1976/63. Landslips in the Glenlusk Valley.

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The Glenlusk Valley comprises an area (about 6 km^2) of high relief west of Berriedale. Deeply incised valleys feed the eastward-flowing Faulkners Rivulet, which is an underfit stream.

Present building development consists of scattered individual houses throughout the area, and more concentrated development on the floor of the eastern part of the valley.

This report describes the nature and location of the landslips within the valley. It includes a zone map of potential landslip areas within which development should be restricted, and special building regulations applied.

GEOLOGY

Bedrock

Detailed mapping of the geology of this area was undertaken by Sutherland (1964; fig. 1). He concludes that a cone sheet of lower to middle Jurassic dolerite intruded sub-horizontal Permian and Triassic strata. He also postulated extensive faulting at the time of intrusion, and later tensional faulting associated with Tertiary epeirogeny.

Within the Glenlusk Valley Triassic rocks are not present. Permian strata and dolerite are complexly faulted, and often intensely jointed. Detailed descriptions of the Permian rocks are given by Sutherland (1964) and Leaman (1976).

Ferntree Group. Comprises the Risdon Sandstone (3-4.6 m thick) overlain by the Ferntree Mudstone (165-180 m thick). The Mudstone is predominantly a siltstone with alternating fissile and non-fissile bands, sandstone and occasionally conglomerate.

Malbina Formation. This formation includes about 85 m of alternating sandstone and subordinate siltstone.

Cascades Group. This is a fossiliferous group of rocks which, in the Glenlusk area, comprises 18 m of massive and fissile siltstone, overlain by 40 m of alternating limestone and fissile siltstone, overlain by an easily weathered siltstone unit 12-20 m thick.

Montmorillonite horizons and nontronite have been observed in the limestone-siltstone unit (Hale and Brill, 1955).

Faulkner Group. This group is about 27 m thick and includes sandstone, siltstone and mudstone.

Bundella Mudstone. Comprises 75 m of massive and fissile siltstone with calcareous and limestone beds.

Undifferentiated Lower Permian. These rocks include 200 m of massive and fissile siltstone and occasional sandstone.

Recent Processes and Superficial Deposits

The Glenlusk area is characterised by deep, steep-sided valleys which contain small, underfit, streams. This may be accounted for by a combination

