

3438-R1.docx  
6 December 2015

Myson+Berkery Architects  
PO Box 68  
Currarong NSW 2540

**Sydney**  
Suite 2.05 / 56 Delhi Road  
North Ryde NSW 2113  
Phone: 02 9878 6005

**Attention: Mr Vince Myson**

Dear Sir,

**PROPOSED RILEYS RUN LODGE EXTENSION, LOT 610 MOUNTAIN DRIVE, THREDBO  
GEOTECHNICAL ASSESSMENT**

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## **1. INTRODUCTION**

### **1.1 General**

This report presents the results of a geotechnical assessment for the above project. The investigation was commissioned on 12<sup>th</sup> November 2015 by Mr Vince Myson on behalf of the lodge owners. The work was carried out in accordance with a proposal by Asset Geotechnical Engineering Pty Ltd dated 8<sup>th</sup> November 2015 (reference 3438-P1).

We understand that the development will involve construction of a new garage at the front of the lodge, which will require excavation of less than about 1m depth (refer attached architectural plan from Myson Berkery Architects).

The building is within the G line as defined in DIPNR's "*Geotechnical Policy – Kosciuszko Alpine Resorts*", November 2003. We note that the proposed works will present a minor geotechnical impact on the site or related land, and a Form 4 "Minimal Impact Certification" in accordance with DIPNR's policy is proposed.

### **1.2 Scope of Work**

The main objectives of the investigation were to assess the surface and subsurface conditions and to provide comments and recommendations relating to:

- Excavation conditions
- Site Classification to AS2870 'Residential Slabs and Footings' (2011)
- Suitable foundations and founding stratum
- Allowable bearing pressure
- Groundwater

In order to achieve the project objectives, the following scope of work was carried out:

- A review of existing regional maps and reports relevant to the site, held within our files.
- Visual observations of surface features.
- Reference to subsurface investigation carried out on a nearby development along Mountain Drive (Feathers Lodge).
- Engineering assessment and reporting

This report should be read in conjunction with the attached Information Sheets. Particular attention is drawn to the limitations inherent in site investigations and the importance of verifying the subsurface conditions inferred herein. Slope instability considerations presented in this report must be read in conjunction with the attached GeoGuides for Slope Management and Maintenance.

## 2. FIELDWORK

The site observations were carried out by the undersigned on 4 November 2015 in conjunction with fieldwork being carried out for other projects in the area.

## 3. SITE DESCRIPTION

The site is located on the northern side of Mountain Drive in Thredbo, as shown in the attached Figure 1. The site is bounded by 1 to 2 storey holiday lodges. Outcrops or boulders of granite are located in the area. The overall gradient in the area locally is about 5° degrees towards the east. There is an existing building on the site of timber and masonry (vener).

Drainage at the site is via overland flow, following the existing gradient towards the east.

Vegetation at the site comprised grass and small trees.

No significant protrusions, tension cracking or seepage were observed on the ground surface at the time of the site visit.

## 4. SUBSURFACE CONDITIONS

### 4.1 Geology

The Tallanagatta 1:250 000 Geological Map indicates that the site is underlain by granitic igneous rock. These rocks typically weather to form residual sandy or clay soils of medium plasticity.

### 4.2 Stratigraphy

#### 4.2.1 Feathers Lodge

A recent investigation carried out by this company at Feathers Lodge indicated a subsurface profile comprising Gravelly SAND and Silty CLAY FILL up to about 1 m thickness overlying Residual Silty CLAY overlying high strength granite bedrock/boulders at depths of up to 0.7 m or more.

#### 4.2.2 Rileys Run

Site development in and around the immediate area of Feathers Lodge is attributed to the presence of fill. It is anticipated that Riley's Run development would not be impacted by fill other than relatively minor thicknesses (less than about 0.3 m) associated with previous development.

Otherwise, a similar profile comprising residual clay soils overlying variably weathered granite bedrock is expected.

