGHOLM**

**DESIGN CALCULATION SUMMARY**



2. **Masonry Retaining Walls**

Refer summary sketch details on Page 5.

3. **Footings**

For Masonry Retaining Wall Footings: Refer details Page 5.

For Other Footings: Typically use 300 mm wide x 200 mm deep footings reinforced with 2/D12 longitudinal bars and R6 links at 600 mm centres. Footings to be 450 mm deep, and founded within firm, natural soils.

Support outer edge footing on 300 mm diameter x 2.5 metre deep piles at 1.5 metre centres – refer summary sketch details on Pages 7 and 8.

**General Notes:**

1. Any parts of the structure which are not covered by the specific design included with these calculations must comply either with the New Zealand Building Code or specific design as detailed by others. Any exceptions to this should be referred back to this Design Office.
2. This design does not include any assessment of site conditions regarding ground stability and/or soil strength. It has therefore been assumed for the purpose of the design that the site is stable and that the soils have a safe allowable bearing capacity of 100 kPa. Compliance with Section 3 of NZS 3604:1990 must be verified on site by others after excavation and prior to the placing of concrete in any foundation hole.
3. The preparation of this design has been based on information shown on the drawings provided to us (particularly with regard to existing structures, ground levels etc), and we have not independently verified this information and are not endorsing that information as to its accuracy.

Association Consulting Engineers of New Zealand | New Zealand Institute of Architects | Institution Professional Engineers of New Zealand

P.I.M. No. ..........

Building Regulation Clause(s) B1

1

# PRODUCER STATEMENT - PS1 - DESIGN

(Guidance notes on the use of this form are printed on the reverse side)

**ISSUED BY:** DR H. D. W. FENDALL
(Suitably qualified Design Professional)

**TO:** Mr and Mrs J. Davidson
(Owner)

**IN RESPECT OF:** Proposed Basement Development
(Description of Building Work)

**AT:** 1 Landing Rd
Laingholm
(Address)

LOT 2 DP 140604 SO ..........

Hugh Fendall Consultants Ltd has been engaged by Mr J. Davidson
(Design Firm) (Owner/Developer/Contractor)

to provide Design of Retaining Walls / Footing services in respect of the
(Extent of Engagement)

requirements of Clause(s) B1 of the Building Regulations 1992 for

☐ All ☑ Part only as specified Refer typed summary list.

of the building work. The design has been prepared in accordance with B1/VM1, VM4
(verification method(s)/acceptable solution(s))

(respectively) of the approved documents issued by the Building Industry Authority and the work is described on

Hugh Fendall Consultants Ltd calculation drawings titled ..........
(Design Firm)

and numbered Reference 99122 and the specification and other documents according to which the building is proposed to be constructed.

As an independent design professional covered by a current policy of Professional Indemnity Insurance to a minimum value of $200,000, **I BELIEVE ON REASONABLE GROUNDS** that subject to:

(i) the site verification of the following design assumptions Stable Site. 100 kPa safe allowable soil bearing capacity.

and (ii) all proprietary products meeting the performance specification requirements,

the drawings, specifications, and other documents according to which the building is proposed to be constructed comply with the relevant provisions of the building code.

(Signature suitably qualified Design Professional)

Date 10-9-01

Registered Engineer, M.IPENZ
(Professional Qualifications)

ERB/AERB Reg No. 8114

Member ACENZ ☐

6A Montel Avenue, HENDERSON
(Address)

IPENZ ☒ ☐ NZIA

This form to accompany Form 3 of the Building Regulations 1992 for the application of a Building Consent.

18/12/92

## GUIDANCE ON USE OF PRODUCER STATEMENTS

This producer statement has been prepared by a combined task committee consisting of members of the New Zealand Institute of Architects, Institution of Professional Engineers New Zealand, Association of Consulting Engineers New Zealand, Building Officials Institute of New Zealand, New Zealand Master Builders Federation and New Zealand Contractors Federation.

Four producer statements are available and brief details on the purpose of each are as follows:

| | |
|---|---|
| **Design:** | Intended for use by the party responsible for the design when the territorial authority carries out a less rigorous review of the documents. |
| **Design Review:** | Intended for use by a suitably qualified independent design professional where the territorial authority does not undertake an internal review and relies on the independent design professional's review to issue the building consent. |
| **Construction:** | Intended for the use by the contractor of the building works where the territorial authority requires a producer statement at the completion of construction. |
| **Construction Review:** | Intended for use by the design professional required by the building consent to undertake construction monitoring of the building works. |

The producer statements system is intended to provide territorial authorities with reasonable grounds for the issuing of a Building Consent or Code Compliance Certificate without having to duplicate design or construction checking by others.

The following criteria are recommended to Territorial Authorities with respect to the use of the producer statements.

### Definition of Suitably Qualified Design Professional

A suitably qualified design professional should have recognised qualifications and experience for the work undertaken and should be either:

(i) an active member of the Association of Consulting Engineers of New Zealand (ACENZ) or;
(ii) a corporate member of the Institution of Professional Engineers of New Zealand (IPENZ) having a current policy of Professional Indemnity Insurance for a sum not less than $200,000 or;
(iii) a member of the New Zealand Institute of Architects (NZIA) having a current policy of Professional Indemnity Insurance for a sum of not less than $200,000.

### Design Build Contracts

If the design professional is engaged by the contractor, the territorial authority should satisfy itself that it is appropriate for the territorial authority to rely upon a producer statement from the design professional.

### Consulting Services during Construction Phase

There are several levels of service which a design professional may provide during the construction phase of a project. The territorial authority is encouraged to require that the service to be provided by the design professional is appropriate for the project concerned.

### Requirement to provide Producer Statement

Territorial authorities should ensure that the applicant is aware of any circumstances in which there may be a requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the design professional's engagement.

### Attached Particulars

Attached particulars referred to in this producer statement refer to supplementary information appended to the producer statement.

HUGH FENDALL CONSULTANTS LTD
Civil & Structural Engineering
6 A Montel Avenue, Henderson, Auckland, 8.
Telephone 0-9-836-1853

| JOB NAME. | | PAGE No. |
|---|---|---|
| SECTION. | | 2 |
| JOB No. | DESIGNED. | |
| DATE. | CHECKED. | |

## 2. RETAINING WALLS

Max retaining = 1.2 m on drawings
But I will design for up to 1.6 m above F.L.

From Geo report use $k_o$ = 0.5

K = 0.5
Density = 18 kN/m3

| Retained Height (m) | Lateral Pressure At Wall Base (kPa) | Resultant Force (kN) | ULS (*1.6) Force (kN) | Maximum BM (ULS) (kN-m) |
|---|---|---|---|---|
| 0.4 | 3.60 | 0.720 | 1.152 | 0.154 |
| 0.5 | 4.50 | 1.125 | 1.800 | 0.300 |
| 0.6 | 5.40 | 1.620 | 2.592 | 0.518 |
| 0.7 | 6.30 | 2.205 | 3.528 | 0.823 |
| 0.8 | 7.20 | 2.880 | 4.608 | 1.229 |
| 0.9 | 8.10 | 3.645 | 5.832 | 1.750 |
| 1 | 9.00 | 4.500 | 7.200 | 2.400 |
| 1.1 | 9.90 | 5.445 | 8.712 | 3.194 |
| 1.2 | 10.80 | 6.480 | 10.368 | 4.147 |
| 1.3 | 11.70 | 7.605 | 12.168 | 5.273 |
| 1.4 | 12.60 | 8.820 | 14.112 | 6.586 |
| 1.5 | 13.50 | 10.125 | 16.200 | 8.100 |
| 1.6 | 14.40 | 11.520 | 18.432 | 9.830 |
| 1.7 | 15.30 | 13.005 | 20.808 | 11.791 |
| 1.8 | 16.20 | 14.580 | 23.328 | 13.997 |
| 1.9 | 17.10 | 16.245 | 25.992 | 16.462 |
| 2 | 18.00 | 18.000 | 28.800 | 19.200 |
| 2.1 | 18.90 | 19.845 | 31.752 | 22.226 |
| 2.2 | 19.80 | 21.780 | 34.848 | 25.555 |
| 2.3 | 20.70 | 23.805 | 38.088 | 29.201 |
| 2.4 | 21.60 | 25.920 | 41.472 | 33.178 |

Refer Masonry Wall analyses below:

Depth (Thickness) = 190 mm
Width = 1000 mm
d = 90 mm

Bar Diameter = 12 mm
Spacing = 600 mm

Number of bars = 1.666667
As = 188.5
Yield = 300 MPa
fc = 4 MPa
As x fy = 56548.62 N
a = 16.6 mm

Mu = 3.9 kN-m
Grade C

Balance Conditions Check
Balance Steel ratio = 0.006422
75 % of Balance = 0.004817
Actual Steel Ratio = 0.002094
Hence: OK

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**REINFORCED MASONRY DESIGN**

| | | | | |
|---|---|---|---|---|
| Depth (Thickness) = | 190 mm | | | |
| Width = | 1000 mm | | | |
| d = | 90 mm | | | |
| Bar Diameter = | 16 mm | | | |
| Spacing = | 600 mm | | | |
| Number of bars = | 1.666667 | | Balance Conditions Check | |
| As = | 335.1 | | Balance Steel ratio = | 0.006422 |
| Yield = | 300 MPa | | 75 % of Balance = | 0.004817 |
| f'c = | 4 MPa | | Actual Steel Ratio = | 0.003723 |
| As x fy = | 100530.9 N | | Hence: | OK |
| a = | 29.6 mm | | | |
| Mu = | 6.4 kN-m | | | |
| | Grade C | | | |

**REINFORCED MASONRY DESIGN**

| | | | | |
|---|---|---|---|---|
| Depth (Thickness) = | 190 mm | | | |
| Width = | 1000 mm | | | |
| d = | 90 mm | | | |
| Bar Diameter = | 16 mm | | | |
| Spacing = | 400 mm | | | |
| Number of bars = | 2.5 | | Balance Conditions Check | |
| As = | 502.7 | | Balance Steel ratio = | 0.012844 |
| Yield = | 300 MPa | | 75 % of Balance = | 0.009633 |
| f'c = | 8 MPa | | Actual Steel Ratio = | 0.005585 |
| As x fy = | 150796.3 N | | Hence: | OK |
| a = | 22.2 mm | | | |
| Mu = | 10.1 kN-m | | | |
| | Grade B | | | |

For up to 1m retaining - Use D12 @ 600 Grade C
" " 1.2m " - Use D16 @ 600 Grade C
" " 1.5m " - Use D16 @ 400 Grade B

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For Footing Widths, Use Masonry Design Charts

For up to 1m retaining, Footing Width = 0.8m
1.2m 1.0m
1.5m 1.6m

Refer summary sketch details page 5.

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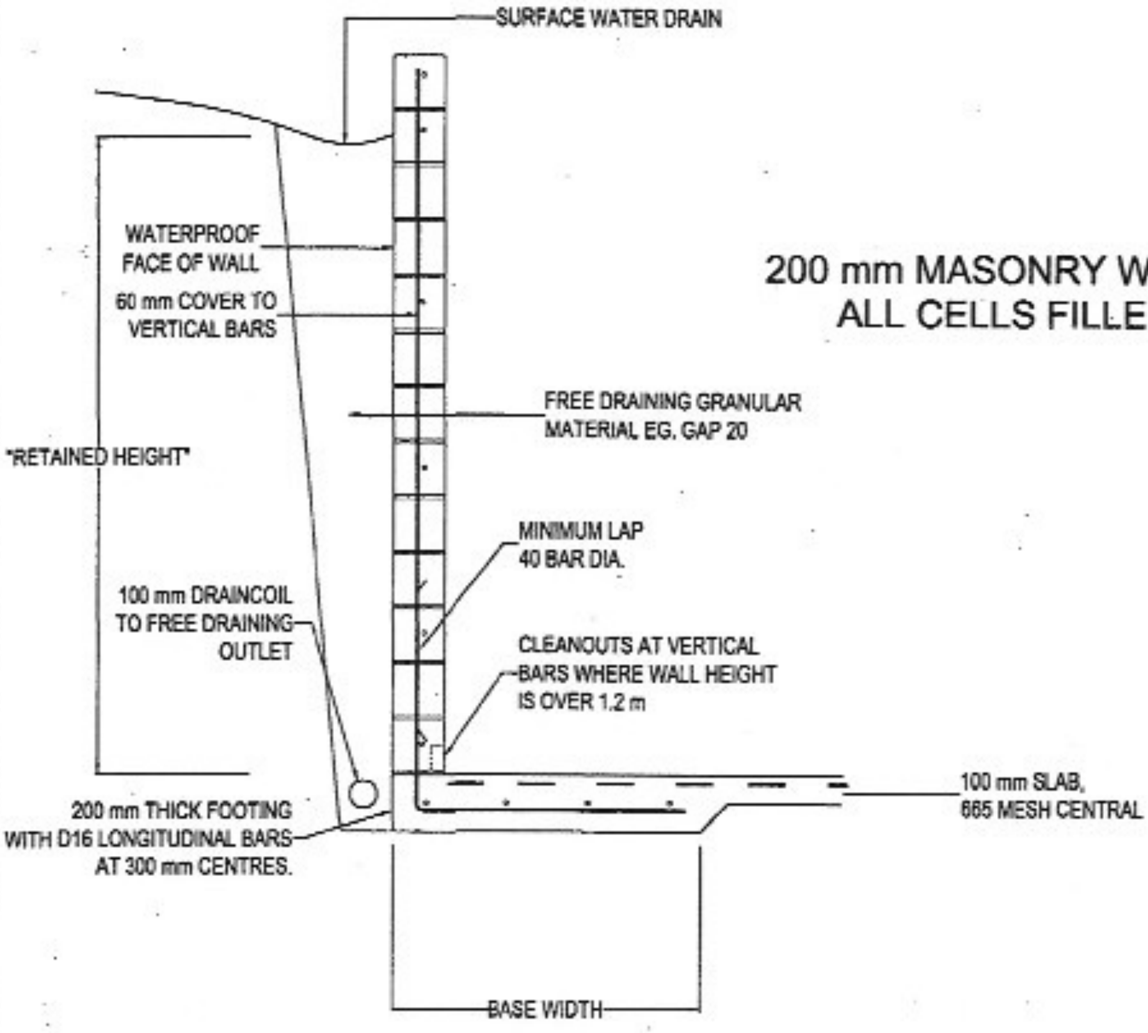
# 200 mm MASONRY WALL
# ALL CELLS FILLED