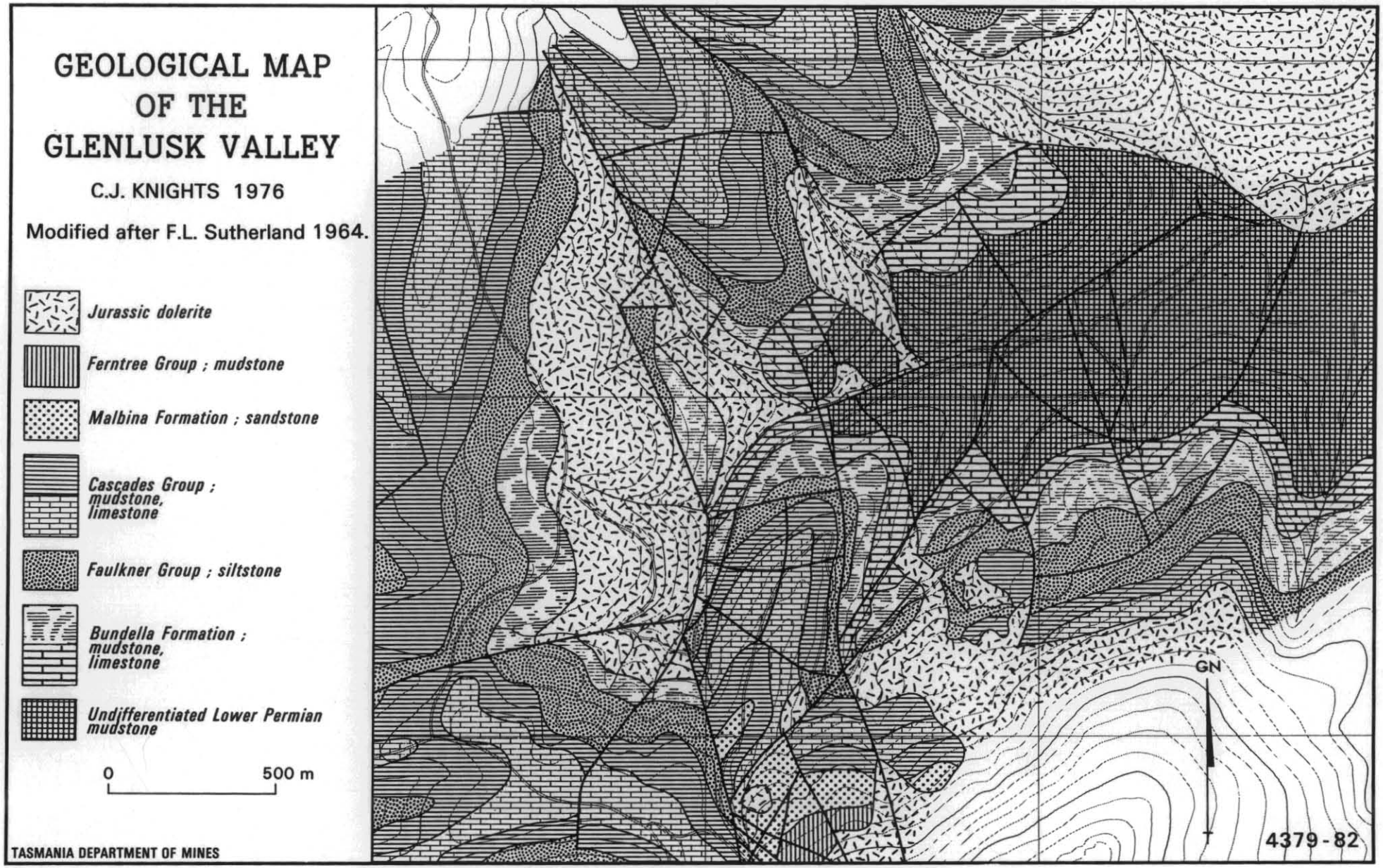

Figure 1.

5 cm

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of three processes. During the early Pleistocene there was a considerable fall in sea level, causing rivers to have greater down cutting energy. The Pleistocene period includes several climatic cycles. Interglacial periods were probably accompanied by heavy rainfall, also each time the ice melted, large quantities of water flowed from the mountains to cause rapid river erosion. It is also probable that Faulkners Rivulet once had a much larger catchment area than at present, but that the headwaters were captured by the north-westward flowing Sorell Creek.

Remnants, 4-5 m deep, of solifluction deposits are present on the south-west side of Glenlusk, and indicate that periglacial processes were active. The fact that these deposits are generally not present in the valley suggests that there has been considerable erosion since solifluction was active.

Weathering products

Weathered rocks and colluvium overly both the dolerite and Permian rocks to a depth of 1-5 m, and tend to be thickest where faults or old landslips have disturbed the underlying rock.

Dolerite weathers to a red-brown clay containing rounded boulders and pebbles of hard rock.

The Permian rocks weather to a brown or grey plastic silty clay which often contains quartz sand and irregular fragments of the original rocks. Several samples of weathered colluvium were air-dried and immersed in fresh water. One of these samples showed quite strong dispersion, and others slaked readily. It is evident that some of the Permian clays are soft, dispersive, highly erodeable and likely to cause difficulties where they are associated with water.

Solifluction deposits

Gravel deposits, formed by frost action and solifluction during Pleistocene times are now found in localised pockets. The deposits consist of small, angular, fragments and some very large blocks of Permian rocks, in a fine silt and clay matrix. Some stratification can be seen.

These deposits do not appear to be subject to landslip. At EN191589 they stand as vertical cliffs, up to 5 m high, despite a slightly dispersive clay matrix.

ANCIENT LANDSLIPS

On either side of the upper Glenlusk road there are scarps of ancient, deeply seated, rotational landslips, each of them covering several hundred square metres. These landslips occurred in Permian rocks at the base of the dolerite, and extended downhill in a series of deep slices. The present surface expression of these features are steep hill scarps, back tilted blocks, ponding, and hummocky toes. In a road cutting [EN176584] the strata of the Permian rocks are seen to be buckled and fractured by the landslip movement.