## 5. DISCUSSIONS & RECOMMENDATIONS

In view of the relatively gentle slopes and the anticipated lack of significant thickness of fill, the site is assessed to be Class M (Moderately reactive) in accordance with AS 2870–2011 “Residential Slabs and Footings”.

High level footings may be designed for the proposed structure for an allowable bearing capacity of 150kPa on rock or residual soil, as the rock (if present) may represent floating boulders. Sounding of the rock after excavation for footings, or additional excavation should be conducted to ensure the load is applied centrally onto a boulder of at least 1m diameter, if a boulder is encountered and cannot be removed.

Higher bearing capacities may be attributed to continuous bedrock, however this would require additional investigation including coring of the rock and / or inspection of footing excavations.

Where some footings are to be on residual soil, and others on rock / bedrock, differential settlements are likely. In this case the structure should be designed to tolerate differential settlements by incorporating architectural joints; connecting services should also be designed accordingly.

The above classification and footing recommendations are provided on the basis that the performance expectations set out in Appendix B of AS2870–2011 are acceptable and that future site maintenance is in accordance with CSIRO BTF 18, a copy of which is attached.

An experienced geotechnical engineer should review footing designs to check that the recommendations of the geotechnical report have been included, and should assess footing excavations prior to pouring concrete, to confirm the design assumptions. Ground conditions should be assessed during excavation of footings, to confirm the founding material is continuous bedrock and not a floating boulder.

## 6. LIMITATIONS

In addition to the limitations inherent in site investigations (refer to the attached Information Sheets), it must be pointed out that the recommendations in this report are based on assessed subsurface conditions from limited investigations. In order to confirm the assessed soil and rock properties in this report, further investigation would be required such as coring and strength testing of rock, and should be carried out if the scale of the development warrants, or if any of the properties are critical to the design, construction or performance of the development.

It is recommended that a qualified and experienced geotechnical engineer be engaged to provide further input and review during the design development; including site visits during construction to verify the site conditions and provide advice where conditions vary from those assumed in this report. Development of an appropriate inspection and testing plan should be carried out in consultation with the geotechnical engineer.

This report and details for the proposed development must be submitted to relevant regulatory authorities that have an interest in the property or are responsible for services that may be within or adjacent to the site, for their review prior to commencement of construction.



Please do not hesitate to contact the undersigned if you have any questions regarding this report or if you require further assistance.

For and on behalf of  
**Asset Geotechnical Engineering Pty Ltd**

*Mark Bartel*

**Mark Bartel**

BE MEngSc MIEAust GMQ RPEQ CPEng NPER (Civil)  
Managing Director / Senior Principal Geotechnical Engineer

*Encl:*

*Information Sheets (3 sheets)*

*CSIRO BTF 18 (4 sheets)*

*Figure 1 Site Locality*

*Form 4*

## SCOPE OF SERVICES

The geotechnical report (“the report”) has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client and Asset Geotechnical Engineering Pty Ltd (“Asset”), for the specific site investigated. The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

The report should not be used if there have been changes to the project, without first consulting with Asset to assess if the report’s recommendations are still valid. Asset does not accept responsibility for problems that occur due to project changes if they are not consulted.

## RELIANCE ON DATA

Asset has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. Asset has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations (“conclusions”) are based in whole or part on the data, Asset will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Asset.

## GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

## LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

Therefore, the recommendations in the report can only be regarded as preliminary. Asset should be retained during the project implementation to assess if the report’s recommendations are valid and whether or not changes should be considered as the project proceeds.

## SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events

such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. Asset should be kept apprised of any such events, and should be consulted to determine if any additional tests are necessary.

## VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that Asset be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

## REPRODUCTION OF REPORTS

This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this Company. Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

## REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. Asset assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Asset or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

## DATA MUST NOT BE SEPARATED FROM THE REPORT

The report as a whole presents the site assessment, and must not be copied in part or altered in any way.

Logs, figures, drawings, test results etc. included in our reports are developed by professionals based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

## PARTIAL USE OF REPORT

Where the recommendations of the report are only partially followed, there may be significant implications for the project and could lead to problems. Consult Asset if you are not intending to follow all of the report recommendations, to assess what the implications could be. Asset does not accept responsibility for problems that develop where the report recommendations have only been partially followed if they have not been consulted.