NOTES:

1. A SAFE ALLOWABLE BEARING PRESSURE OF 100 kPa IS REQUIRED UNDER WALL FOOTING.
2. GRADE "B" MASONRY REQUIRES ENGINEERING INSPECTIONS TO BE CARRIED OUT DURING CONSTRUCTION.
4. CONCRETE AND GROUT STRENGTH TO BE 17.5MPa 28 DAYS.

| RETAINED HEIGHT | VERTICAL BARS | HORIZONTAL BARS | BASE WIDTH | MASONRY GRADE |
|---|---|---|---|---|
| UP TO 1.0 m | D12 @ 600 | D12 @ 600 | 0.8 m | C |
| UP TO 1.2 m | D16 @ 600 | D12 @ 600 | 1.0 m | C |
| UP TO 1.5 m | D16 @ 400 | D12 @ 600 | 1.6 m | B |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Scales | NOT TO SCALE | | Project 99122 |
| Drawn HDWF | Date 9-01 | | Sheet 5 of |

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DAVIDSON, 1 LANDING ROAD, LAINGHOLM

CANTILEVER MASONRY RETAINING WALL

# 3 FOOTINGS

Typically, strip footings to be 650 mm deep

Along front edge, we must use 2.5 m deep piles:

Design Piles to carry all footing loads

ie,

**FOOTING LINE:** Outer Edge Footing

Loads to Footing Are:

| Item | Size (b*d) | | Density (kN/m3) | Contributary Width (m) | Gravity Load (kPa) | Live Load (kPa) | Loads per metre G (kN/m) | Loads per metre Q (kN/m) |
|---|---|---|---|---|---|---|---|---|
| Strip Footing | 0.3 | 0.2 | 25 | | | | 1.5 | |
| Subfloor Wall | 0.2 | 0.6 | 20 | | | | 2.4 | |
| Floors | | | | 0 | 0.5 | 1.5 | 0 | 0 |
| Deck | | | | 0.6 | 0.5 | 2 | 0.3 | 1.2 |
| Wall | | | | 2.4 | 2 | | 4.8 | |
| Roof | | | | 0 | 0.85 | 0.25 | 0 | 0 |
| | | | | | | Totals (kN/m | 9 | 1.2 |

Total Working Load 10.2 kN/m
ULS Loads 1.4G 12.6 kN/m
1.2G+1.6Q 12.7 kN/m

Pile Spacing 1.5 metres

Working Load per Pile = 7.7 kN (each side of single span)
and = 15.3 kN (if multiple spans)
Maximum BM in Beam 3.6 kN-m (wl^2/8)

**REINFORCED CONCRETE DESIGN**

Depth (Thickness) = 200 mm
Width = 300 mm
d = 100 mm

Bar Diameter = 12 mm
Spacing = 150 mm

Number of bars = 2
As = 226.2
Yield = 300 MPa
f'c = 20 MPa
As x fy = 67858 N
a = 13.3 mm

Mu = 5.4 kN-m

Balance Conditions Check
Balance Steel ratio = 0.032111
75 % of Balance = 0.024083
Actual Steel Ratio = 0.00754
Hence: OK

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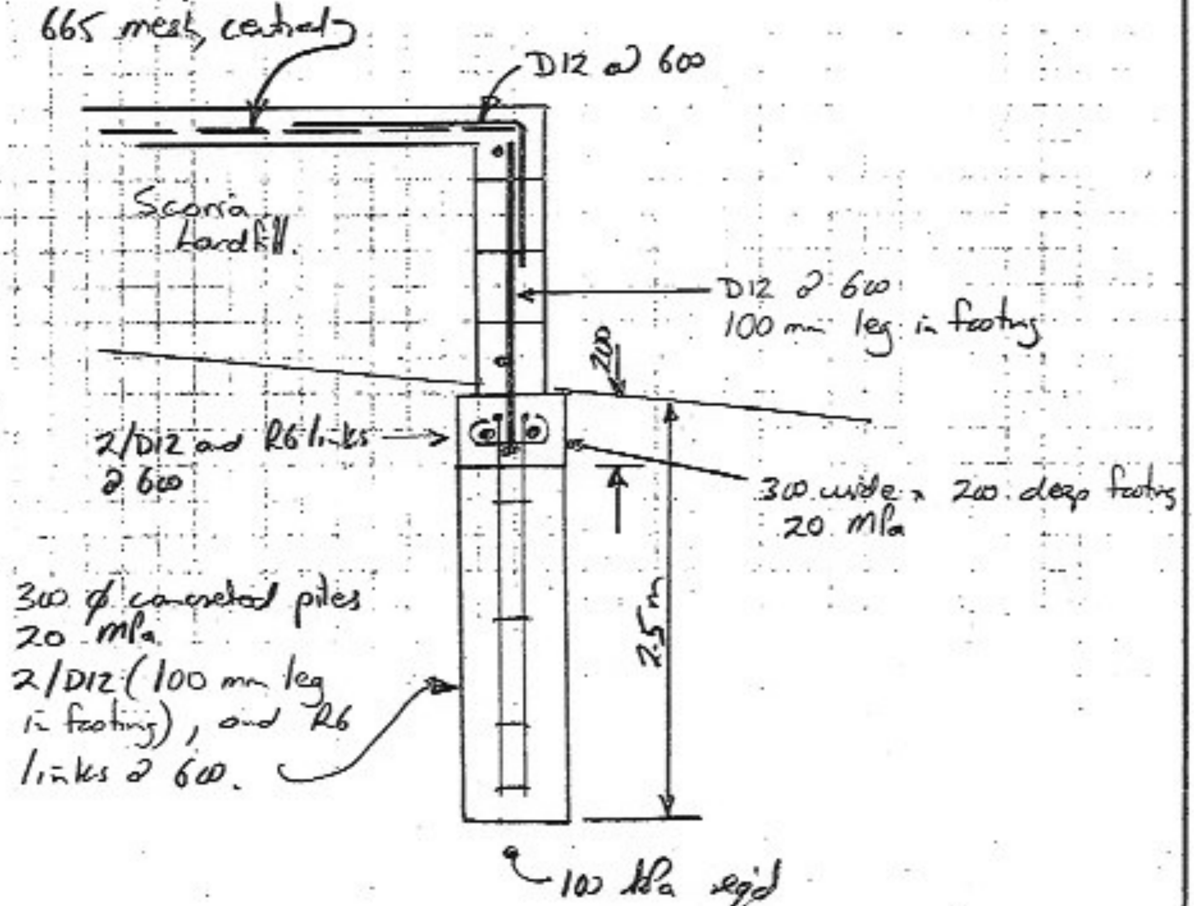
⇒ Use 300 wide x 200 deep footing
Reinforce with 2/D12 bars

Support on 300 mm dia piles @ 1.5 m crs

⇒ Refer sketch below and on page 8.

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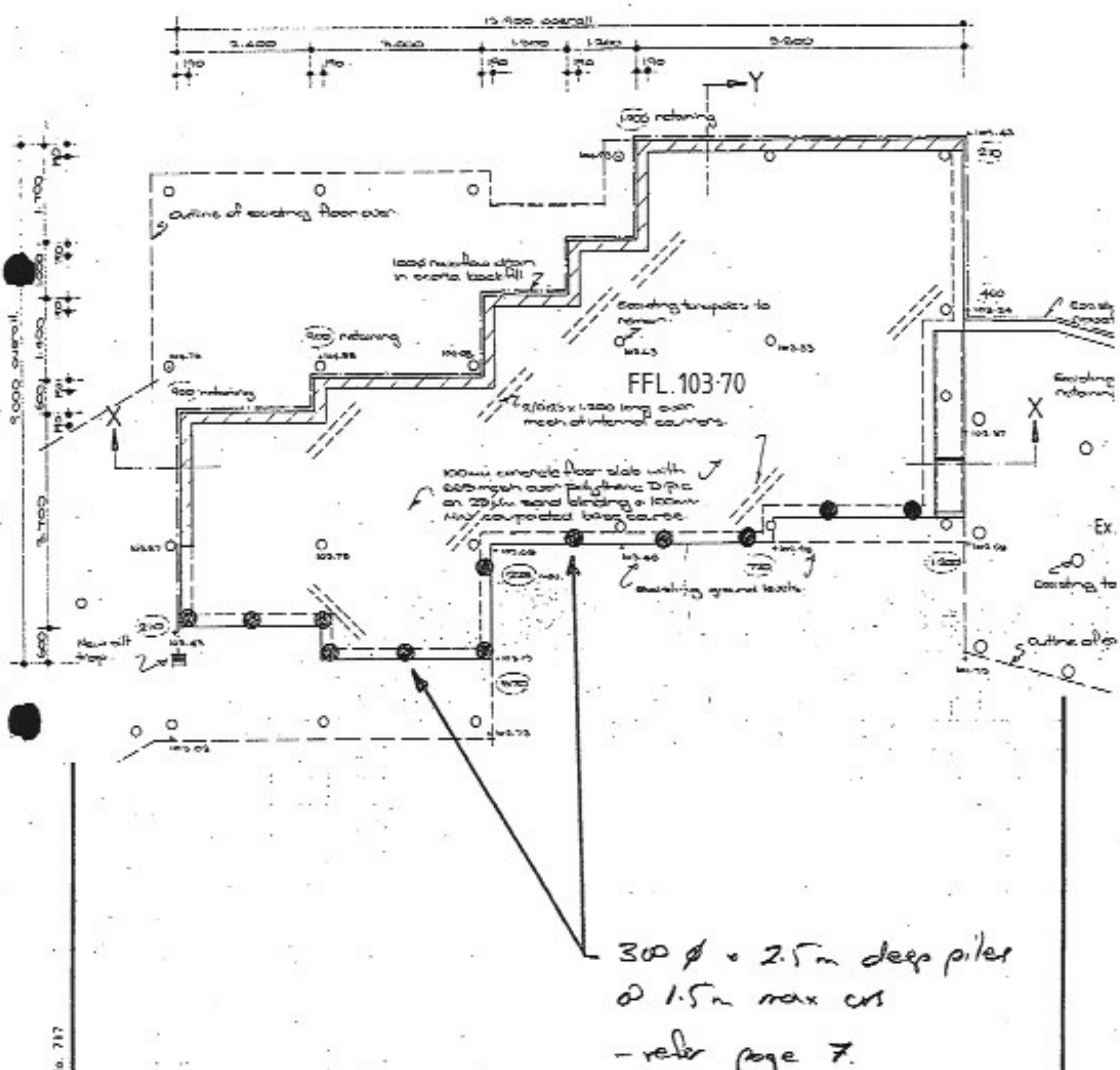


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Civil and Structural Engineering

Dr. H.D.W. FENDALL Director
B.E. (Civil) Hons., Ph.D, M.IPENZ
R.N. McLEAN Director
B.E. (Civil) Hons., M.IPENZ

6A Montel Avenue,
Henderson,
AUCKLAND, 8.
Ph. & Fax 09-836-1853

Ref: 99121
18 June 1999

Mr & Mrs J & J. Davidson,
1 Landing Road,
Laingholm,
WAITAKERE CITY.

Dear Sir & Madam,

**PROPOSED NEW GARAGE , DECK ADDITIONS &**
**DRIVEWAY RETAINING WALL**
**AT 1 LANDING ROAD, LAINGHOLM**

**GEOTECHNICAL APPRAISAL**

## 1. INTRODUCTION

As requested, we have carried out a Geotechnical Appraisal Report at the above site in order to ascertain the ground conditions at the proposed garage, retaining wall and deck locations, and thereby determine if the building areas are sufficiently stable for the proposed development. Our investigations were aimed at determining what, if any, soil stabilisation measures are required, and also to determine appropriate foundation types and depths for the proposed structures.