The age of these landslips is unknown, but they show no signs of recent instability. They may date from a time with a much wetter climate, or from a time of high seismicity during Quaternary times.

Disturbance and fracturing of the rock caused by these ancient landslips has enabled deep weathering to occur, and thick colluvium to form which is subject to modern day processes of shallow landslip and failure of cuttings.

RECENT LANDSLIPS

Shallow recent landslips are common throughout the cleared land in the Glenlusk Valley. They occur in weathered Permian material on slopes greater than 18°, and in weathered dolerite colluvium on slopes greater than 25°. Active slips are uncommon in bushland, although bent trees, and small scallops indicate that soil creep is active. Where slips are present they can be attributed to recent oversteepening of the slope, or to redirection of drainage.

Downslope of forested areas, or fences, there is often a scarp 1.0-1.5 m high, indicating that deep soil erosion has taken place. This erosion takes place through the actions of soil wash, soil creep and landslip. It is therefore often not possible to tell whether hummocky ground is due to soil creep, or to inactive landslips. Recognised recent landslips are indicated on Figure 2.

In Permian-derived material landslips range from shallow soil slips, a few metres wide, to slips 50 m wide and 4 m deep. Slips have been reported to occur suddenly, and typically they form a spoon-shaped depression with a bulging toe accompanied by a short mudflow. The material involved is generally a brown or grey clay mixed with rock fragments. Slips are more common when the colluvium is derived from mudstone or siltstone horizons.

In dolerite-derived material landslips are less common. The largest one seen is situated above the Molesworth Road [EN151589], and was probably initiated by the shallow road cutting at the toe. It is in weathered dolerite clay and talus, and is estimated to be 4-5 m deep and 25 m wide.

Faults and Landslips

Fracturing of the rocks by faults has allowed deep weathering to occur. Faults are particularly likely to be associated with landslip when they are aligned parallel or sub-parallel to a hillside or cutting; as for example at EN172579, where a fault in Faulkner and Cascades Group strata has formed a plane of weakness close to the surface of the hillside, and where there is also a thick layer of clay-rich colluvium provided by erosion of the fault material. In the road cuttings, and natural slopes of this hill there are many landslips 1-3 m deep.

LANDSLIPS AND HOUSING DEVELOPMENT

Within the mapped area there must be many landslips which have not been recognised because they have been smoothed over the natural processes, or by man's activities. In forested areas the present apparent stability may often be maintained only by the trees.

All land which is underlain by Permian rocks and slopes at more than 18°, or is underlain by dolerite, and slopes at greater than 25°, must therefore be at risk. Such land is unsuitable for general subdivision, although individual houses may be built on it if sited with care.

The 'at risk' areas are indicated on Figure 3.

Criteria for siting individual houses within the potential landslip zone

Within this zone there are areas of gently sloping land which are suitable for individual house sites. Where solid rock can be shown by test pitting to be within foundation depth, these sites may also be suitable for building.