## OTHER LIMITATIONS

Asset will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.

**LOG ABBREVIATIONS AND NOTES**

**METHOD**

**borehole logs**

AS auger screw \*  
AD auger drill \*  
RR roller / tricone  
W washbore  
CT cable tool  
HA hand auger  
D diatube  
B blade / blank bit  
V V-bit  
T TC-bit

**excavation logs**

NE natural excavation  
HE hand excavation  
BH backhoe bucket  
EX excavator bucket  
DZ dozer blade  
R ripper tooth

\* bit shown by suffix e.g. ADV

**coring**

NMLC, NQ, PQ, HQ

**SUPPORT**

**borehole logs**

N nil  
M mud  
C casing  
NQ NQ rods

**excavation logs**

N nil  
S shoring  
B benched

**CORE—LIFT**

|| casing installed  
| | barrel withdrawn

**NOTES, SAMPLES, TESTS**

D disturbed  
B bulk disturbed  
U50 thin-walled sample, 50mm diameter  
HP hand penetrometer (kPa)  
SV shear vane test (kPa)  
DCP dynamic cone penetrometer (blows per 100mm penetration)  
SPT standard penetration test  
N\* SPT value (blows per 300mm)  
\* denotes sample taken  
Nc SPT with solid cone  
R refusal of DCP or SPT

**USCS SYMBOLS**

GW Well graded gravels and gravel-sand mixtures, little or no fines.  
GP Poorly graded gravels and gravel-sand mixtures, little or no fines.  
GM Silty gravels, gravel-sand-silt mixtures.  
GC Clayey gravels, gravel-sand-clay mixtures.  
SW Well graded sands and gravelly sands, little or no fines.  
SP Poorly graded sands and gravelly sands, little or no fines.  
SM Silty sand, sand-silt mixtures.  
SC Clayey sand, sand-clay mixtures.  
ML Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands.  
CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.  
OL Organic silts and organic silty clays of low plasticity.  
MH Inorganic silts of high plasticity.  
CH Inorganic clays of high plasticity.  
OH Organic clays of medium to high plasticity.  
PT Peat muck and other highly organic soils.

**MOISTURE CONDITION**

D dry  
M moist  
W wet  
Wp plastic limit  
Wl liquid limit

**CONSISTENCY**

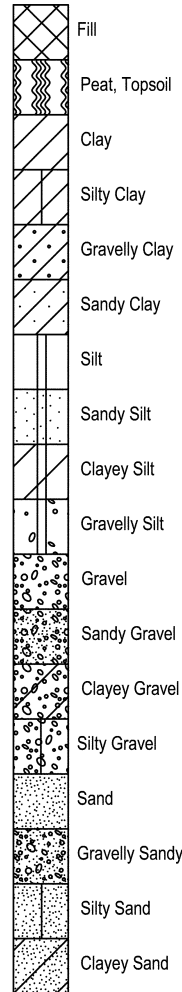
VS very soft  
S soft  
F firm  
St stiff  
VSt very stiff  
H hard  
Fb friable

**DENSITY INDEX**

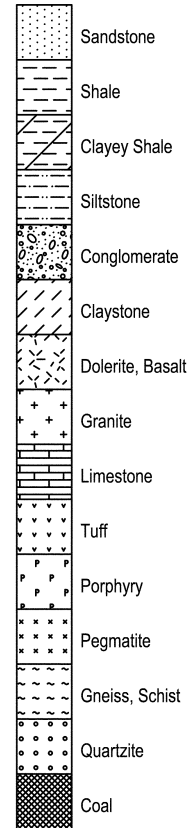
VL very loose  
L loose  
MD medium dense  
D dense  
VD very dense