It is concluded that the building areas are sufficiently stable for the proposed developments provided that the recommendations contained in Section 5 herein are implemented. These recommendations include subsoil and surface drainage measures, and the requirement for deep pile foundations specifically designed to resist lateral pressures resulting from the downhill creep of the near surface soils.

Please note that this report only considers the issues of soil strength and stability issues in relation to the proposed structures and not to any other aspect of the proposed development nor any issues relating to the existing dwelling.

## 2. SITE DESCRIPTION

### 2.1 GENERAL

The legal description of the property is Lot 2, DP 140604 and it is located to the south of the intersection of Laingholm Drive and Landing Road. Vehicle access to the site is via a common accessway off Laingholm Drive approximately 85 metres to the north-east of Landing Road. The property has a irregular shape with an area of 3,298 square metres and a road frontage to Laingholm Drive of 74.1 metres.

The existing dwelling is located near the centre of the property while the proposed new garage will be located towards the north-west as indicated on Drawing 1 attached. New deck areas are also proposed to the south of the dwelling as shown.

The ground surface in the vicinity is characterised by a large east-west trending ridge to the south of the site. The site is located at the north-western end of a broad crested side spur extending off the main ridge. The spur falls down towards the north with average ground gradient of around 15 - 20 degrees although some steeper areas are present.

Most of the slopes have a uniform, stable appearance although past slumping of the road cutting along the eastern side of Laingholm Drive is apparent. In addition, down hill soil creep in the form of curved and leaning trunks of the vegetation is apparent on most of the moderate to steeper sloped areas.

To the north and west of the proposed garage location are fill batter slopes which fall down away from the garage at about 30 degrees. The natural slopes below are typically 20 degrees although about 13 metres to the west of the garage is a road cutting which slopes at about 45 degrees over a vertical height of about 6 metres. Around 5 – 10 metres to the south of the garage is an apparent old slump that extends up towards the driveway. This slump was presumably a result of the road cutting below.

### 2.2 GEOLOGY

The New Zealand Industrial Series Geological Map for the Cornwallis Area (Sheet N 42/7 - 1:25,000 scale), indicates that the proposed building area is underlain by a residual soil ($sz_3$) which has been derived from in-situ weathering of the underlying Waitemata Formation rocks. The soils are described as greyish white to yellowish brown, soft to very stiff, clays and silts which grade down into the underlying sandstones and mudstones within around 8 metres of the ground surface. The underlying Waitemata Formation sandstones and mudstones were laid down in a sea floor environment during the early Miocene Period (around 19 - 24 million years ago). Subsequent uplifting has occurred and the normal forces of erosion have produced the topography now evident.

The clays and silts derived from in-situ weathering of the Waitemata Formation normally have a safe allowable bearing capacity of at least 100 kPa for the support of standard, shallow dwelling foundations. However, the near surface clays in particular can be subject to significant shrinkage and swelling movements as a result of seasonal moisture content variations. This can detrimentally affect standard shallow (about 450 mm deep) footings and can result in cracking of brittle veneers, etc.

In addition, downhill creep of the near surface soils can occur on slopes greater than around 15 - 20 degrees and slumping can occur on slopes greater than around 20 degrees, depending upon groundwater conditions, vegetative cover, etc.

On steeper slopes such as this, adequate protection must be provided against the risk of soil slumping, and pile foundations that are specifically designed to resist lateral pressures caused by downhill soil creep must be utilised.

## 3. INVESTIGATIONS

Our investigations to ascertain the soil strength and stability in the vicinity of the proposed garage, driveway retaining wall and southern deck included a visual appraisal of the property and surrounding areas, the surveying of three cross-sections through the proposed building areas, and the drilling of three boreholes each to a depth of 3.5 metres. Shear vane measurements of "undrained" soil strengths were undertaken at approximately 0.5 metre intervals within the boreholes using a Geonor hand shear vane.

The locations of the boreholes and cross-sections are indicated on Drawing 1 attached and the survey cross-sections are plotted on Drawings 2, 3 and 4. The Borelog Records which include the shear vane strength results are also included herewith following the drawings.

Fill material comprising mainly silty clays and some clayey silts was initially encountered in boreholes 1 & 3 and extended to 0.8 metres and 0.9 metres depth respectively.

The natural soils within all three holes initially comprised mainly grey & orange with some brown colouration, clayey silts and silty clays, and these materials extended to 2, 3.5 & 2.5 metres depth in Boreholes 1, 2 and 3 respectively. Underneath these layers in all three Boreholes, firm to stiff silts were encountered and it is inferred that these latter materials are transitioning into the less weathered underlying rocks.

The watertable was noted to be at 0.9 metres depth in Borehole 1, and 3.1 metres in Borehole 3 at the time of drilling. The fill material in particular was moist to wet due to extended wet weather.

The peak shear strength measured within the fill ranged between 44 to 66 kPa, while the remolded strength ranging between 26 and 40 kPa.

The weathered silty clays and clayey silts were reasonably firm with the peak shear strengths typically ranging between 116 and 188 kPa, and the remolded strengths ranging between 48 and 100 kPa. The deeper silts encountered within all three Boreholes were noticeably stronger with the peak strengths measured being 228 kPa or greater and the remolded strengths being 56 kPa and 126 kPa.

In general, the soil sensitivity (ratio of peak shear strength to remolded shear strength) was reasonably low, being mostly between about 1.4 and 2.7 with one high value of 4.29. This indicates that the soils do not unduly lose strength upon shearing.

## 4. DISCUSSION

### 4.1 GARAGE

#### A) Fill Stability

The existing ground slope (fill surface) within the southern half of the proposed garage building area is quite gently being about 5 - 6 degrees. However, within the northern portion and immediately to the west are fill batter slopes which slope at up to about 30 degrees over a vertical height of around 1.5 metres. Based on our test boreholes and cross-section surveys it is inferred that the natural ground surface slopes in the immediate vicinity slopes at typically 15 to 20 degrees – refer cross-sections A-A and B-B.

When placing fill on a slope, it is essential that all topsoil be first removed, and that slopes greater than around 10 degrees are "benched" prior to commencement of filling - to help ensure the stability of the fill. It is considered unlikely that this work was carried out in this case and therefore it must be concluded that the existing fill is at risk of downhill creep and / or slumping. Hence, it is recommended that sufficient fill is removed to ensure a maximum fill depth of 0.5 metres, and that the proposed garage be constructed with a suspended floor system supported on deep pile foundations.

#### B) Overall Slope Stability

Even though removal of the fill will take some weight off the slopes below, the slopes must still be considered to be potentially unstable with respect to the steep road cutting to the west. To ascertain the slope stability safety factors and thereby determine if any stabilisation measures are required, a slope stability analysis has been carried out using the computer programme UTEXAS2. The computer model is shown on Drawing 5 on which is indicated the assumed effective stress soil strength parameters.

Although the watertable was encountered at 0.9 metres to 3.1 metres within our test boreholes, a significant rise in groundwater level is likely to occur during wetter, winter conditions - particularly in view of the extensive slopes uphill of the site. Hence, the groundwater table was initially taken to be at the ground surface for the analysis.

A selection of the slip circles analyses are shown on Drawing 5 so as to demonstrate the safety factor trends. In general, the smaller slip circles encompassing material near the road cutting have the smaller safety factors, while the stability gradually increases as the larger slip circles encompass more and more of the gentler slopes.

The table overleaf summarises the results for the slip circles shown on the diagram and shows the effect of lowering the ground water table. Note that circles with a radius of 23 metres or more extend into the proposed garage building area.

| SLOPE STABILITY ANALYSIS | | | | |
|---|---|---|---|---|
| CIRCLE RADIUS (Refer Drawing 5) | SAFETY FACTORS FOR WATER TABLE DEPTHS OF | | | |
| | 0 (Surface) | 1 metre | 2 metres | 3 metres |
| 10 | 0.81 | 1.07 | 1.30 | 1.50 |
| 15 | 0.85 | 1.12 | 1.35 | 1.56 |
| 20 | 0.86 | 1.12 | 1.36 | 1.57 |
| 25 | 0.89 | 1.14 | 1.36 | 1.57 |

As can be seen, the safety factors do not vary significantly with the size of the circle but are markedly changed by lowering the ground water level. The NZ Building Act Approved Documents specify a minimum safety factor of 1.5 and hence it is clear that the water table must be maintained below a depth of 3 metres.

The option of utilising a soldier pile retaining wall or similar is not considered appropriate in this case due to the depth of the potential slip circles.

It is considered that the deeper silty soils are likely to be reasonably porous. Hence, a system of horizontal drainage bores should be able to provide sufficient reduction in ground water levels when combined with surface water drainage measures. The bores would comprise 32 mm diameter slotted uPVC pipes wrapped in filter cloth which are inserted into 40 mm diameter holes bored into the face of the road cutting. As indicated on drawings 1 and 2, nine bores each 20 metres long are recommended.

**C) Soil Bearing Capacity**

The fill material within the proposed garage area is of soft to moderate strength and is not suitable to support any loads from the proposed structure. Hence all foundations will have to be taken down and founded within the firm, natural soils beneath.

Potential downhill creep of the fill may still occur although the resulting forces on the piles will not be significant provided that the fill is reduced to a depth not greater than 0.5 metres as outlined in Section 4.1A above.

Downfill creep of the upper, more clayey, natural soils could also occur and it is considered necessary that deep pile foundations be utilised – particularly around the outer edges of the garage. It is considered that the piles must be specifically designed to resist the lateral soil pressures that could be developed by the downhill creep of the upper 1.5 metres of soil depth. These pressures should be assessed using an "at-rest" soil pressure co-efficient ($K_0$ of 0.75) together with an effective width of three times the pile diameter. Subject to the specific design calculations, a pile depth of at least 3.5 metres should be adopted for the piles along the north-eastern and north-western sides of the garage.

The natural soils were noted to be reasonably firm throughout, with a minimum peak shear strength of 100 kPa measured within the upper clays and a minimum of 200 kPa within the stiff silts below a depth of about 2 – 2.5 metres. Hence, it is considered that the following soil bearing pressures can be utilised for foundation design:

| ITEM | Safe Allowable Soil Bearing Pressure For Unfactored Loads | Allowable Soil Bearing Pressure For Ultimate Limit State Loads |
|---|---|---|
| Shallow Footings (minimum 450 mm deep into natural soils). | 100 | 150 |
| Piles (at least 2 metres into natural soils). | 150 | 200 |

Note that these bearing pressures and embedment depths apply to the natural soils only.

The existing fill is also not considered suitable for the support of "slab-on-grade" floors, and hence a suspended floor system will be required for the garage.

## 4.2 DRIVEWAY RETAINING WALL

It is proposed to retain the outer (north-western) side of the driveway as it approaches the proposed garage. Cross-section C-C and Borehole 3 reveal the soils in this vicinity to comprise:

- up to about 1 metre of existing fill, overlying
- 1.5 metres of moderate strength clays, then
- firm to stiff silts.

Down hill creep or slumping of the clay soils cannot be ruled out and hence these cannot be relied upon to provide long term support to a retaining wall. Hence, the proposed pole retaining wall will have to be designed for an effective retained height of 2 metres of the existing soils plus the depth of any proposed additional fill.

Specific design of the wall will be required, and it is considered that a safe allowable lateral soil pressure of 100 kPa can be adopted for piles extending into the firm silts.

## 4.3 PROPOSED DECK TO SOUTH OF DWELLING

As shown on the drawings prepared by Mr M. Saunders, it is proposed to construct a new timber deck to the south of the dwelling. This area is well clear of the steeper slopes down to the road with the natural surface gradients being around 15 – 20 degrees.

The dwelling location was the subject of a Geotechnical Appraisal report by Ormiston Associates Ltd in March 1997 (Reference 388/503). This report indicated that the then proposed site was suitable for the dwelling provided a number of recommendations regarding foundation types and depths etc were implemented.

It is our opinion that the previous report is applicable to the proposed deck area and that the deck can be constructed at the intended location provided that it is supported on piles which extend to a depth of at least 2 metres below the ground surface. Note that this depth may be reduced within excavated areas provided that:

- The piles extend to a depth of at least 2 metres below the original ground surface, and
- A minimum pile depth of 1 metre is achieved.

## 5. SUMMARY AND RECOMMENDATIONS

Outlined above are our findings regarding the soil strength and stability which have been based on a visual assessment of the property together with the survey and subsoil investigations. As a result, it is our professional opinion, not to be construed as a guarantee, that the site is sufficiently stable for the proposed garage, driveway retaining wall and deck. This conclusion is based on the assumption that the following recommendations will be implemented:

A. The proposed items must be located as shown on Drawing 1 attached, and must be constructed in accordance with the plans provided to us by Mr M. Saunders.

Note however, that the foundations must be constructed as recommended by this report.

B. To ensure that the proposed garage and driveway areas have a long term slope stability safety factor in excess of 1.5 as required by the NZ Building Act Approved Documents;

- a system of drainage nine, 20 metre long drainage bores must be installed as outlined on drawings 1 and 2.
- sufficient of the existing fill within the garage area must be removed to limit it depth to 0.5 metres.

C. All structural loads from the proposed garage must be taken down and founded within the firm, natural soils beneath the fill. A suspended floor system will also be required.

Specific foundation design by a Registered Engineer experienced in Geomechanics and familiar with the site and this report will be required.

