Tasmania

**Tasmanian Geological Survey**
**Record 1998/01**

# Stability conditions at Shark Point Road, Penna

*by W. L. Matthews*

## INTRODUCTION

The Sorell Municipal Council has become aware of a number of stability and foundation problems in the Shark Point Road area at Penna, and there has been minor damage to at least one house. Although there has already been considerable residential development in the Penna area, which is about 5 km west of Sorell and 16 km northeast of Hobart, there is potential for further areas to be developed. An examination of the area was requested to aid in determining the reasons for the problems, whether anything can be done to improve the situation, and if further development should be limited. The possibility of the effects of farm dams, the nearby sand pit, and leaks from the water supply pipeline were to be examined.

The major housing development is on the lower side of Shark Point Road, just behind the shoreline. There is some undeveloped land between the road and the shoreline and further development is possible on the inland or northwestern side of the road. Part of the area has been previously examined by the Division as the result of a localised problem, apparently related to high groundwater levels, on the western end of the settlement (Weldon, 1986).

## TOPOGRAPHY

The access road to Shark Point extends along a narrow, gently-sloping flat area, on which many of the houses in the area have been built. The seaward side of this gently sloping area ends abruptly in a steep slope to the shoreline. The height of this slope increases from 2–3 metres at the eastern end of the settlement to about 10 m for most of the western area that has been developed. As the land on the western side of the development rises higher the gently sloping flat area becomes less obvious. The area behind the flattish land rises more steeply, with varying slope angles, to Pontos Hills.

The gently sloping land near the access road is probably related to an erosion terrace formed as a result of a higher sea level. The land behind this zone is typical of land underlain by similar rocks in the region. The steep slope to the shoreline is a result of erosion by the sea and is likely to remain steep as undercutting of the base of the slope continues.

## GEOLOGY

The geology of the area is covered by the Hobart (Leaman, 1972) and Sorell (Gulline, 1982) 1:50 000 scale geological map sheets.

The rock types occurring in the area comprise Permian-age siltstone and fine sandstone containing a few pebbles, Triassic sandstone (probably with minor shale beds), Jurassic dolerite, Tertiary clay and silty clay, and localised Quaternary deposits including wind-blown sand. The distribution of these materials is shown on Figure 1. Tertiary basalt occurs to the east of the area.

The Permian mudstone and sandstone are exposed along the shoreline in two small outcrops on either side of a dolerite body. It is not certain that the western exposure is definitely Permian in age as it has been considerably altered as a result of baking by the intruding dolerite. This outcrop may be Triassic in age but the presence of occasional pebbles and probable worm casts indicate that it is more likely to be Permian. Boulders of baked sedimentary rock occur above the road and up the western margin of the dolerite body.

The main area of Permian rock exposure is on the lower slopes of the land above the road, and these rocks extend around the slope to the northeast and north of the middle section of the settlement. Extensive surface exposures are present in a number of locations, including the small stream that traverses the area. The Permian rocks tend to be covered by relatively shallow soils.

Triassic rocks are exposed on the western part of the shoreline section where localised cliffs occur. There are also two small exposures of sandstone along the eastern part of the shoreline which may be Triassic or Tertiary in age, with the former being the more likely. A broader zone of Triassic sandstone occurs