**GRAPHIC LOG**

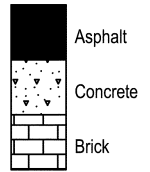
**Soil**



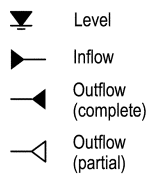
**Rock**



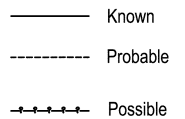
**Other**



**Water**



**Boundaries**



**WEATHERING**

XW extremely weathered  
HW highly weathered  
MW moderately weathered  
SW slightly weathered  
FR fresh

**STRENGTH**

EL extremely low  
VL very low  
L low  
M medium  
H high  
VH very high  
EH extremely high

**RQD (%)**

$$= \frac{\text{sum of intact core pieces} > 2 \times \text{diameter}}{\text{total length of section being evaluated}} \times 100$$

**DEFECTS**

|             |            |                |
|-------------|------------|----------------|
| <b>type</b> |            | <b>coating</b> |
| JT          | joint      | cl clean       |
| PT          | parting    | st stained     |
| SZ          | shear zone | ve veneer      |
| SM          | seam       | co coating     |

**shape**

|    |            |    |              |
|----|------------|----|--------------|
| pl | planar     | po | polished     |
| cu | curved     | sl | slickensided |
| un | undulating | sm | smooth       |
| st | stepped    | ro | rough        |
| ir | irregular  | vr | very rough   |

**inclination**

measured above axis and perpendicular to core

## AS1726-1993

Soils and rock are described in the following terms, which are broadly in accordance with AS1726-1993.

## SOIL

### MOISTURE CONDITION

| Term  | Description   |
|-------|---|
| Dry   | Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through the hand.   |
| Moist | Feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.  |
| Wet   | As for moist, but with free water forming on hands when handled. Moisture content of cohesive soils may also be described in relation to plastic limit ( $W_P$ ) or liquid limit ( $W_L$ ) [ $\gg$ much greater than, $>$ greater than, $<$ less than, $\ll$ much less than]. |

### CONSISTENCY OF COHESIVE SOILS

| Term      | Su (kPa) | Term       | Su (kPa)  |
|-----------|----------|------------|-----------|
| Very soft | < 12     | Very Stiff | 100 – 200 |
| Soft      | 12 – 25  | Hard       | > 200     |
| Firm      | 25 – 50  | Friable    | –         |
| Stiff     | 50 – 100 |            |           |

### DENSITY OF GRANULAR SOILS

| Term         | Density Index (%) | Term       | Density Index (%) |
|--------------|-------------------|------------|-------------------|
| Very Loose   | < 15              | Dense      | 65 – 85           |
| Loose        | 15 – 35           | Very Dense | >85               |
| Medium Dense | 35 – 65           |            |                   |

### PARTICLE SIZE

| Name        | Subdivision | Size (mm)   |
|-------------|-------------|-------------|
| Boulders    |             | > 200       |
| Cobbles     |             | 63 – 200    |
| Gravel      | coarse      | 20 – 63     |
|             | medium      | 6 – 20      |
|             | fine        | 2.36 – 6    |
| Sand        | coarse      | 0.6 – 2.36  |
|             | medium      | 0.2 – 0.6   |
|             | fine        | 0.075 – 0.2 |
| Silt & Clay |             | < 0.075     |

### MINOR COMPONENTS

| Term  | Proportion by Mass |              |
|-------|--------------------|--------------|
|       | coarse grained     | fine grained |
| Trace | ≤ 5%               | ≤ 15%        |
| Some  | 5 – 2%             | 15 – 30%     |

### SOIL ZONING

|         |   |
|---------|---|
| Layers  | Continuous exposures.                       |
| Lenses  | Discontinuous layers of lenticular shape.   |
| Pockets | Irregular inclusions of different material. |

### SOIL CEMENTING

|            |  |
|------------|--|
| Weakly     | Easily broken up by hand.                        |
| Moderately | Effort is required to break up the soil by hand. |