D. The proposed driveway retaining wall can be constructed a maximum of 1 metre beyond the outer edge of the existing drive provided it is specifically designed in accordance with the recommendations of this report.

E. The proposed deck to the south of the dwelling must be supported on piles constructed in accordance with the recommendations herein.

F. Note that normal inspection of the soils at the base of all excavated foundation holes must be undertaken prior to the placing of concrete to ensure that sufficient depth has been achieved and that sufficient soil bearing capacity is available.

G. Point discharges of stormwater onto the ground surface adjacent to any structure could soften the soils and result in foundation problems. Hence, all runoff from roofed and paved areas must be collected and piped directly to the road water table.

H. Any earthworks on the property involving filling or excavation over 0.5 metres in depth must only be carried out on the advice of a Registered Engineer experienced in Geomechanics who can ensure that the existing stability of the building site would not be compromised.

## 6. LIMITATIONS

This Report has been prepared for the purpose of assessing the ground strength and stability at the proposed building site, so as to determine any required soil stabilisation measures and appropriate foundation types / depths. The Report shall not be relied upon for any other purpose.

Recommendations and opinions contained in this report are based upon data from auger holes put down during these investigations. The nature and continuity of subsoil conditions away from the boreholes are inferred and it must be appreciated that actual conditions could vary considerably from the assumed model.

Erosion of steep slopes by soil creep movements and surface slumping is an on-going phenomenon. Therefore the erection of any building above a reasonably steep slope will always be subject to some degree of risk.

Provided the above recommendations are implemented, we would consider that this risk is acceptable in terms of the erection of the proposed garage and other items. However, it must be accepted that the value of the property will be reduced in the event of any significant soil failure, even if this occurs outside the proposed building areas.

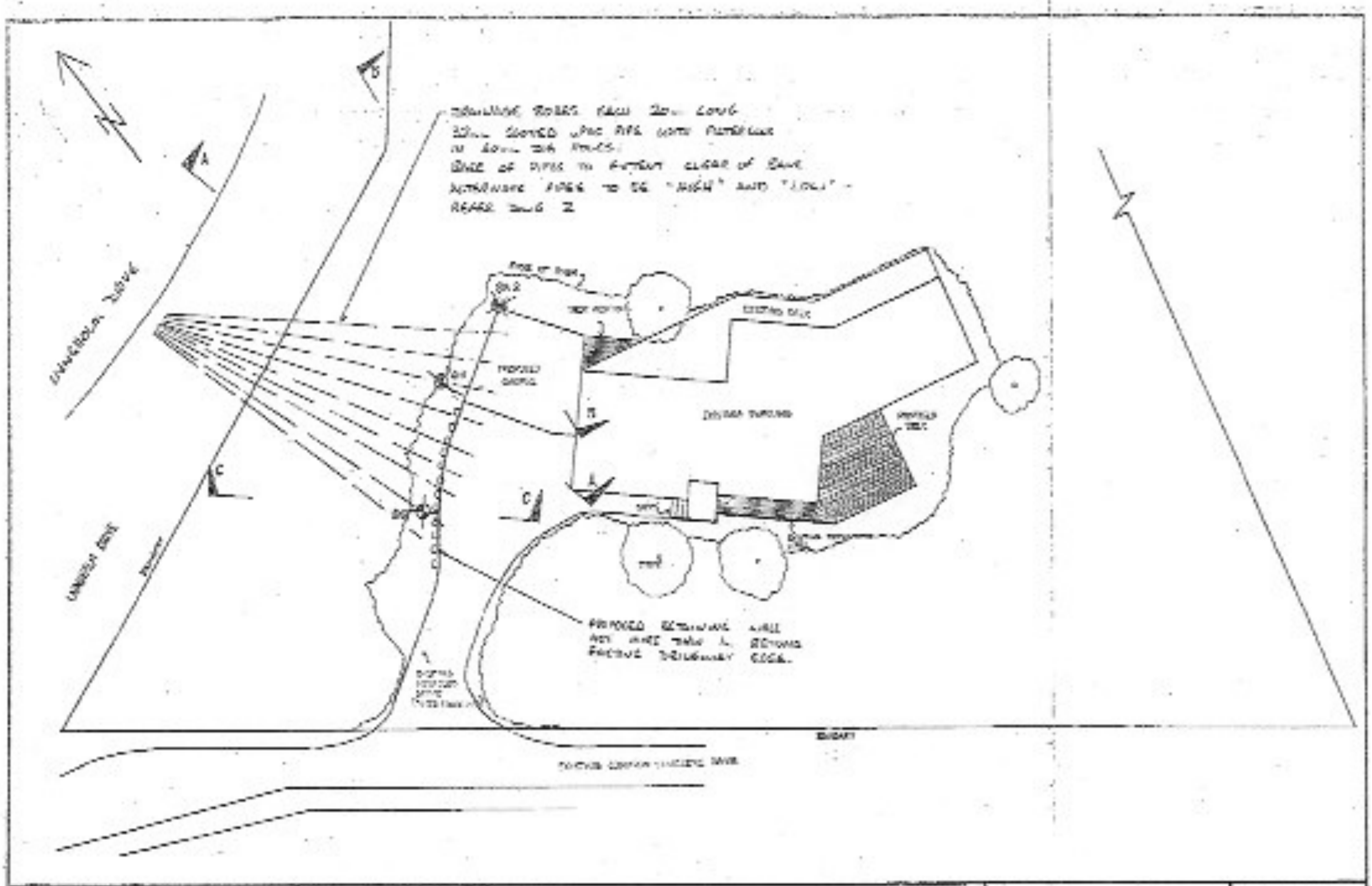
During excavation and construction the site should be examined by an Engineer or Engineering Geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based upon this Report.

This report has been prepared solely for the benefit of Mr and Mrs Davidson as our client with respect to the brief, and for the Local Territorial Authority to assess compliance with the Building Act. The reliance by other parties on the information or opinions contained in the Report shall, without our prior review and agreement in writing, be at such parties sole risk.

Yours faithfully,

Hew Fendall

Dr H.D.W. Fendall
Director
HUGH FENDALL CONSULTANTS LIMITED



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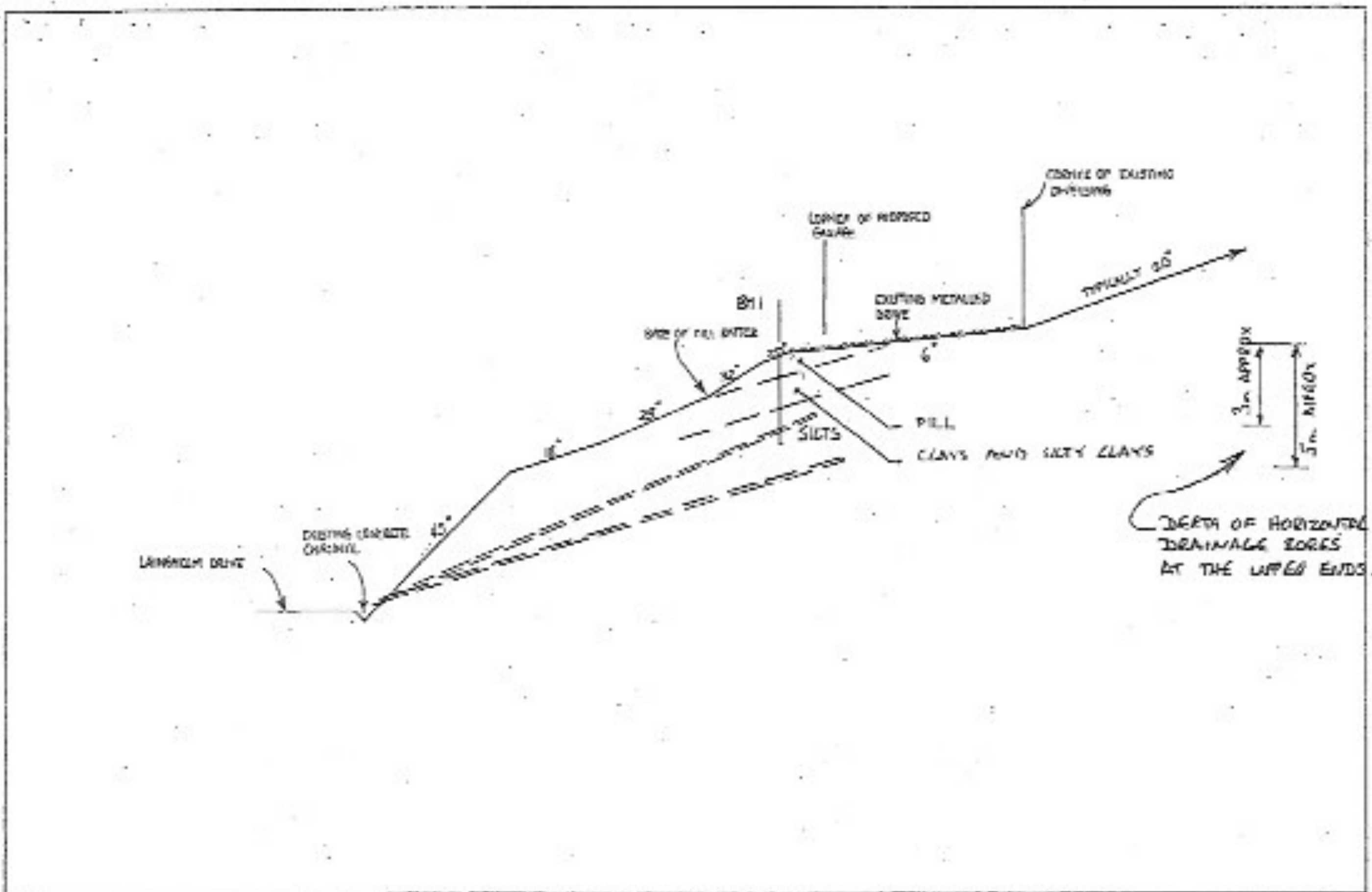
|---|---|---|---|
| | | DRAWN | DATE | SHEET 1 OF |

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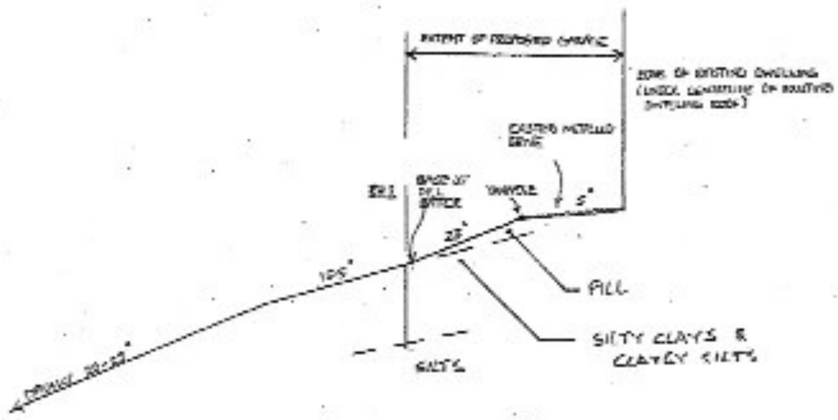
| [illegible] Avenue, Henderson, AUCKLAND | CROSS SECTION A-A | DRAWN [illegible] \| DATE [illegible] | SHEET 2 OF 5 |

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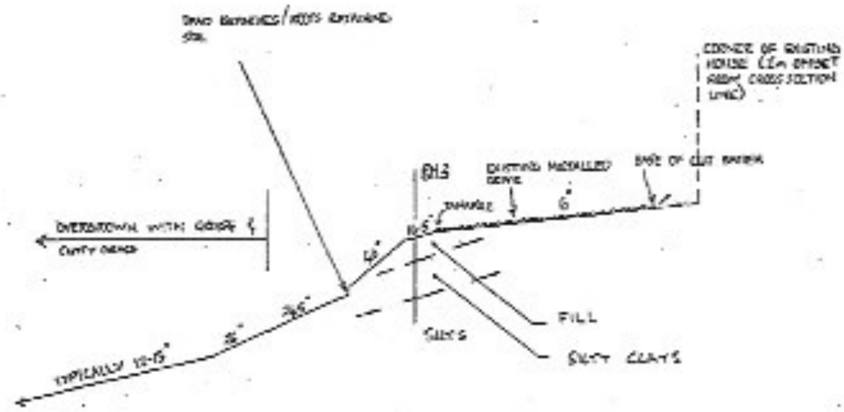