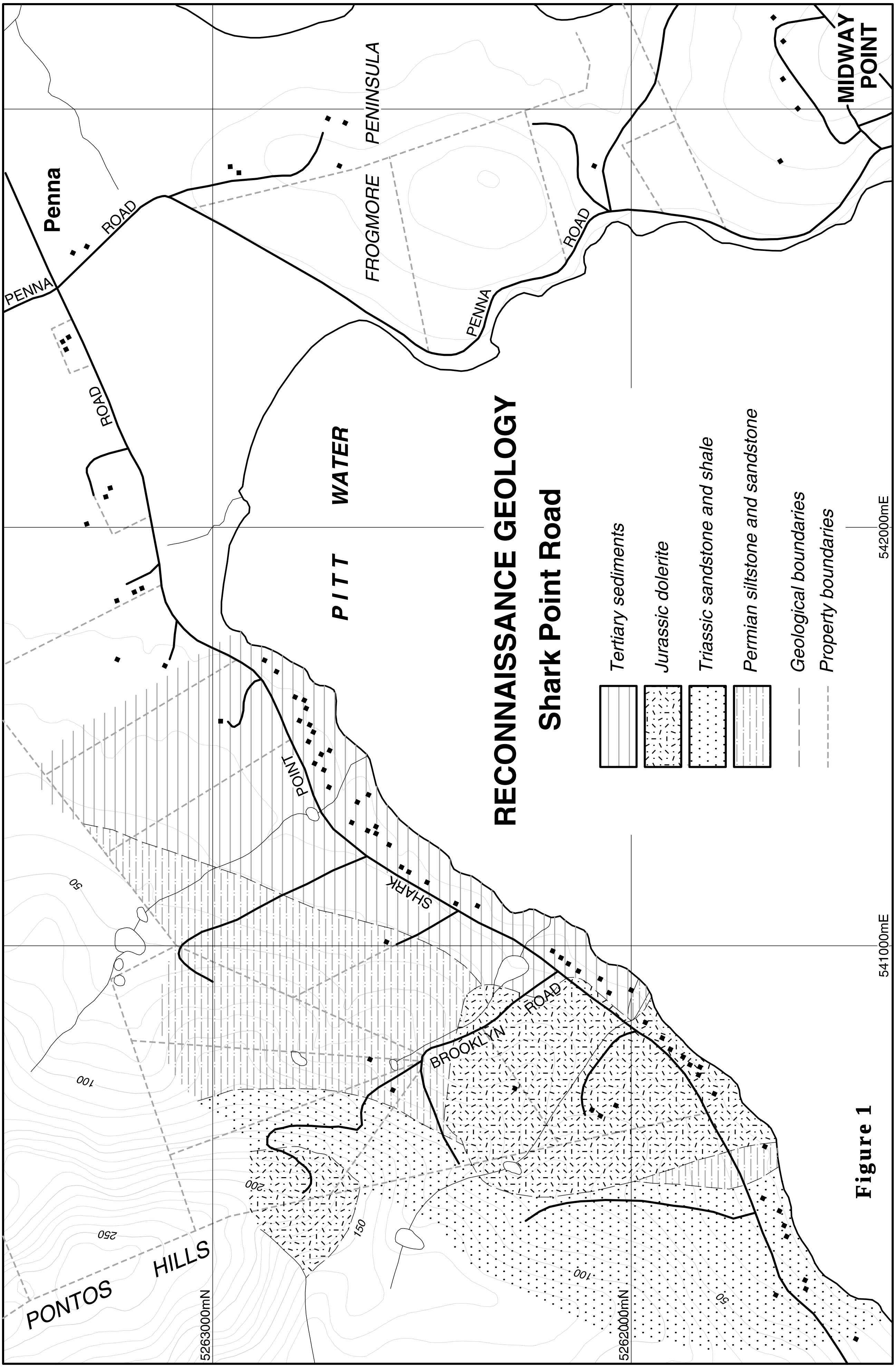
RECONNAISSANCE GEOLOGY
Shark Point Road
Tertiary sediments
Jurassic dolerite
Triassic sandstone and shale
Permian siltstone and sandstone
Geological boundaries
Property boundaries
PITT WATER
FROGMORE PENINSULA
MIDWAY POINT
Penna
PENNA ROAD
SHARK POINT ROAD
BROOKLYN ROAD
PONTOS HILLS
5263000mN
5262000mN
541000mE
542000mE
5770a
50
100
150
200
250

Figure 1

higher on the slopes above the Permian rocks. The sandstone is also exposed in the sand pit above the settlement but the Triassic rocks are generally more deeply weathered than the Permian and bedrock is covered by thicker accumulations of soil and loose material.

Jurassic dolerite occurs in a broad zone along the shoreline and road in the middle part of the settlement, and is overlain by Permian rocks above the road. Dolerite also occurs at higher levels and caps Pontos Hills, the highest ground in the area. The dolerite is variably weathered, with some zones of deeper soil in the near-shore areas, and crops out commonly at shoreline levels, in road cuttings, and at higher levels on the slopes above the road, as well as on the top of the ridge forming Pontos Hills.