### USCS SYMBOLS

| Symbol | Description   |
|--------|---|
| GW     | Well graded gravels and gravel-sand mixtures, little or no fines.                           |
| GP     | Poorly graded gravels and gravel-sand mixtures, little or no fines.                         |
| GM     | Silty gravels, gravel-sand-silt mixtures.   |
| GC     | Clayey gravels, gravel-sand-clay mixtures.  |
| SW     | Well graded sands and gravelly sands, little or no fines.                                   |
| SP     | Poorly graded sands and gravelly sands, little or no fines.                                 |
| SM     | Silty sand, sand-silt mixtures.   |
| SC     | Clayey sand, sand-clay mixtures.  |
| ML     | Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands. |
| CL     | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.      |
| OL     | Organic silts and organic silty clays of low plasticity.                                    |
| MH     | Inorganic silts of high plasticity.   |
| CH     | Inorganic clays of high plasticity.   |
| OH     | Organic clays of medium to high plasticity.   |
| PT     | Peat muck and other highly organic soils.   |

## ROCK

### SEDIMENTARY ROCK TYPE DEFINITIONS

| Rock Type    | Definition (more than 50% of rock consists of .....        |
|--------------|--|
| Conglomerate | ... gravel sized (>2mm) fragments.                         |
| Sandstone    | ... sand sized (0.06 to 2mm) grains.                       |
| Siltstone    | ... silt sized (<0.06mm) particles, rock is not laminated. |
| Claystone    | ... clay, rock is not laminated.                           |
| Shale        | ... silt or clay sized particles, rock is laminated.       |

### LAYERING

| Term             | Description  |
|------------------|--|
| Massive          | No layering apparent.  |
| Poorly Developed | Layering just visible. Little effect on properties.              |
| Well Developed   | Layering distinct. Rock breaks more easily parallel to layering. |

### STRUCTURE

| Term               | Spacing (mm) | Term                | Spacing     |
|--------------------|--------------|---------------------|-------------|
| Thinly laminated   | <6           | Medium bedded       | 200 – 600   |
| Laminated          | 6 – 20       | Thickly bedded      | 600 – 2,000 |
| Very thinly bedded | 20 – 60      | Very thickly bedded | > 2,000     |
| Thinly bedded      | 60 – 200     |                     |             |

### STRENGTH

| Term          | Is50 (MPa) | Term           | Is50 (MPa) |
|---------------|------------|----------------|------------|
| Extremely Low | <0.03      | High           | 1.0 – 3.0  |
| Very low      | 0.03 – 0.1 | Very High      | 3.0 – 10.0 |
| Low           | 0.1 – 0.3  | Extremely High | >10.0      |
| Medium        | 0.3 – 1.0  |                |            |

NOTE: Is50 = Point Load Strength Index

### WEATHERING

| Term             | Description   |
|------------------|---|
| Residual Soil    | Soil derived from weathering of rock; the mass structure and substance fabric are no longer evident.  |
| Extremely .....  | Rock is weathered to the extent that it has soil properties (either disintegrates or can be remoulded). Fabric of original rock is still visible. |
| Highly .....     | Rock strength usually highly changed by weathering; rock may be highly discoloured.   |
| Moderately ..... | Rock strength usually moderately changed by weathering; rock may be moderately discoloured.   |
| Slightly .....   | Rock is slightly discoloured but shows little or no change of strength from fresh rock.   |
| Fresh            | Rock shows no signs of decomposition or staining.   |

### DEFECT DESCRIPTION

| Type         | Description   |
|--------------|---|
| Joint        | A surface or crack across which the rock has little or no tensile strength. May be open or closed.  |
| Parting      | A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering/bedding. May be open or closed.            |
| Sheared Zone | Zone of rock substance with roughly parallel, near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. |
| Seam         | Seam with deposited soil (infill), extremely weathered insitu rock (XW), or disoriented usually angular fragments of the host rock (crushed).               |

### Shape

|            |                                    |
|------------|------------------------------------|
| Planar     | Consistent orientation.            |
| Curved     | Gradual change in orientation.     |
| Undulating | Wavy surface.                      |
| Stepped    | One or more well defined steps.    |
| Irregular  | Many sharp changes in orientation. |