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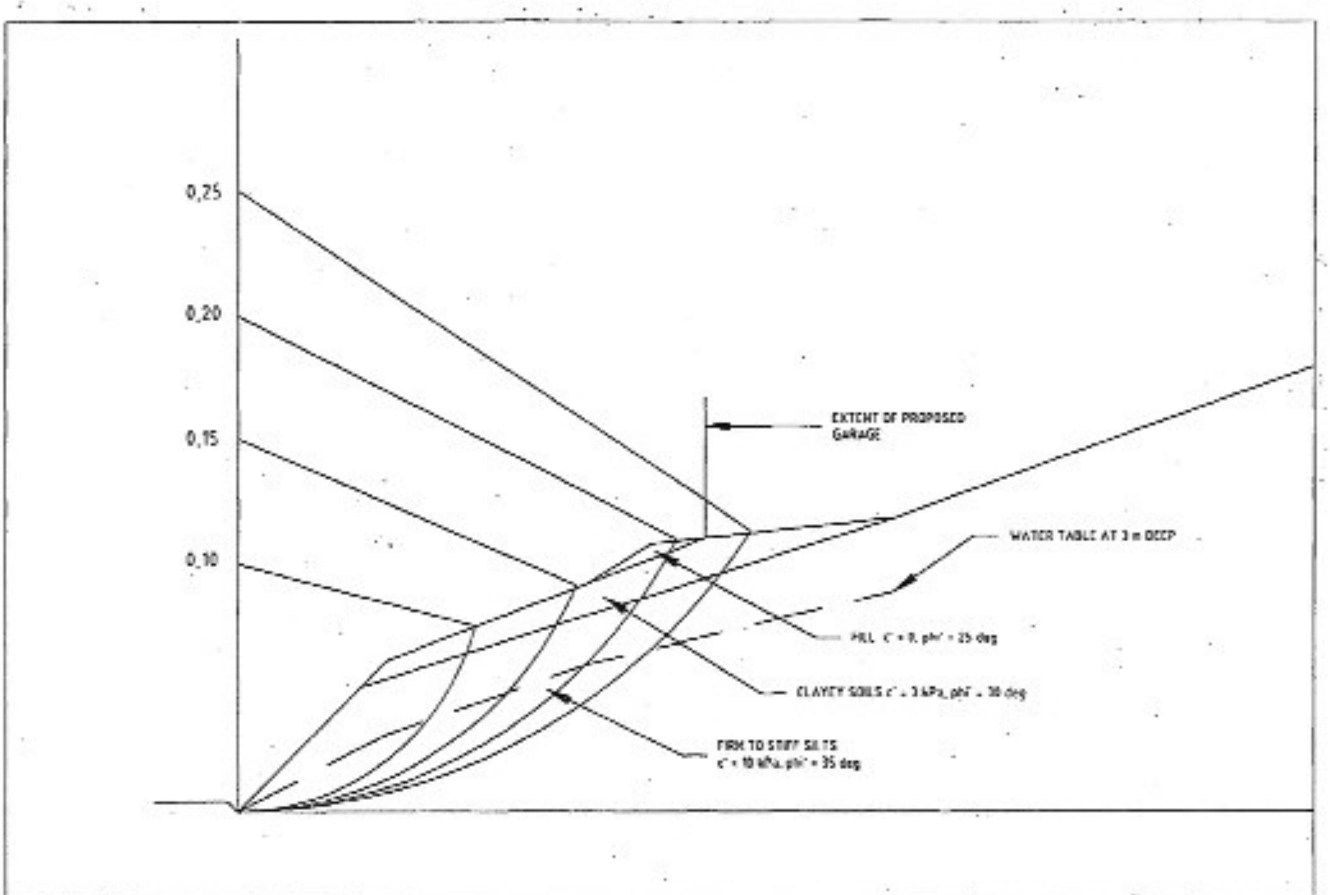
| HUGH FENDALL CONSULTANTS LTD<br>Civil and Structural Engineering | MR & MRS J + J DAVIDSON , 1 LANDING ROAD , LAINGHOLM | SCALES 1:200 | | PROJECT |
| 5A Nortel Avenue, Henderson, AUCKLAND | CROSS SECTION C-C | DRAWN | DATE 15/6/99 | SHEET 4 OF 5 |

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| Civil and Structural Engineering<br>6A Montel Avenue, Henderson ph 836-1853 | SLOPE STABILITY ANALYSIS | Drawn HDWF Date 17/6 | Sheet 5 of 5 |

# HUGH FENDALL CONSULTANTS LTD

## BORELOG RECORD

**CLIENT:** Mr & Mrs J & J Davidson, 1 Landing Road, Laingholm
**DRILLED BY:** Aveen Singh
**COMMENTS:** Rainy day

**REFERENCE NO:** 99122
**BOREHOLE NO:** 1
**DRILLED DATE:** 14 /6 /99

| Depth (m) | SOIL DESCRIPTION | Soil Graph | WL | GEONOR SHEAR VANE STRENGTHS (kPa) 0 50 100 150 200 | S |
|---|---|---|---|---|---|
| | FILL-dark brown Silty Clay with grass roots. Soft, Wet, Plastic | | | | |
| 0.5 | | | | 40 ○ ☆ 68 | 1.70 |
| 0.8 | Dark greyish Silty CLAY with light yellow mottling. Firm, Moist/wet, Plastic | | ▽ | 0.9m | |
| 1.0 | Orange & grey Silty CLAY. Firm, Moist, Plastic | | | ○ 68 116 | 1.71 |
| | Orange & grey slightly Clayey SILT with rusty brown mottling. Firm, Wet, Friable/Slightly plastic | | | | |
| 1.5 | | | | ○ 62 100 | 1.47 |
| 2.0 | | | | ○ 100 240+ | |
| | Light greyish brown SILT with light orange mottling. Dark brown mottling appearing @ 2.3m, Firm, Moist, Friable | | | | |
| 2.5 | Light greyish SILT with rusty orange & brown mottling. Firm, Moist, Friable | | | ○ 56 240 | 4.29 |
| 3.0 | Reddish mottling appeAring @ 2.9m | | | | UTP |
| | Light yellowish orange mottling appearing @ 3.2m<br>Reddish brown & black mottling @ 3.4m | | | | |
| 3.5 | | | | | UTP |
| | End of Bore = 3.5m | | | | |
| 4.0 | | | | | |

**S** = Soil Sensitivity (Ratio of Peak Strength to Remolded Strength)
☆ = Peak Shear Strength
○ = Remolded Shear Strength
**UTP** = Unable to Penetrate Vane
**UTA** = Unable to Auger
**WL** = Ground Water Level

# HUGH FENDALL CONSULTANTS LTD
## BORELOG RECORD

**CLIENT:** Mr & Mrs J & J Davidson, 1 Landing Road, Laingholm
**DRILLED BY:** Aveen Singh
**COMMENTS:** Rainy day

**REFERENCE NO:** 99122
**BOREHOLE NO:** 2
**DRILLED DATE:** 14 /6 /99

| Depth (m) | SOIL DESCRIPTION |
|---|---|
| | TOPSOIL- Firm, Moist, Slightly friable |
| | Light greyish & light orange Silty CLAY with rusty orange speckling. Firm, Moist, Plastic |
| 0.5 | Increase in Silt content @ 0.5m |
| | Light greyish brown SILT with rusty orange speckling. Firm, Moist, Friable |
| 1.0 | Firm, Dry Friable below 1.0m |
| | Light greyish mottling appearing @ 1.4m |
| 1.5 | Light greyish Clayey SILT with orange mottling & speckling. Firm, Moist, Friable/Slightly plastic |
| 2.0 | 1-2mm white stones appearing @ 2.2m |
| 2.5 | Dark orange Clayey SILT with light grey speckling. Firm, Moist, Friable/Slightly plastic |
| | Light greyish brown Clayey SILT with rusty brown mottling & speckling. Firm, Moist, Friable/Slightly plastic |
| 3.0 | Light greyish Clayey SILT with rusty orange mottling & speckling. Firm, Moist, Friable |
| | Dark rusty brown SILT with black mottling. Firm, Dry Friable |
| 3.5 | Light greyish brown SILT with orange mottling. Firm, Moist, Friable |
| | End of Bore = 3.5m |
| 4.0 | |

GEONOR SHEAR VANE STRENGTHS (kPa)

| Depth (m) | Remolded | Peak | S |
|---|---|---|---|
| 0.5 | 110 | 154 | 1.40 |
| 1.0 | | | UTP |
| 1.5 | 76 | 174 | 2.29 |
| 2.0 | 68 | 184 | 2.71 |
| 2.5 | 100 | 188 | 1.88 |
| 3.0 | 96 | 182 | 1.90 |
| 3.5 | | | UTP |

**S** = Soil Sensitivity (Ratio of Peak Strength to Remolded Strength)
☆ = Peak Shear Strength
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**UTP** = Unable to Penetrate Vane
**UTA** = Unable to Auger
**WL** = Ground Water Level

# HUGH FENDALL CONSULTANTS LTD

## BORELOG RECORD

**CLIENT:** Mr & Mrs J & J Davidson, 1 Landing Road, Laingholm
**DRILLED BY:** Aveeri Singh
**COMMENTS:** Rainy day

**REFERENCE NO:** 99122
**BOREHOLE NO:** 3
**DRILLED DATE:** 14 /6 /99

| Depth (m) | SOIL DESCRIPTION | Soil Graph | WL | GEONOR SHEAR VANE STRENGTHS (kPa) 0 50 100 150 200 | S |
|---|---|---|---|---|---|
| | FILL- mixture of dark brown & orange Silty Clay. Firm, Moist, Plastic | | | | |
| 0.5 | FILL- dark greyish slightly Clayey Silt with orange mottling. Soft, Wet, Friable between 0.4 -0.9m | | | 26 ○ ☆ 44 | 1.59 |
| 0.9 / 1.0 | Light greyish brown Silty CLAY with orange mottling & speckling. Moderate-firm, Moist, Plastic. Firm, Moist, Plastic below 1.2m | | | 72 ○ 116 | 1.61 |
| 1.5 | Increase in Silt content @ 1.4m | | | ○ 70 126 | 1.80 |
| | Light greyish brown slightly Clayey SILT with orange mottling & speckling. Firm, Moist, Friable | | | | |
| 2.0 | Light blue mottling appearing @ 1.9m | | | 48 ○ 114 | 2.38 |
| | Lots of rusty brown mottling @ 2.2m | | | | |
| 2.5 | | | | | UTP |
| | Dark rusty brown SILT. Firm, Moist, Friable | | | | |
| 3.0 | Light greyish SILT with orange mottling & speckling. Firm, Moist, Friable | | ▽ 3.1m | 84 ○ 228 | 2.71 |
| 3.5 | Dark greyish slightly Clayey SILT. Firm, Wet, Friable | | | 126 ○ 240 ☆ | 1.90 |
| | End of Bore = 3.5m | | | | |
| 4.0 | | | | | |

**S** = Soil Sensitivity (Ratio of Peak Strength to Remolded Strength)
☆ = Peak Shear Strength
○ = Remolded Shear Strength
**UTP** = Unable to Penetrate Vane
**UTA** = Unable to Auger
**WL** = Ground Water Level

ORMISTON ASSOCIATES LTD
CONSULTANTS IN GEOTECHNICAL ENGINEERING, GEOLOGY & ENGINEERING GEOLOGY
54 Ponsonby Road Ponsonby PO Box 47-822 Ponsonby
Auckland 1 New Zealand
Telephone 09-378 1081 Facsimile 09-378 9834

Your Ref:

Our Ref: 388/503

# FOUNDATION INVESTIGATION
# FOR PROPOSED HOUSE
# AT
# 1 LANDING ROAD, LAINGHOLM
# FOR
# MADDREN HOMES

**For: Maddren Homes**
**P O Box 244**
**Kumeu**
**AUCKLAND**

**By: Ormiston Associates Ltd**
**P.O. Box 47-822**
**Ponsonby**

**Date: March 1997**

A.W. Ormiston BSc (Geol.) MSc (Eng Geol.) M.Aus.I.M.M.
L. G. Dooley B.E.(Hons)(Civil), N.Z.C.E, M.IPENZ. Reg Eng.

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Telephone 09-378 1081 Facsimile 09-378 9834

Your Ref:

Our Ref: 388/503

12 March 1997

Maddren Homes
P O Box 244
KUMEU

Attention: Lois Green

Dear Madam,

**FOUNDATION INVESTIGATION FOR PROPOSED HOUSE AT 1 LANDING ROAD, LAINGHOLM**

## 1. Introduction

As requested by Lois Green of Maddren Homes, we have undertaken a foundation investigation at the above address for a proposed residential dwelling to be constructed at the property.

Our brief was to:

(i) Assess subsoil conditions at the property.

(ii) Assess site stability and provide recommendations on site stabilisation measures if required.

(iii) Provide recommendations on foundation depths and provide foundation design parameters.

The findings presented in this report will be used to support a Building Consent application to the Waitakere City Council.

## 2. Previous Reports

An investigation has been previously undertaken on Lot 2 as part of an investigation for the Rudolf Steiner School. The investigation and reporting was undertaken by Works Consultancy

A.W. Ormiston BSc (Geol.) MSc (Eng Geol.) M.Aus.I.M.M.
L. G. Dooley B.E.(Hons)(Civil), N.Z.C.E, M.IPENZ, Reg Eng

Services and their report is entitled "Proposed Subdivision, Landing Road, Laingholm, Lots 1 to 4 for Steiner School - Geotechnical Investigations." dated 1990, Ref: unknown. This report provided the location of a recommended building platform on relatively gently sloping ground adjacent to Landing Road. The report also recommended specific design of foundations.