Tertiary sediments occur at the eastern end of the settlement and continue further to the east. These rocks occupy the lower-lying flat land, and where exposed consist of silty clay and some bouldery zones near where Permian rocks crop out at lower levels. The most detailed knowledge of the nature of these sediments comes from drill hole information. Holes drilled to about eight metres in the settlement area as part of this survey (Appendix 1) show the sediments to be mainly clay and silty clay. Water bores drilled about 30 years ago to the east of the area were drilled to several tens of metres in dominantly clayey material.

The Quaternary material includes deposits around the stream, sediments on top of the gently sloping zone where development has taken place, and windblown sand derived from the weathering of Triassic sandstone.

## STABILITY

Recent landslide movements are evident within the built-up area, all occurring on the steep slope to the shoreline (fig. 2). The three known active areas do not appear to have affected the nearest structures significantly but in each case there are cracks in the soil very close to these structures. There are also signs of old landslides at some points between the road and the shoreline and probable old landslides in one area of steeper land above the road.

The main area of concern is that part of the settlement underlain by Tertiary sediments, where these materials underlie the steeply-sloping land behind the shoreline. A relatively broad zone shows signs of old movements, resulting in the land having a hummocky appearance. It is in this zone that two of the three known recent movements have taken place.

Only the areas underlain by Tertiary sediments on or near the steep slopes to the shoreline are regarded as having a risk of instability. The land back from the steeper shoreline zone is generally almost flat and the risk of landslides affecting these areas is regarded as low. There is always some risk of a portion of the flat land near the steep slope being affected as progressive failures on these slopes continue and it is important that this prospect is taken into account when development is being considered.

Landslide risk in other parts of the area where the older rocks occur is likely to be largely restricted to zones where there are thick accumulations of soil, loose material and deeply weathered rock on the steeper slopes. This is the situation where the most westerly landslide movement has taken place. Such zones may occur on or near the steep slope to the shoreline where the older rocks are present and on some of the steeper slopes above the road. One such area has been identified uphill of the road and this area could require special attention if further development is proposed.

One important aspect in the formation of landslides is the presence of water in association with sloping land underlain by landslide-prone material. Zones where surface and subsurface water flow is directed can be particularly at risk from landslides. Zones low on the slope or just above sea level are likely to become saturated or near-saturated during heavy rainstorms and it is in this condition that landslides are most likely to occur. Saturation can take place as a result of dam leaks or bursts and leaking pipes, and landslides can also occur under these circumstances.

## EXPANSIVE OR REACTIVE SOIL

Clay soils are common throughout the area and particular care will need to be taken to ensure that foundations are designed to take expansive properties into account. Deep soil on dolerite and Tertiary sediments is likely to have expansive properties and any future building on deep soils underlain by these rock types should have site classification investigations so that foundations can be designed accordingly. The Permian and Triassic sediments are not as likely to produce expansive soils but any area where thick clay soils overlie these rocks should be treated in a similar manner to thick soils on Tertiary sediments and dolerite.

The cracks which have developed in one house, and which have been brought to the attention of the Sorell Council, are probably due to expansive or reactive clay.

## EROSION

Tunnel and gully erosion are evident in some parts of the area (fig. 2). These features are often associated with soils on Permian, Triassic and Tertiary sediments, and in the Shark Point area the most obvious examples are in the Permian soils above the road.

Continued erosion at shoreline level will take place from time to time as a result of wave action at high tide.

## DRILLING

Five holes were drilled at selected sites (fig. 2) to examine the rock sequence in areas where problems have occurred. These holes were left open for a time to enable measurement of groundwater levels.

The westernmost three holes (1–3) were drilled in soil and loose material overlying bedrock. These holes encountered probable bedrock at a few metres depth. The eastern two holes (4, 5) were drilled in the Tertiary sediments and bedrock was not reached in either hole. The logs of the bore holes are given in Appendix 1.

It is apparent from the drilling and previous investigations that there is a variable depth of loose unconsolidated material overlying bedrock in the western part of the settlement. It also appears that there is a deep zone of loose material, made up mainly of sand and clayey sand, in holes 1 and 2 with much shallower depths in hole 3 (i.e. decreasing towards the dolerite area). The thickness of loose material over bedrock is expected to decrease in a westerly direction along the road, as probable outcrops of sandstone can be seen in road cuttings in this area. The conclusion is that the upslope drainage from the dolerite area east of hole 3, and the sandstone area west of hole 2, will be directed to the zone around holes 1 and 2. This is because the surface contours favour this flow direction and because the contours on the top of bedrock will also encourage this, i.e. flow through the sandy sediments on top of bedrock will be towards the lowest point on the bedrock surface.