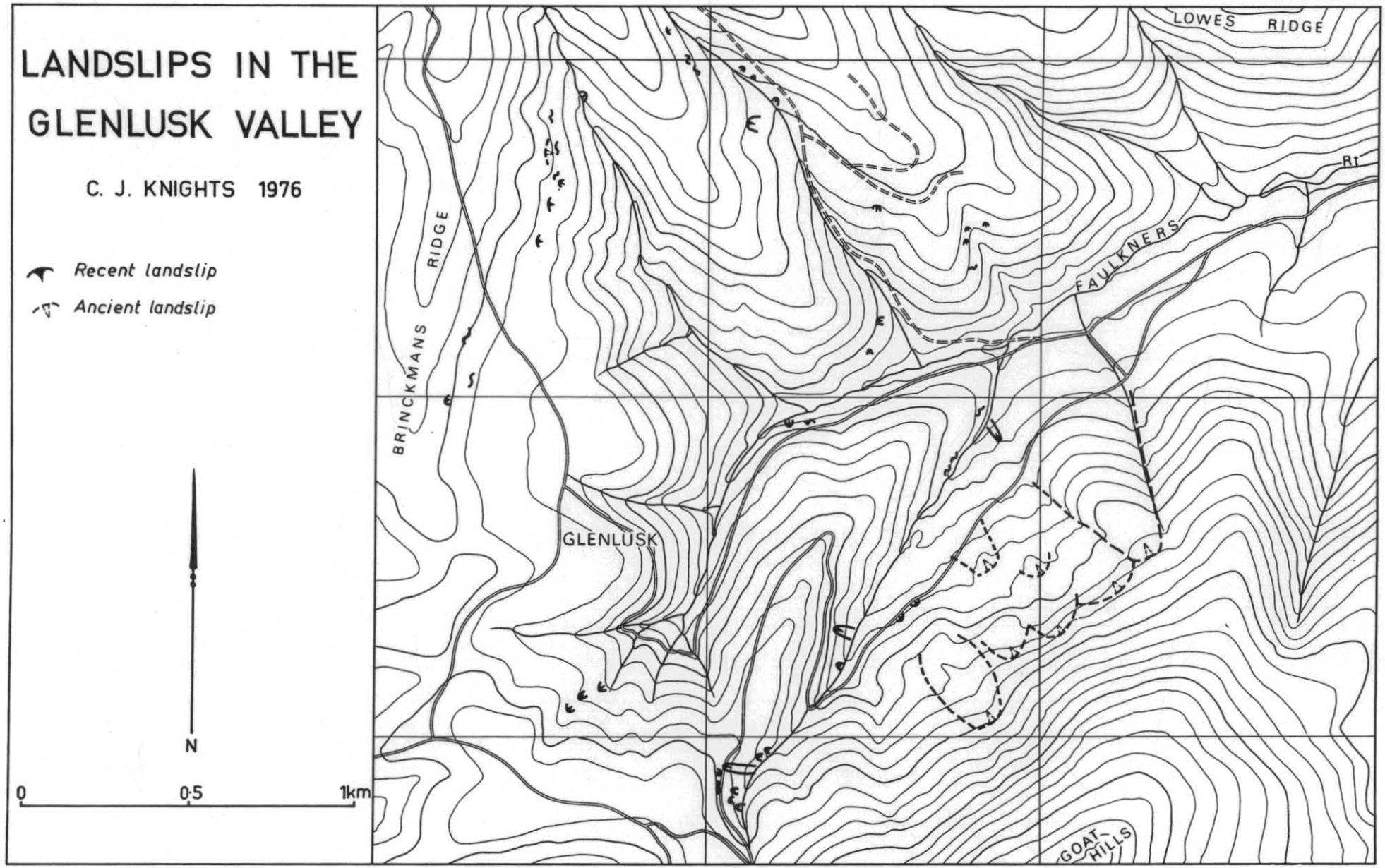
LANDSLIPS IN THE GLENLUSK VALLEY
C. J. KNIGHTS 1976
Recent landslip
Ancient landslip
N
0
0·5
1km
LOWES RIDGE
BRINCKMANS RIDGE
FAULKNERS
GLENLUSK
GOAT HILLS
5 cm

Figure 2.