## 3. Site Description

The property is legally described as Lot 2, DP 140604, with an approximate area of 3298m2. The property is located on the southern side of Landing Road and at the time of our investigation was covered in bush. From the northern boundary at Landing Road, the ground slopes up to the southern boundary at angles varying from 10 ° to 16° adjacent to Landing Road, increasing to 21° at the location of the proposed building platform. A concrete right of way is located immediately above the southern boundary providing access to several properties above the subject site.

At the time of our investigation there were no obvious signs of recent, major deep seated instability or signs of relic instability observed on the subject property, however, we did observe soil creep on the steeper slopes at the property at the location of the proposed building platform. Soil creep is the slow, downslope movement generally within the upper 0.5m to 1.0m of the ground surface and is noticeable on ground slopes generally greater than 15°. Vegetation on slopes assists in the retention of the upper site soils. Foundations can be designed to accommodate soil creep loads.

## 4. Geology

Reference has been made to the Geological Map of New Zealand, Sheets R11, Scale 1:50,000 dated 1992 which indicates that the site is underlain by weathered residual soils of the Waitemata Group. These soils are derived from weathering of the parent sedimentary sandstones and siltstones to form a mantle of residual soils typically comprising firm to very stiff clays, silts and sands of variable plasticity. These soils are prone to shrinkage in the summer when the ground-water tables are low and also prone to swelling in winter when the groundwater tables are high.

On steeper slopes the residual soils are prone to a translational failure mode when they become saturated. Generally movement of the residual soils often occurs at the contact between the weaker soil mantle and the underlying harder material. Instability can also be associated with the perching of the groundwater table above the contact with the hard, less-weathered materials. The occurrence of deep-seated failures within the underlying sandstones and siltstones is relatively uncommon, however this is dependent on slope geometry, bedding plane angles, faults and groundwater levels.

The presence of the residual soils of the Waitemata Group was confirmed at the site during our investigation.

## 5. Site Investigations

Investigations at the site comprised a walkover inspection and the drilling of 4 hand augered boreholes, BH1 to BH4 to depths of 5.0m below the existing ground level. In-situ undrained shear strength testing was undertaken in each borehole at intervals of depth to obtain a strength profile. The undrained shear strength values given on the boreholes logs are corrected dial readings off the Pilcon hand held shear vane. In addition, Scala Penetrometer testing was undertaken from the base of the boreholes BH1 to BH4 in order to assess soil strengths at depth. . The boreholes were drilled by R & G Soil Search on our behalf and under our direction. The measurements of the groundwater table were undertaken in each borehole, with all boreholes dry. A tape and clinometer survey was undertaken at the site to locate the boreholes and to obtain a cross-section through the site. It should be noted that these are approximate survey methods only and that the existing site features shown are approximate only.

The locations of the boreholes and proposed house are shown on the attached Site Plan Drawing No. 388/503-1

## 6. Subsoil Conditions

The subsoil conditions encountered at the locations of the boreholes are summarised below and are shown on Cross-Section A-A on Drawing No 388/503-2. A full description of the site soils is shown on the attached boreholes logs. Subsurface conditions have been extrapolated between the boreholes and opinions and recommendations are based on this assumption however, even though such inference is made no guarantee can be made as to the validity of such inferences or assumptions due to the inherent variability of natural soil deposits, consequently, variations between the boreholes may exist and may vary away from our cross-section.

The soil descriptions provided on the borehole logs are generally in accordance with the descriptions provided in the New Zealand Geomechanics Society Published 1984.

- Borehole BH1 was located upslope of the proposed house location, near the existing concrete right of way. The soils comprised fill up to a depth of 0.7m overlying natural ground. The fill is likely to have been placed during the construction of the existing right of way close to this borehole. The natural deposits beneath the fill comprise clayey silts and silts exhibiting insitu undrained shear strengths ranging from 72kPa to 152kPa.

- Borehole BH2 was located near the upslope edge of the proposed house. The natural deposits comprise clayey silts and silts exhibiting insitu undrained shear strengths ranging from 128kPa to greater than 191kPa and UTP (Unable to Penetrate).

- Borehole BH3 was located near the downslope edge of the proposed house. The natural deposits comprise clayey silts and silts exhibiting insitu undrained shear strengths ranging from 99kPa to greater than 191kPa and UTP (Unable to Penetrate).

- Borehole BH4 was located below the proposed house, with the natural soils comprising clayey silts and silts exhibiting insitu undrained shear strengths ranging from 80kPa to greater than 191kPa and UTP (Unable to Penetrate).

- The groundwater was measured in all boreholes on the 6 March 1997 with all boreholes dry. These readings represent a summer condition, consequently groundwater could rise above the base of the boreholes following prolonged or intense periods of rainfall, particularly during the winter period.

- Scala Penetrometer results from boreholes BH1, BH2, BH3 and BH4 indicate that the "inferred" surface of the relatively less weathered sandstone and siltstone ("Bedrock") ranged in depth from approximately 5.0m to 5.5m below the existing ground level at those locations. Generally 10 blows per 50mm penetration with the Scala Penetrometer is indicative of the inferred surface of the less weathered sandstone/siltstone or a more dense layer. The table below indicates the depth to the inferred "bedrock" contact below the existing ground level.

The shallower depths to "bedrock" in boreholes BH1 and BH2 are likely to have resulted following the removal of the residual soil mantle by land slippage features.

| Borehole Number | *Groundwater Table Depth Below GL (m) | Inferred "Bedrock" Contact Depth Below GL (m) |
|---|---|---|
| BH1 | Dry | 5.5 |
| BH2 | Dry | 5.0 |
| BH3 | Dry | 5.4 |
| BH4 | Dry | 5.0 |

* Groundwater Measurements taken on 6 March 1997

## 7. Land Stability

As discussed under the 'Site Description' section of this report there were no obvious signs of major recent deep seated instability observed at the site, however, there were signs of soil creep on the moderately steep to steep slopes at the property and at the location of the proposed building platform. In order to reduce the risk of the proposed house being affected by possible soil creep extending in an upslope direction piles proposed to support the house will need to be designed to resist soil creep. This aspect is discussed further under the "Foundations" Section of this report.

The stability of the property and the proposed building platform is discussed in the following sections.

### 7.1 Stability - General

A qualitative risk assessment has been undertaken at the site based on the geomorphic mapping undertaken, observations of the surrounding environs and the information obtained from the soils investigation.

The stability of the site has been assessed by taking into account the following factors.

(i) **Slope Angle:**

In general the steeper the slope below a particular building platform the lower the Factor of Safety and the greater the risk is to the proposed building platform from slope instability. Slopes at this site are considered to be moderately sloping at the location of the proposed building platform.

(ii) **The Slope Length:**

In general the longer the length of slope the greater the likelihood of instability occurring on the slope. Slope lengths are in the order of 20m to 50m in length.

(iii) **Existing Instability:**

The presence of pre-existing relic slump features and/or shallow surface creep and erosion features can indicate that the risk of further retrogressive slumping uphill and towards any proposed building platform or surface creep downslope of the building platform. As discussed, at the time of our investigation there were no obvious signs of recent, major deep seated instability or signs of relic instability observed on the subject property, however, as discussed, we did observe soil creep at the site.

**7.2 Stability Requirements**

In general, Council require that potential building sites have a theoretical Factor of Safety against instability in excess of 1.5 for residential development purposes. However, these empirical values should be used as **a guide** only in assessing site stability, and should be used in conjunction with a qualitative assessment based on a walkover inspection of the site, an interpretation of the site features and the information obtained from the boreholes drilled at the site. The quantitative assessment of stability of the proposed building platform has been undertaken and is discussed in the following sections.

**7.3 Stability Analyses**

In order to assess the stability of the slope and to satisfy Council's requirements, an analytical check on the overall stability of the building site is shown on cross-section A-A' on Drawing No. 388/503-2 has been carried out using assumed planar failure surfaces. The stability analysis models the ground conditions and a groundwater regime for existing conditions and for raised groundwater conditions (groundwater raised + 4.0m above that measured on 6 March 1997) which, in our opinion, represents a worst case scenario. It is our assessment that groundwater is likely to flow towards the base of the slopes at the site, towards Landing Road.

Assumed lower bound effective stress shear strength parameters have been used in the stability analysis based on the soil description and the undrained shear strengths of the soils and **ignores** any positive contribution from proposed piled foundations and/or remedial measures which may be recommended. Effective stress shear strength parameters used in the analysis are as follows:

| Soil type | Effective Friction Angle Ø' | Effective Cohesion c' kPa |
|---|---|---|
| Silt, clayey | 28° | 5 |
| Sandstone/Siltstone | 35° | 20 |

The results of the stability analyses are discussed in the following.

**7.3.1 Discussion**

Under both existing groundwater conditions (Dry) and raised groundwater conditions, the proposed building platform has a theoretical Factor of Safety against instability acceptable for building purposes. The installation of piles and a basement excavated into the site with associated drainage will enhance the stability of the building platform.

**7.3.2 Conclusions**

Based on the results of our site inspection, and geological mapping, the information obtained from the boreholes drilled at the site, and our theoretical stability analysis, we consider the risk of major, deep-seated land instability affecting the site to be low, with the risk of shallow instability in the form of soil creep affecting the proposed development to be moderate to high. As discussed, foundations can be designed to accommodate soil creep loads.

## 8. Building Act Considerations

The development of this site and the construction of the proposed dwelling is not likely to accelerate, worsen or result in erosion, avulsion, alluvion, falling debris, subsidence, inundation, or slippage of the Building Platform, provided that the recommendations of this report with regard to the installation of deep piled foundations and horizontally bored drains are undertaken and that proper construction techniques are carried out.

## 9. Foundations

Drawings have been supplied to us which indicate that the proposed house will comprise a, single storey, lightweight dwelling supported on a pole platform structure comprising conventional timber Senton piles with a basement excavated below the central part of the house supported on shallow strip footings. A garage is proposed for the site at a later date.

Both piled foundations and shallow footings are considered an appropriate foundation type for this site. However, given the moderately steep slopes at the site and the presence of soil creep, we recommend that a **timber pole platform structure** be incorporated into the house design. Piles should comprise minimum 175mm SED Tanalised timber piles. Piles should comprised concrete encased Tanalised timber piles.

We provide foundation embedment depths and design parameters for both timber piled foundations and strip footings in the following sections.

**Proposed Basement**

Where the proposed **basement** is to be founded on a level cut platform rather than on the existing sloping ground, then it will be possible to found all or part of the load-bearing walls of the structure on either conventional near surface pad or strip footings. Conventional shallow foundations on cut natural ground should be embedded a minimum depth of **0.45m** below the finished ground level into firm natural ground.

Where footings come within **2m** of the downslope edge of any cut bench the embedment depth should be increased to **0.6m** minimum below the final ground level. Refer to Drawing No. 388/503-3 for schematic foundation layout. Piles **2.5m** minimum depth should be used to support the basement foundations along the downslope perimeter. These piles are not intended as load bearing piles, merely as a precaution to protect the strip footing against the detrimental affects of seasonal shrinkage and swelling of the site soils and soil creep.

### *9.1* Shallow Foundations

Foundations for the basement comprising shallow pad and strip footings should be founded a minimum depth of **450mm** below the finished ground level into firm natural ground..

(i) **Working Load Design**

The in-situ undrained shear strengths of the site soils provide an Allowable Bearing Capacity for design purposes of **100kPa** for shallow pad and strip foundations, based on an insitu undrained shear strength of Cu = 50kPa.

(ii) **Ultimate Limit State Design**

The Dependable Bearing Capacity to be used in conjunction with Ultimate Limit State Design in accordance with NZS 4203:1992 shall be **150kPa**. A Strength Reduction Factor of ∅bc = 0.5 and an insitu undrained shear strength Cu = 50kPa have been used to assess the Dependable Bearing Capacity.

### *9.2* Pile Foundations

The use of **bored piles** comprising concrete encased Tanalised timber piles is considered acceptable for this site. We recommend piles be founded a **minimum depth of 3.0m** below finished ground level. Driven piles **are not** recommended. Bored piles will allow the recommended embedment depths to be achieved and soil conditions to be confirmed. Skin friction should be ignored within **1.0m** of the ground surface.

(i) **Working Load Design**

The Allowable End-bearing Capacity of the soils for design purposes can be taken as **300kPa**, with an Allowable Skin Friction of 10kPa based on an undrained shear strength of $c_u$ = 100kPa

(ii) **Ultimate Limit State Design**

The Dependable Bearing Capacity to be used in conjunction with Ultimate Limit State in accordance with NZS 4203:1993 shall be **450kPa**. A strength reduction factor of Øbc = 0.5 and an undrained shear strength of $c_u$ = 100kPa have been used to assess the Dependable Bearing Capacity. The Ultimate Skin Friction for piles can be taken as 15kPa.

**9.3 Lateral Loads on Piles**

In addition, to account for the possible influence of soil creep we recommend that all piles be designed to resist lateral loading. To minimise the magnitude of lateral load acting it is recommended that the piles should be concrete encased to within **1.0m** of the ground surface with the remainder of the annulus to ground surface backfilled with scoria or fine gravel. The magnitude of the lateral load acting on a pile should be determined over an area given by a depth of **1.0m** and a width of 3 times the pole diameter (3xB, where B= drilled pile hole Dia). At-rest earth pressure conditions should be assumed using a value of the coefficient $\mathbf{K_o = 0.5}$ and a bulk density for the surficial soils of $\gamma = 18kN/m^3$.