Tests have been conducted on samples from holes 4 and 5 in the Tertiary sediments (Table 1). These tests show that these sediments are highly plastic, with one strength test indicating that the material strength, once failed, is very low. The $\phi'_r$ angle of 9° is nearly as low as any value known from Tertiary sediments in the Tamar Valley.

X-ray analysis was used to determine the percentage of various minerals present in the material. Smectite is a clay mineral that is particularly expansive under most circumstances and is fairly common in similar sediments throughout the State. Kaolinite is a clay mineral with much lower expansive properties.

## WATER LEVELS

Water levels were measured soon after the bores were drilled in late 1994. Further measurements were made during the winter of 1995 and in mid-September 1995.

Standing water levels have varied and are obviously related to weather conditions prior to measurement. Soon after drilling, water levels in holes 1 and 2 were about 1.5–2.5 m below the surface, while the water in hole 5 was at about 1.5 metres. The latest readings (September 1995) showed water levels in hole 1 at 3.5 m, hole 3 at l.0 m and hole 4 at 7.6 m, with no water in the other two holes. The measured water levels do not appear to be closely interrelated, although generally they will all be high or low at the same time.

The lowering of water levels by drainage systems will aid in maintaining stability. In particular, a drain installed through the sand overlying bedrock in the western part of the settlement, where a problem has existed for some time, would be advantageous. A drain to bedrock in the vicinity of holes 1, 2 and 3 should intercept a large proportion of the water seeping through the surface sand from upslope of the road before it reaches the steep slope zone near the shoreline.

## INFLUENCE OF MAN-MADE STRUCTURES AND ACTIVITIES

A water supply pipeline has been installed along the road. Some breaks in the pipe have been recorded,

**Table 1**

*X-ray analysis of drill hole samples*

| Hole No. | Depth (mm) | LL | PL | LS | $\phi'_r$ | $C'_r$ | X-ray analysis Qtz (%) | Smec (%) | Kaol (%) |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 5.5 | 154 | 38 | 27 | | | | | |
| 4 | 7.3–8.8 | 124 | 35 | 23 | 9 | 3 | 20 | 26 | 55 |
| 5 | 3.3-4.3 | 132 | 37 | 23 | | | | | |

LL = liquid limit, PL = plastic limit, LS = linear shrinkage, Qtz = quartz, Smec = smectite, Kaol = kaolinite.

$\phi'_r$, $C'_r$ are residual shear strength parameters determined from shear box tests.

(Analyses and determinations by R. N. Woolley, Mineral Resources Tasmania.