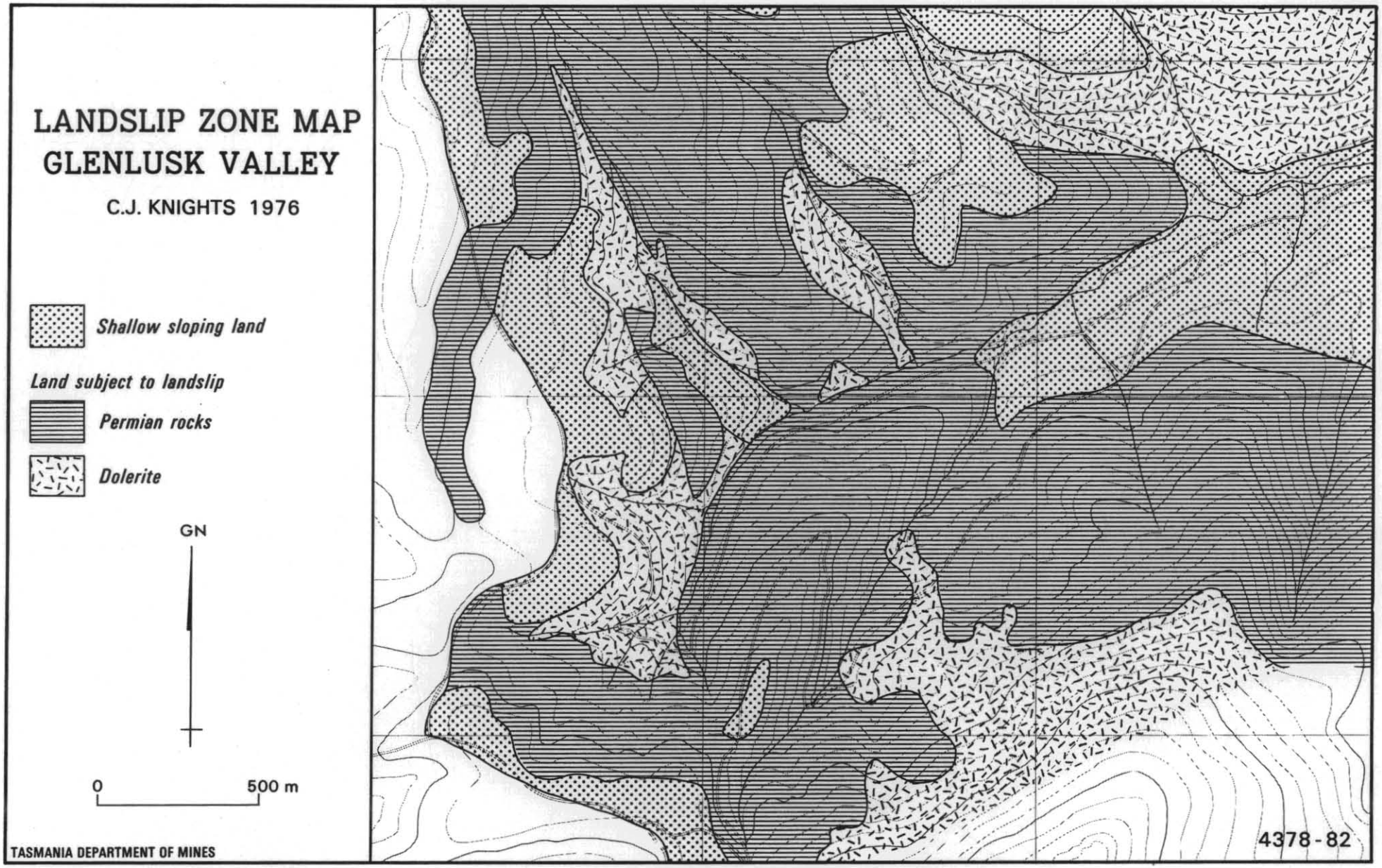

Figure 3.

5 cm

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Permian rock can be considered as solid when individual blocks are greater than 0.5 m across. Dolerite rock can be considered as solid when a level of hard rock is found in two adjacent test pits.

Factors such as the proximity of known landslips, nature of the colluvium, presence and attitude of faults, nature of drainage, should also be taken into account.

Houses to be built in the potential landslip zone should be constructed in accordance with *Building Amendment Regulations, No. 5,* 1974 which control drainage, depth of cuttings, size of house, etc.

CONCLUSIONS

Within the Glenlusk Valley recent landslips are common on land underlain by Permian-derived material and which slopes at more than 18°, and on land underlain by dolerite-derived material which slopes at more than 25°.

Recent slips are most common on cleared land; ancient, very large landslips are present above the upper Glenlusk Valley road. Recognised recent landslips are shown on Figure 2 and potential landslip zones on Figure 3.

No general housing development should take place within the potential landslip zone. Individual houses should be sited with care and be at least 100 m apart; they should be built in accordance with *Building Amendment Regulations, No. 5,* 1974.

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