### Roughness

|              |  |
|--------------|--|
| Polished     | Shiny smooth surface.  |
| Slickensided | Grooved or striated surface, usually polished.   |
| Smooth       | Smooth to touch. Few or no surface irregularities.   |
| Rough        | Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper. |
| Very Rough   | Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper.     |

### Coating

|         |  |
|---------|--|
| Clean   | No visible coating or discolouring.                                      |
| Stained | No visible coating but surfaces are discoloured.                         |
| Veneer  | A visible coating of soil or mineral, too thin to measure; may be patchy |
| Coating | Visible coating ≤1mm thick. Thicker soil material described as seam.     |

# Foundation Maintenance and Footing Performance: A Homeowner's Guide



CSIRO

BTF 18  
replaces  
Information  
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

## Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

## Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

## GENERAL DEFINITIONS OF SITE CLASSES

| Class  | Foundation  |
|--------|---|
| A      | Most sand and rock sites with little or no ground movement from moisture changes  |
| S      | Slightly reactive clay sites with only slight ground movement from moisture changes   |
| M      | Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes   |
| H      | Highly reactive clay sites, which can experience high ground movement from moisture changes   |
| E      | Extremely reactive sites, which can experience extreme ground movement from moisture changes  |
| A to P | Filled sites  |
| P      | Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise |



### Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

### Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

### Effects of Uneven Soil Movement on Structures

#### Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpend).

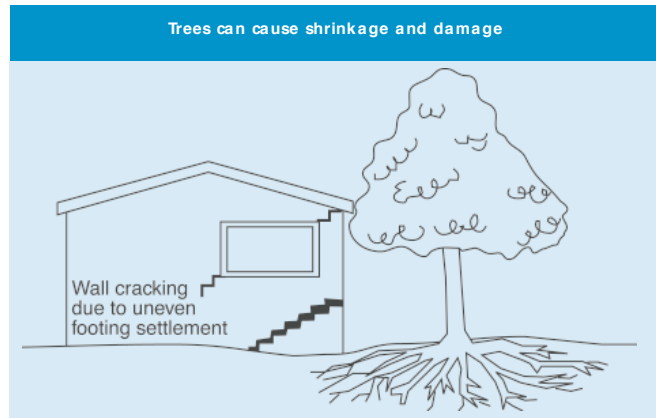
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

#### Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

#### Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

#### Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

#### Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

#### Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

#### Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

### Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

### Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

### Prevention/ Cure

#### Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

#### Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

#### Protection of the building perimeter

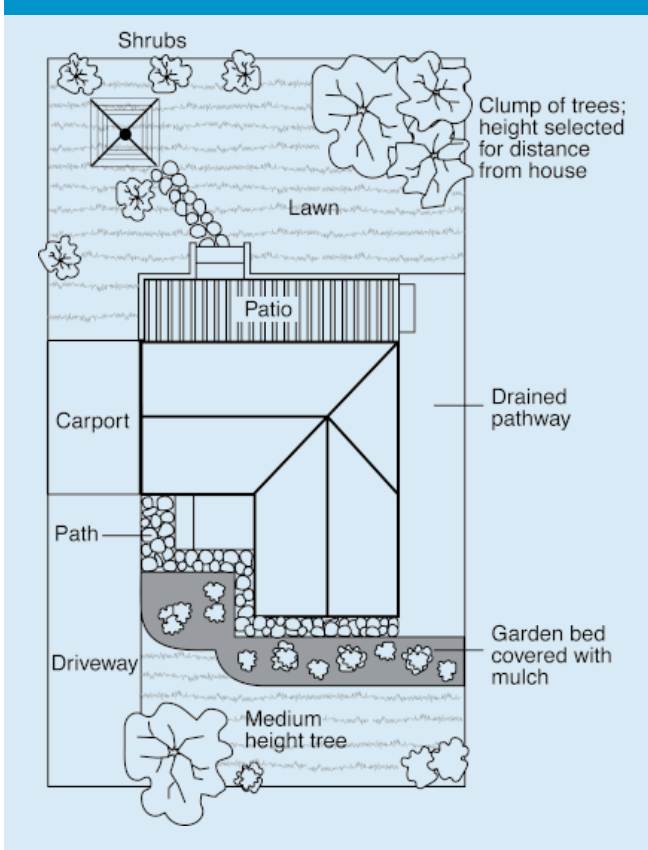
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

### CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

| Description of typical damage and required repair   | Approximate crack width limit (see Note 3)                | Damage category |
|---|---|-----------------|
| Hairline cracks   | <0.1 mm   | 0               |
| Fine cracks which do not need repair  | <1 mm   | 1               |
| Cracks noticeable but easily filled. Doors and windows stick slightly   | <5 mm   | 2               |
| Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired   | 5–15 mm (or a number of cracks 3 mm or more in one group) | 3               |
| Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted | 15–25 mm but also depend on number of cracks              | 4               |

### Gardens for a reactive site



- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

#### The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

#### Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

#### Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

#### Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

### Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

**This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.**

should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

#### Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

**Warning:** Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

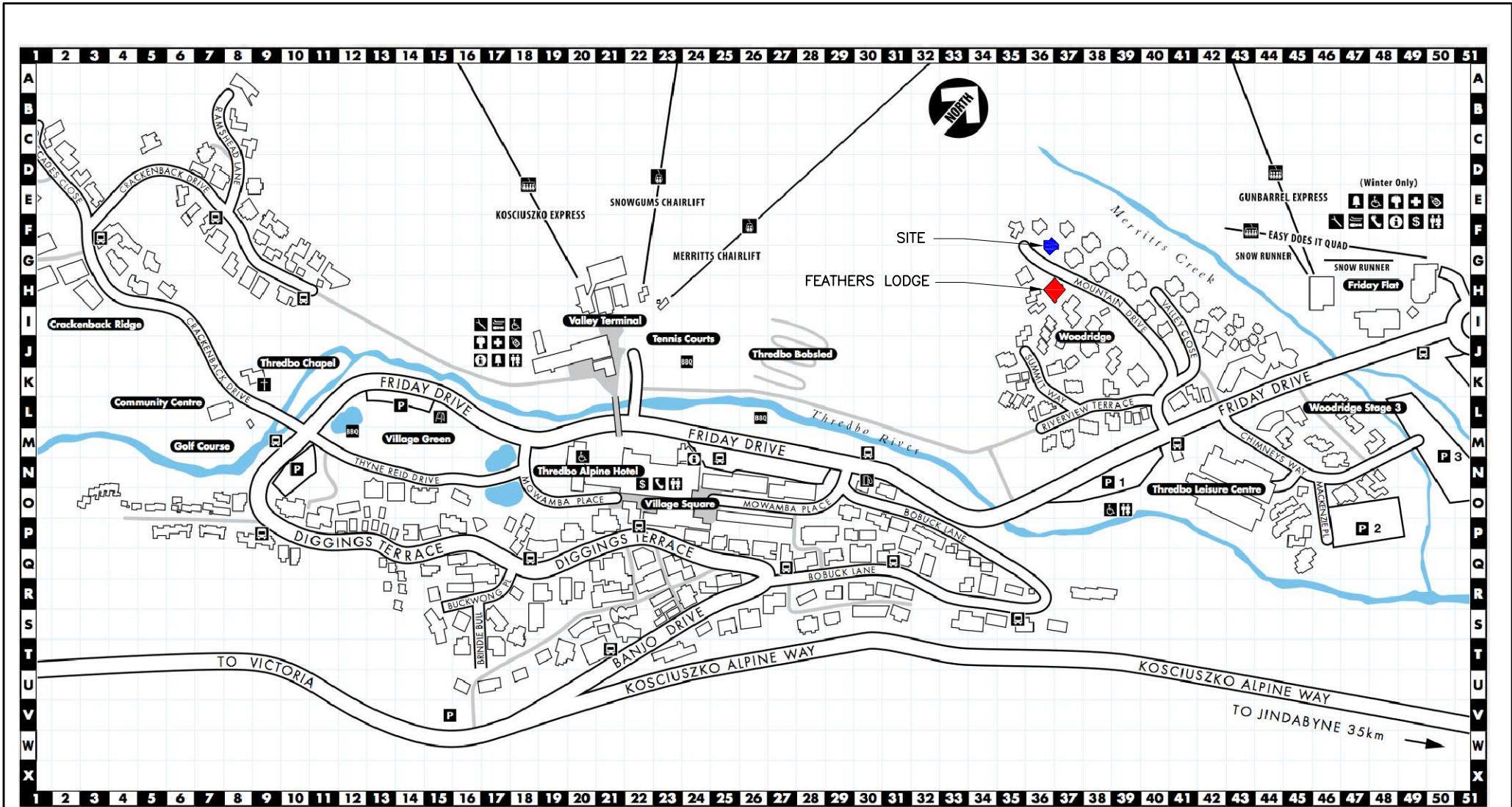
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| issue | date   | description   |
|-------|--------|---------------|
| A     | 6.2.15 | INITIAL ISSUE |