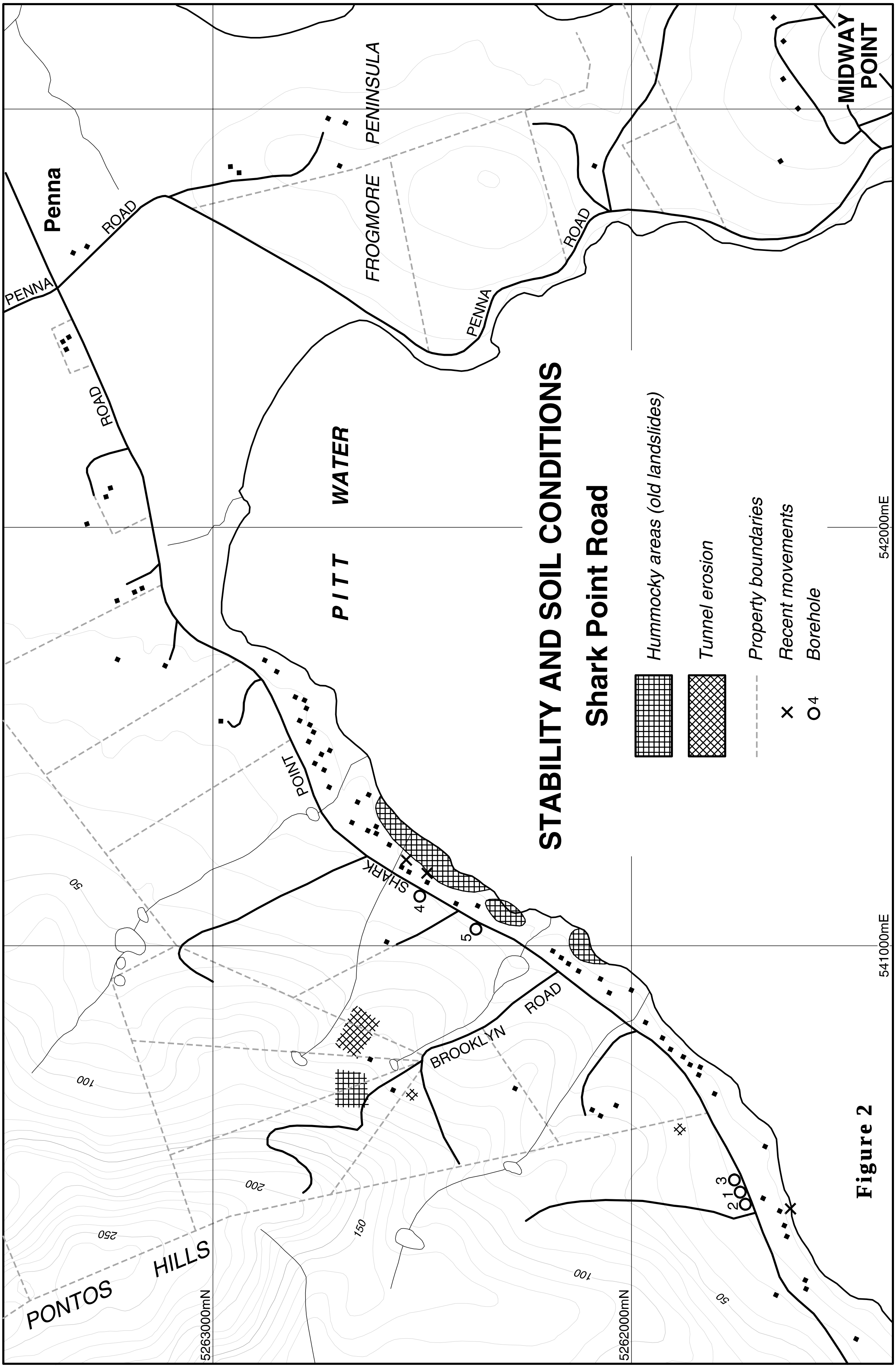
STABILITY AND SOIL CONDITIONS
Shark Point Road
Hummocky areas (old landslides)
Tunnel erosion
Property boundaries
Recent movements
Borehole
PITT WATER
FROGMORE PENINSULA
MIDWAY POINT
Penna
PENNA ROAD
SHARK POINT ROAD
BROOKLYN ROAD
PONTOS HILLS
5263000mN
5262000mN
541000mE
542000mE
5770b

**Figure 2**

resulting in the discharge of water into the soil. Particular danger exists if such breaks occur in the areas underlain by the Tertiary sediments and in zones where thick soil overlies the older rocks.

Dams in the area may leak and cause continual saturation of soil downslope. There is no evidence of significant leaks from dams and it is unlikely that property owners would allow large leakages to continue, because the effectiveness of the dams would be greatly reduced if water could not be retained for summer use.

The sand pit above the western part of the settlement has caused considerable disturbance to the surface and has probably resulted in greater infiltration (and less run off) of water during rainstorms. The effect of this on the stability of the shoreline cannot be determined with certainty. Greater infiltration may result in subsurface water movement through the area extending over a longer period. There may be some advantage in reducing the amount of water reaching the shoreline area during a rainstorm as the degree of saturation may be lower than would otherwise occur.

The land downslope of the sand pit is underlain by sandy soil and infiltration of rainwater into this zone will be considerable. This will provide a source of seepage water on the shoreline zone. The effect of this infiltration on increasing the risk of instability of the shoreline area, where houses have been built, is not regarded as particularly significant.