**9.4 Soil Category**

The site soils have been categorised as Site Soil **Category B**, **Intermediate Soil Sites** in accordance with NZS 4203:1992, Code of Practice for General Structural design and Design Loadings for Buildings.

### 9.5 Foundations Above/Behind Retaining Walls

Where foundations are located within the zone of influence behind any retaining walls they should be embedded a minimum depth of **0.45m** below the zone of influence line defined by a 45° inclined plane rising from the toe of the back of the wall to the ground surface. The general foundation requirements with respect to embedment at various locations is presented schematically on Drawing No. 388/503-3.

### 9.6 Existing Services

The location of **all services** should be **verified** at the site prior to the commencement of foundation construction. Where it is proposed to construct the house over existing services, then foundations should comprise bored piles designed in accordance with the above pile design parameters.

Piles should extend well below the invert level of the pipe generally 1.0m side clearance is required from each side of the sewer to the pile with side clearances to the pipe in accordance with the Waitakere City Council's requirements.

## 10. Earthworks

No vertical cuts or fills should be made on the slopes around the house site in excess of **500mm** unless they are retained by suitable retaining walls designed by a Registered Engineer who has read this report. Soil obtained from foundation excavations should be spread as a thin layer away from slopes or removed off-site, so as to not add extra load onto slopes. Any unsupported excavations should be battered back at a maximum angle of 18 (3H:1V), with the exposed excavation planted on completion.

## 11. Earth Retaining Structures

For the design of free-standing cantilevered walls soil pressures may be determined for active earth pressure conditions. Factors of safety and surcharge loadings appropriate to the conditions should be in accordance with "Retaining Wall Design Notes - MWD, NZ, Issue C: July 1973". Particular attention should be paid to the surcharge influence of sloping ground above any wall and the effect of sloping ground at the toe of any wall. If effective stress shear strength parameters are required for design, we recommend c' = 0kPa and $\varnothing = 30°$ be used.

Free-draining granular backfill, accompanied by a perforated pipe drain located at the base of the wall, should be installed behind all retaining walls to avoid build-up of hydrostatic pressures.

Reinforced concrete masonry walls **forming part of the house** and retaining soil should be designed for At-Rest soil conditions as follows.

Design Parameters

| | | |
|---|---|---|
| (i) | Soil Friction Angle (assumed) | $\varnothing = 30°$ |
| (ii) | Active Earth Pressures (Ko conditions) | Ko = 0.5 |
| (iii) | Soil Density | $\gamma = 18kN/m^3$ |
| (iv) | Surcharge Loadings from the slope above the proposed wall | |
| (v) | Factors of Safety as outlined in the above-mentioned 'Retaining Wall Design Notes' and factored loads in accordance with the relevant New Zealand Code of Practice (NZS 4203:1992). | |

The proposed driveway to be built at the property is likely to require the construction of retaining walls on the sloping ground. Fills should be limited to in height to approximately 1.2m, with walls designed for traffic surcharge loads and with the slope of the ground below the wall taken into account in design.

## 12. Vegetation

Vegetation growing on slopes assists in stabilisation by root-binding, preventing erosion and lowering soil moisture content. Additional planting of fast-growing and shallow-rooting trees (e.g. all native trees and bushes and Karo) should be encouraged wherever possible. **Large trees** should be kept well away from shallow surface foundations to prevent root interaction effects.

## 13. Stormwater Control

Concentrated stormwater flows from driveways, roofed and paved areas must be collected and carried in sealed pipes to the existing system located at the property. Stormwater flows must not be allowed to run onto or over the slopes or saturate the ground so as to adversely affect slope stability or foundations.

## 14. Observation of Construction

The recommendations given in this report are based on limited site data from discrete boreholes locations. Variations in ground conditions could exist across the site. The nature and continuity of subsoil conditions away from the boreholes are inferred and it must be appreciated that actual conditions could vary considerably from the assumed model.

During excavation and construction the site should be examined by a Registered Engineer or Engineering Geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based.

It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based upon this report. Ormiston Associates Ltd would be pleased to provide this service to Maddren Homes and believe that the project would benefit from such continuity. In any event it is essential Ormiston Associates Ltd are contacted if there is any variation in subsoil conditions from those described in the report as it may affect the design parameters recommended in the report.

## 15. Limitations

This report has been prepared for the sole benefit of Maddren Homes as our client with respect to the brief for the presently proposed development and to be used in design by his appointed Consultants and support a Building Consent application to Council. It is not to be relied upon or used out of context by any other person without reference to Ormiston Associates Ltd. The reliance by other parties on the information or opinions contained in the report shall, without prior review and agreement in writing, be at such parties sole risk.

We trust the above meets your present requirements. If there are any further queries, please do not hesitate to contact the undersigned.

Yours faithfully,
ORMISTON ASSOCIATES LTD.

Leigh Dooley
Registered Engineer

A W Ormiston
Director

**BOREHOLE LOGS**

# BOREHOLE LOG BH1

Sheet 1 of 1

| | |
|---|---|
| **Job No:** | 388/503 |
| **Project:** | 1 Landing Rd, Laingholm |
| **Borehole Location:** | see site plan |
| **Surface Elevation:** | **Datum:** |
| **Surface Conditions:** | Gentle slope, long grass. |

Undrained Shear Strength (kPa) Corrected to BS 1377
• Field vane (peak)
□ Remoulded

| Geol. Unit | Soil / Rock Description | Depth (m) | Groundwater | Remoulded (kPa) | Field vane peak (kPa) |
|---|---|---|---|---|---|
| FILL | SILT, clayey, very stiff, moist, moderately plastic, intermixed orange, light grey and grey, occ. topsoil inclusion. | | Groundwater not encountered 6 March 1997 | 30 | 135 |
| WAITEMATA GROUP SOILS | SILT, clayey, stiff, moist to wet, moderately plastic, orange, occ. light grey mottle. | 1 | | 30 | 83 |
| | SILT, loose, moist, non plastic, mottled orange and light grey, freq. limonite gravels(fine) and staining. | | | 44 | 138 |
| | Predominantely light grey, occ. orange mottle, occ. trace of fine sand. | 2 | | 28 | 88 |
| | | | | 14 | 86 |
| | Becoming orange. | 3 | | 30 | 152 |
| | Slightly clayey, stiff, wet, slightly plastic, orange. | | | | |
| | Becoming grey. | | | 14 | 72 |
| | | 4 | | 14 | 75 |
| | SILT, loose, wet, non plastic, grey, trace of fine sand. | | | 41 | 138 |
| | Clayey, very stiff, wet, slightly plastic, grey. | 5 | | 39 | 138 |
| | E.O.B. 5.0 m (Target Depth) | | | | |

**Drill Method** Hand Auger
**Date Drilled** 5 March 1997
**Drilled By** GRG
**Shear Vane No.** DR 4529

**Observations**

R & G SOIL SEARCH
PO BOX 47 559, PONSONBY
OFFICE 360 8300
FAX 378 9834

# BOREHOLE LOG BH2

Sheet 1 of 1

**Job No:** 388/503
**Project:** 1 Landing Rd, Laingholm
**Borehole Location:** see site plan
**Surface Elevation:** **Datum:**
**Surface Conditions:** Moderate slope, bushclad.

| Geol. Unit | Graphic Log | Soil / Rock Description | Depth (m) | Sample Type | Groundwater | Undrained Shear Strength (kPa) Corrected to BS 1377 (• Field vane (peak), □ Remoulded) |
|---|---|---|---|---|---|---|
| WAITEMATA GROUP SOILS | | TOPSOIL | | | Groundwater not encountered 6 March 1997 | |
| | | SILT, clayey, very stiff, moist, slightly plastic, grey, orange mottling, freq. rootlets(1-2mmØ). | | | | □ 49, • 161 |
| | | Moderately plastic. | 1 | | | □ 41, • 128 |
| | | Slightly clayey, very stiff, moist to wet, non to slightly plastic, grey, orange, occ. partly decomposed rootlets(1-2mmØ). | | | | |
| | | SILT, loose to medium dense, moist to wet, non plastic, light grey, occ. orange mottling. | | | | 191+ |
| | | Wet, grey and light grey, freq. limonite staining. | 2 | | | 191+ |
| | | | | | | 191+ |
| | | 200mm lens of limonite gravels(fine). | 3 | | | UTP |
| | | Light grey, wet, freq. limonite staining, occ. carbonaceous inclusion(1-5mmØ). | | | | 191+ |
| | | | 4 | | | 191+ |
| | | | | | | 191+ |
| | | Becoming dense. | 5 | | | UTP |
| | | E.O.B. 5.0 m (Target Depth) | | | | |

**Drill Method** Hand Auger
**Date Drilled** 5 March 1997
**Drilled By** RIF
**Shear Vane No.** DR 2942

**Observations**

R & G SOIL SEARCH
PO BOX 47-559, PONSONBY
OFFICE 360 8300
FAX 378 9834

# BOREHOLE LOG BH3

Sheet 1 of 1

**Job No:** 388/503
**Project:** 1 Landing Rd, Laingholm
**Borehole Location:** see site plan
**Surface Elevation:** **Datum:**
**Surface Conditions:** Moderate slope, bushclad.

| Geol. Unit | Graphic Log | Soil / Rock Description | Depth (m) | Sample Type | Groundwater | Undrained Shear Strength (kPa) Corrected to BS 1377 (• Field vane (peak), □ Remoulded) |
|---|---|---|---|---|---|---|
| WAITEMATA GROUP SOILS | | SILT, loose, moist, non plastic, brown. | | | Groundwater not encountered 6 March 1997 | |
| | | Slightly clayey, very stiff, moist, slightly plastic, brownish orange, light grey, freq. rootlets(1-2mmØ). | | | | 52 / 157 |
| | | Clayey, very stiff, moist, slightly to moderately plastic, orange and light grey. | 1 | | | 57 / 114 |
| | | Slightly clayey, very stiff, moist, non plastic, light grey mottled orange, freq. limonite staining. | | | | 27 / 142 |
| | | SILT, loose, moist to wet, light grey, freq. limonite staining and gravels(fine).. | 2 | | | 35 / 99 |
| | | Wet. | | | | 34 / 149 |
| | | Loose to medium dense, wet, light grey, red/brown mottling, occ. black speckles. | 3 | | | 191+ |
| | | Intermixed dark orange, red/brown, black, medium dense, freq. weakly cemented clasts(2-10mmØ). | | | | 191+ |
| | | | 4 | | | UTP |
| | | Becoming light grey, freq. limonite staining, loose to medium dense. | | | | 38 / 125 |
| | | | 5 | | | 52 / 170 |
| | | E.O.B. 5.0 m (Target Depth) | | | | |

Undrained shear strength scale: 50 100 150 200

**Drill Method** Hand Auger
**Date Drilled** 6 March 1997
**Drilled By** RJF
**Shear Vane No.** DR 2942

**Observations**

R & G SOIL SEARCH
PO BOX 47-559, PONSONBY
OFFICE 360 8300
FAX 378 9834

# BOREHOLE LOG BH4

Sheet 1 of 1

**Job No:** 388/503

**Project:** 1 Landing Rd, Laingholm

**Borehole Location:** see site plan

**Surface Elevation:** **Datum:**

**Surface Conditions:** Moderate slope, bushclad.

| Geol. Unit | Graphic Log | Soil / Rock Description | Depth (m) | Sample Type | Groundwater | Undrained Shear Strength (kPa) Corrected to BS 1377 (• Field vane (peak); □ Remoulded) |
|---|---|---|---|---|---|---|
| WAITEMATA GROUP SOILS | | SILT, loose, moist, non plastic, brown. | | | Groundwater not encountered 6 March 1997 | |
| | | Slightly clayey, very stiff, moist to wet, slightly plastic, brownish orange and light brown. | | | | 39 / 102 |
| | | Clayey, stiff, wet, moderately to highly plastic, orange with light grey mottles, occ. limonite staining.. | 1 | | | 30 / 80 |
| | | SILT, loose, moist to wet, slightly plastic, light grey with orange mottles, occ. light brown staining. | | | | 30 / 91 |
| | | Becoming medium dense, wet, light brown, freq. limonite staining. | 2 | | | UTP |
| | | | | | | UTP |
| | | Loose to medium dense. | | | | |
| | | | 3 | | | 191+ |
| | | Becoming dark gry, occ. lense of less weathered loose SILT, trace of clay. | | | | 191+ |
| | | Slightly sandy(fine), loose to medium dense, wet, non plastic, dark grey, grey. | | | | |
| | | | 4 | | | 191+ |
| | | Medium dense. | | | | UTP |
| | | SILT, dense, moist, non plastic, grey and dark grey. | | | | |
| | | E.O.B. 4.8 m (Too Dense To Auger) | 5 | | | UTP |