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PROPOSED RILEYS RUND LODGE  
 EXTENSION  
 LOT 610 MOUNTAIN DRIVE, THREDBO  
 for  
 MYSON BERKERY ARCHITECTS

SITE LOCALITY

drawn: MAB

date: 6.2.15

checked: MAB

scale: NTS

job no.:

3438

fig:

1

issue:

A



# Geotechnical Policy – Kosciuszko Alpine Resorts Form 4 – Minimal Impact Certification

Date received: \_\_\_\_/\_\_\_\_/\_\_\_\_

DA no: \_\_\_\_\_

This form may be used where minor construction works which present minimal or no geotechnical impact on the site or related land are proposed to be erected within the “G” line area of the geotechnical maps. A geotechnical engineer or engineering geologist must inspect the site and/or review the proposed development documentation to determine if the proposed development requires a geotechnical report to be prepared to accompany the development application. Where the geotechnical engineer determines that such a report is not required then they must complete this form and attach design recommendations where required. A copy of form 4 with design recommendation, if required, must be submitted with the development application.

**Please contact the Alpine Resorts Assessments Team in Jindabyne for further information.**  
Phone 02 6456 1733.

To complete this form, please place a cross in the boxes  and fill out the white sections.

## 1. Declaration made by geotechnical engineer or engineering geologist in relation to a nil or minimal geotechnical impact assessment and site classification

I,

Mr  Ms  Mrs  Dr  Other

First name

Mark

Family name

Bartel

OF

Company/organisation

Asset Geotechnical Engineering Pty Ltd

certify that I am a geotechnical engineer /engineering geologist as defined by the “Policy” and I have inspected the site and reviewed the proposed development known as

Rileys Run, Lot 610, Thredbo

As a result of my site inspection and review of the following documentation

(List of documentation reviewed)

Hand drawn plans by Myson Berkery Architects dated 15.10.2015

Survey by Peter W Burns (Ref 4735.610\_CD\_01\_A, dated 3.8.15)

I have determined that;

- the current load-bearing capacity of the existing building will not be exceeded or adversely impacted by the proposed development, and
- the proposed works are of such a minor nature that the requirement for geotechnical advice in the form of a geotechnical report, prepared in accordance with the "Policy", is considered unnecessary for the adequate and safe design of the structural elements to be incorporated into the new works, and
- in accordance with AS 2870.1 Residential Slabs and Footings, the site is to be classified as a type  
(insert classification type)

M

- I have attached design recommendations to be incorporated in the structural design in accordance with this site classification.

I am aware that this declaration shall be used by the Department as an essential component in granting development consent for a structure to be erected within the "G" line area (as identified on the geotechnical maps) of Kosciuszko Alpine Resorts without requiring the submission of a geotechnical report in support of the development application.

#### 4. Signatures

Signature

*Mark Bartel*

Chartered professional status

CPEng, No 35641

Name

Mark Bartel

Date

06 December 2015

#### 5. Contact details

**Alpine Resorts Assessments team**

Snowy River Avenue

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