## CONCLUSIONS AND RECOMMENDATIONS

The area along Shark Point Road can be divided into three main sections. From the eastern end these are:

1. An area underlain by Tertiary sediments;

2. An area underlain by Jurassic dolerite and some Permian siltstone;

3. An area underlain by Triassic sandstone (and perhaps mudstone) beds.

### *Tertiary sediments*

This area consists dominantly of clay and silty clay and these sediments are expected to be at least several tens of metres thick. The height of the slope from the shoreline to the bench on which the houses and roadway are constructed is lower on the eastern end and gradually increases in height to the west.

Old landslides, and some more recent movements, occur on the western part of the foreshore slope in this segment. Houses built on the edge of this slope, particularly where old landslide movements are present, have some risk of being affected by landslides in the future. Homes further back from the edge are at much less risk.

The clay has expansive properties and the foundations of light structures, such as houses, need to be designed accordingly. Site classifications according to AS2870 should be made for any new structures. Houses should be sited at least 20 m from the steep slope to the shoreline unless specific advice suggests otherwise.

### *Jurassic dolerite*

This zone is indicated by boulders and outcrops on the foreshore, and sporadic outcrops and boulders along the road. Contact with baked Permian-age siltstone to fine sandstone occurs on the eastern side and this can be seen on the shoreline. Baked sandstone/siltstone with a few pebbles and probably of the same age is in contact with the dolerite on the western side. This contact can also be seen on the shoreline.

The dolerite is variably weathered on the sloping land around the road and the top of the slope to the foreshore. Exposures of dolerite in road cuttings on the eastern side of the zone show it to be deeply weathered.

The soil on the dolerite is dark brown to black and can be expected to have expansive properties.

Slumping is possible on the steep slope to the shoreline although no definite examples of this were noted. Signs of possible old landslides are present.

There should be little risk of significant landslides affecting this zone. However it would be advisable to build any new structures a little back from the steep slope to the foreshore as a precaution against unstable conditions developing in areas where weathering is deep. A distance of some 15–20 m from the steep slope is recommended wherever this is possible. Where not possible, subsurface investigations to locate bedrock or weathered rock need to be undertaken, so that foundations can be extended to these zones.

The expansive nature of the clay soil may require the design of special foundations where the soil over bedrock is thick.

### *Triassic sandstone*

This zone, on the western part of the settlement, is characterised by some outcrops of rock on the foreshore and occasional sandstone boulders in road cuttings. The soil is sandy over most of this area. It is sometimes a little difficult to determine the boundary with the dolerite because of windblown deposits covering the contact.

From test pits and drilling, the material overlying bedrock consists of sand, clayey sand and clay.

Development in this zone should be confined to areas away from the steep slope to the foreshore, particularly in areas where there is a thick unconsolidated layer overlying bedrock.

### *Drainage*

Because problems with stability have developed in at least three places along the road near to houses, it is important that the sloping land to the foreshore is kept as dry as possible. The need to discharge septic tank and sullage water, as well as stormwater, from each home will make this difficult. It is also important to prevent water from upslope of the road entering the zone between the road and the foreshore wherever possible, except in specific drains. The integrity of the water supply line serving the area needs to be ensured, as leakages from this pipe will increase the risk of stability problems in a large part of the steep slope to the foreshore.

The most critical zones where it is important to reduce water infiltration on the steep slope to the foreshore are the eastern part of the area underlain by Tertiary sediments and the zone where deep unconsolidated material overlies Triassic sandstone.

Although it is probably not economic to install sewerage, sullage and stormwater collection systems, this would be the most desirable measure to help maintain stable conditions along the foreshore. This, combined with the removal of stormwater from upslope of the road and a guaranteed mechanism preventing the water supply pipeline from leaking, would be the main means of helping to ensure stable conditions. A deep drain to bedrock in the area where deep unconsolidated sand overlies sandstone (i.e. in the vicinity of holes 1–3) should pick up a large proportion of the seepage water from upslope and prevent it discharging on the steep slope to the foreshore. The sand cover in this area allows ready infiltration of rainwater underground. Some water will seep into bedrock and this drain will not intercept any of this water. The effect of the sand pit upslope may be small and insignificant in this process, as long term residents have suggested seepage has come out in this area before the sand pit operated. The extensive sand cover in the whole area will ensure that a large proportion of rainfall will percolate underground and form a long-term supply for seepages lower on the slope.