**Drill Method** Hand Auger
**Date Drilled** 6 March 1997
**Drilled By** GRG
**Shear Vane No.** DR 4529

**Observations**

R & G SOIL SEARCH
PO BOX 47-559, PONSONBY
OFFICE 360 8300
FAX 378 9834

Scala Penetrometer Test Sheet-Table of Blows Per 50mm Increment

Job Name : 1 Landing Rd, Laingholm

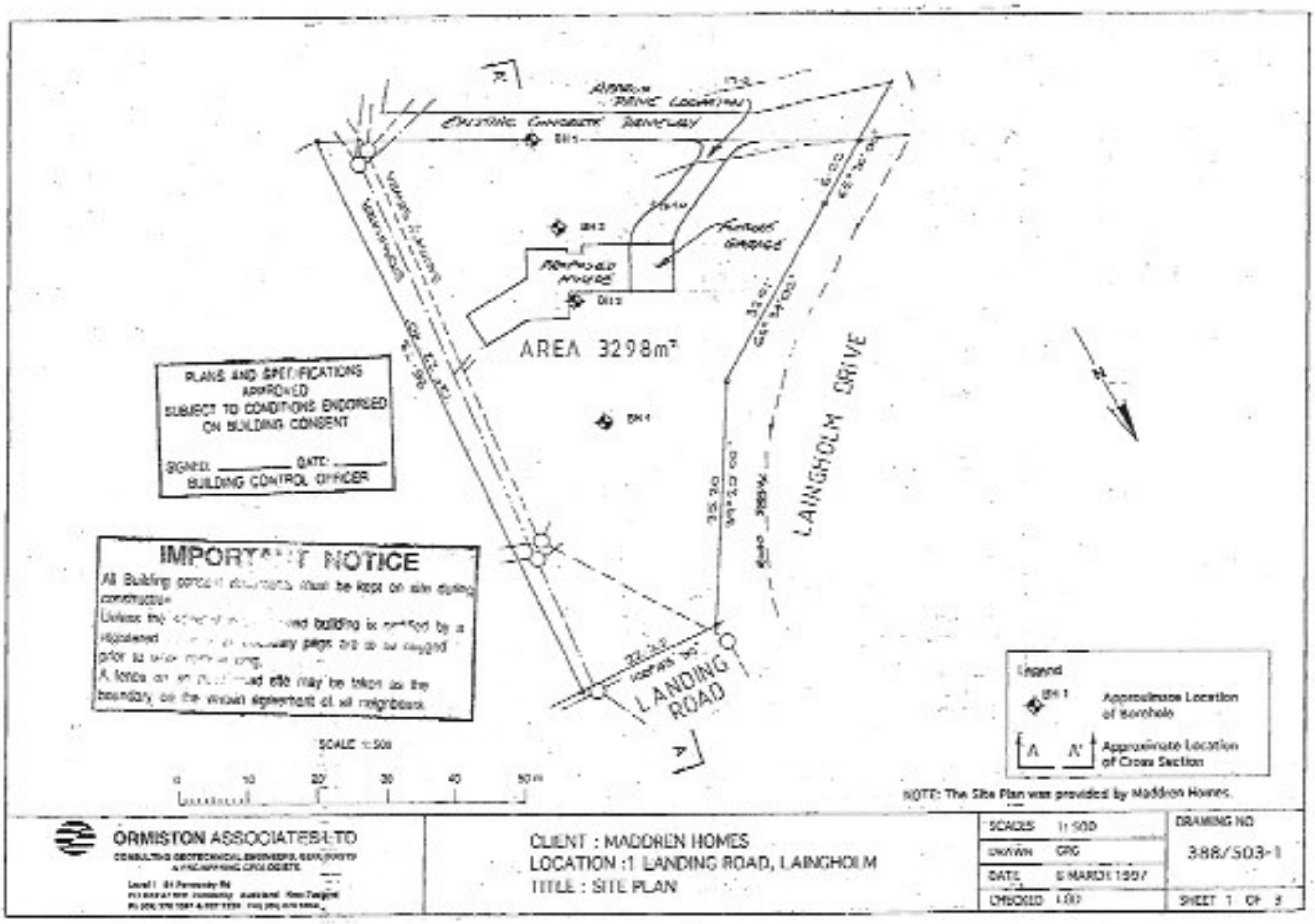
Job No : 388/503

Date : 6 March.1997

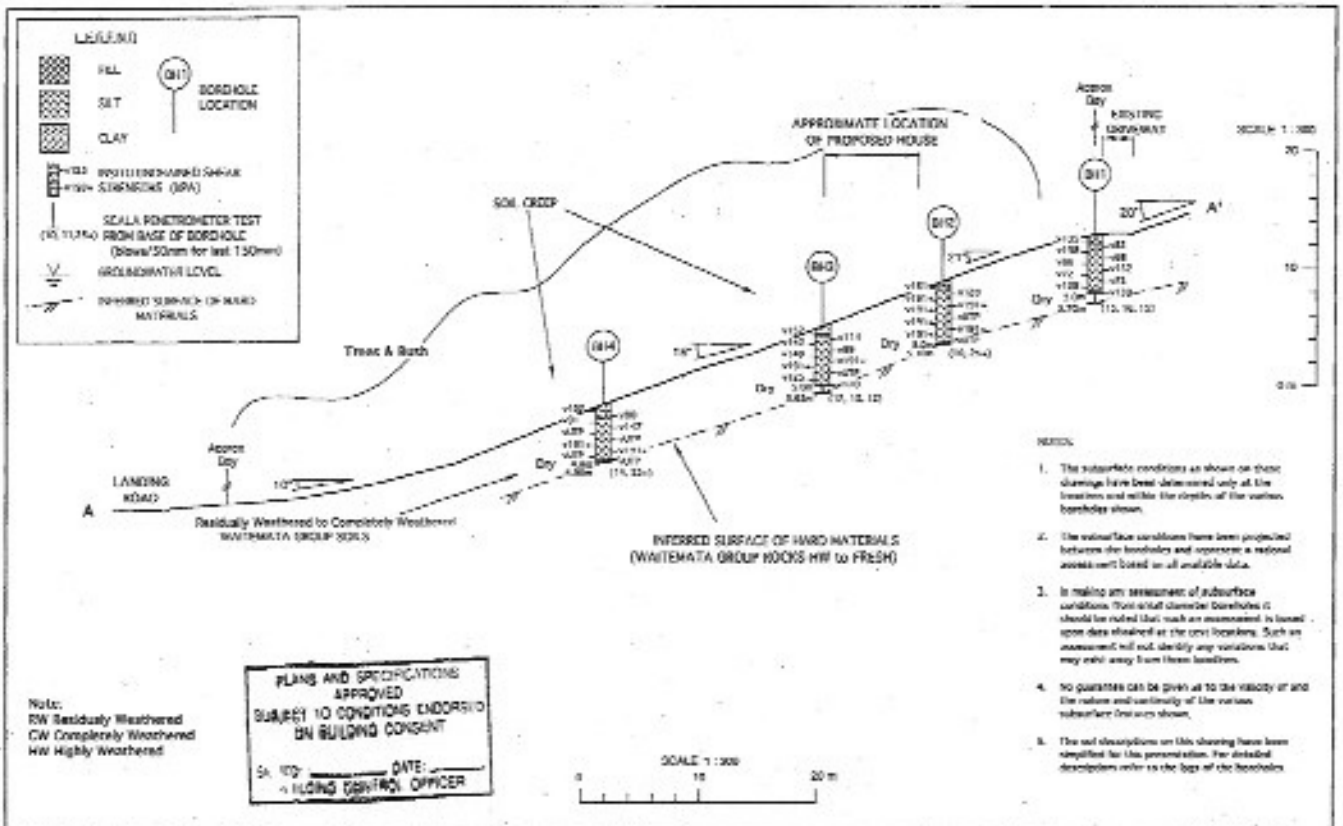
Tested by : RJF/GRG

| Borehole Number | BH 1 | BH 2 | BH 3 | BH 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Start Depth (m) | 5.00 m | 5.00 m | 5.00 m | 4.80 m | | | | | |
| 50 | 4 | 10 | 2 | 14 | | | | | |
| 100 | 4 | 25+ | 2 | 25+ | | | | | |
| 150 | 4 | | 2 | | | | | | |
| 200 | 5 | | 2 | | | | | | |
| 250 | 8 | | 3 | | | | | | |
| 300 | 9 | | 4 | | | | | | |
| 350 | 8 | | 4 | | | | | | |
| 400 | 9 | | 10 | | | | | | |
| 450 | 10 | | 13 | | | | | | |
| 500 | 11 | | 14 | | | | | | |
| 550 | 14 | | 12 | | | | | | |
| 600 | 15 | | 12 | | | | | | |
| 650 | 16 | | 12 | | | | | | |
| 700 | 15 | | | | | | | | |
| 750 | | | | | | | | | |
| 800 | | | | | | | | | |
| 850 | | | | | | | | | |
| 900 | | | | | | | | | |
| 950 | | | | | | | | | |
| 1000 | | | | | | | | | |
| 1050 | | | | | | | | | |
| 1100 | | | | | | | | | |
| 1150 | | | | | | | | | |
| 1200 | | | | | | | | | |
| 1250 | | | | | | | | | |
| 1300 | | | | | | | | | |
| 1350 | | | | | | | | | |
| 1400 | | | | | | | | | |
| 1450 | | | | | | | | | |
| 1500 | | | | | | | | | |
| 1550 | | | | | | | | | |
| 1600 | | | | | | | | | |
| 1650 | | | | | | | | | |
| 1700 | | | | | | | | | |
| 1750 | | | | | | | | | |
| 1800 | | | | | | | | | |
| 1850 | | | | | | | | | |
| 1900 | | | | | | | | | |
| 1950 | | | | | | | | | |
| 2000 | | | | | | | | | |
| Depth End | 5.70 m | 5.10 m | 5.65 m | 4.90 m | | | | | |

Drawings



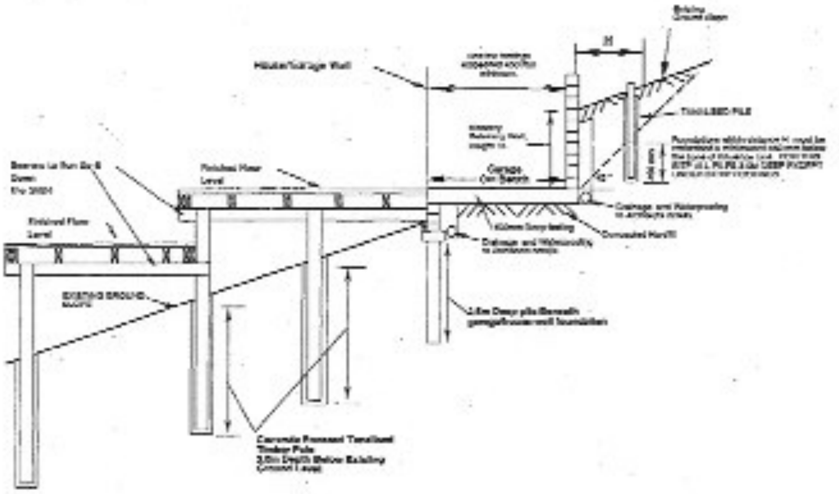
EXISTING CONCRETE DRIVEWAY
PROPOSED HOUSE
AREA 3298m²
LAINGHOLM DRIVE
LANDING ROAD
N
PLANS AND SPECIFICATIONS APPROVED SUBJECT TO CONDITIONS ENDORSED ON BUILDING CONSENT
SIGNED: ______ DATE: ______
BUILDING CONTROL OFFICER
IMPORTANT NOTICE
SCALE 1:500
0 10 20 30 40 50 m
Legend
Approximate Location of Borehole
A A' Approximate Location of Cross Section
NOTE: The Site Plan was provided by Maddren Homes.
ORMISTON ASSOCIATES LTD
CLIENT : MADDREN HOMES
LOCATION :1 LANDING ROAD, LAINGHOLM
TITLE : SITE PLAN
SCALES 1:500
DRAWN GRG
DATE 6 MARCH 1997
CHECKED
DRAWING NO
388/503-1
SHEET 1 OF 3




ORMISTON ASSOCIATES LTD

CLIENT : MADDREN HOMES
LOCATION :1 LANDING ROAD, LAINGHOLM
TITLE : CROSS SECTION A-A'

| | | |
|---|---|---|
| SCALES | 1:300 | DRAWING NO |
| DRAWN | GRG | 388/503-2 |
| DATE | 6 MARCH 2007 | |
| CHECKED | LGU | SHEET 2 OF 3 |




PLANS AND SPECIFICATIONS APPROVED
SUBJECT TO CONDITIONS ENDORSED ON BUILDING CONSENT
SIGNED: ________ DATE: ________
BUILDING CONTROL OFFICER

**SCHEMATIC DRAWING FOR GENERAL FOUNDATION REQUIREMENTS FOR BENCHES ON SLOPES GREATER THAN 15°.**

| | | | | |
|---|---|---|---|---|
| **ORMISTON** ASSOCIATES LTD<br>CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS | CLIENT : MADOREN HOMES<br>LOCATION : 1 LANDING ROAD, LAINGHOLM<br>TITLE : FOUNDATIONS ON BENCHES - TYPICAL DETAILS | SCALES: Not To Scale<br>DRAWN: LGO<br>DATE: 12 MAR 1997<br>CHECKED: LGO | | DRAWING NO<br>388/303-3<br>SHEET 3 OF 3 |