As it is unlikely that waste water and stormwater will be collected, the method of discharge of these, particularly in areas where problems have developed, needs to be examined. It is not desirable to discharge water onto the slope directly in front of the houses, as is the case in at least one of the problem areas (in the western part of the settlement). This water should be piped around the contour and discharged, preferably in a flat zone on the lot.

### *New Developments*

Any new developments along the foreshore need to be closely controlled as far as positioning of houses and discharge of water is concerned. There may also be an occasional lot where any development would be inappropriate.

Possible problems are not confined to the area near the shoreline, as some hummocky land occurs on steep slopes above the road where some development has already taken place. Such areas should also require geotechnical advice before development proceeds.

## REFERENCE

LEAMAN, D. E. 1972. Geological Atlas 1:50 000 series. Sheet 82 (8312S). Hobart. *Department of Mines, Tasmania.*

GULLINE, A. B. 1982. Geological Atlas 1:50 000 series. Sheet 83 (8412S). Sorell. *Department of Mines, Tasmania.*

WELDON B. D. 1986. High groundwater levels along Shark Point Road, Penna. *Unpublished Report Department of Mines Tasmania* 1986/80.

[25 March 1998]

# APPENDIX 1

## Logs of drill holes, Shark Point Road

*Hole 1*

| | |
|---|---|
| 0–0.1 | Dark grey brown sandy soil — moist. |
| 0.1–0.2 | Lighter brown grey sand, a little clay. |
| 0.2–0.3 | Grey sand, loose, fairly dry. |
| 0.3–0.9 | Light brown sand, minor clay, a little moist. |
| 0.9–1.3 | Light brown sand, a little clay, becoming more moist. |
| 1.3–3.2 | Slightly darker sand, a little clay. |
| 3.2–3.4 | Mid-brown grey sand, a little clay. |
| 3.4–4.4 | Mid to dark brown clayey sand, sandy clay, some pellets of this material. Drilling became hard. |

*Hole 2*

| | |
|---|---|
| 0–0.1 | Fill — dolerite soil and fragments. |
| 0.1–0.7 | Light grey brown sand, moist. |
| 0.7–1.5 | Brown sand, a small clay content. |
| 1.5–2.0 | Brown clayey sand, clay increasing. |
| 2.0–2.2 | Light grey sand, moist. |
| 2.2–3.4 | Grey brown sand with clayey nodules. |
| 3.4–3.7 | Hard drilling, weathered dolerite?/sandstone? |

*Hole 3*

| | |
|---|---|
| 0–0.9 | Grey sand (quartz), wet. |
| 0.9–1.8 | Mid-brown clayey sand with rock fragments, sandstone particles. Too hard to drill further. |

*Hole 4*

| | |
|---|---|
| 0–0.5 | Dark grey brown sandy clay, plastic. |
| 0.5–1.6 | Lighter grey and grey brown sandy clay, plastic. |
| 1.6–2.0 | Red sandy clay, moist and plastic. |
| 2.0–3.4 | Red and light grey mottled silty clay and plastic clay. |
| 3.4–3.7 | Light brown plastic clay. |
| 3.7–6.7 | Light brown silty clay, plastic. |
| 6.7–9.0 | Light grey clay, plastic. |
| 9.0–9.1 | Mid-brown silty clay, plastic. |

*Hole 5*

| | |
|---|---|
| 0–0.1 | Dark brown clayey silt soil. |
| 0.3–0.9 | Mid-brown grey plastic clay. |
| 0.9–1.2 | Light brown and grey mottled clay. |
| 1.2–1.5 | Light grey and brown silty clay. |
| 1.5–2.0 | Light brown grey plastic silty clay. |
| 2.0–3.4 | Light grey-cream clayey sand (fine) some silt. |
| 3.4–4.3 | Light grey plastic clay. |
| 4.3–5.2 | Pink and grey mottled plastic clay. |
| 5.2–7.0 | Light pink-grey silty clay, plastic. |
| 7.0–7.3 | Light brown silty clay, moist. |
| 7.3–9.1 | Brown sandy clay, pinkish towards end. |