Tasmania Department of Resources and Energy

Division of Mines and Mineral Resources — Report 1991/27

Geological investigation of a proposed reservoir inlet pipeline at Clives Hill, Old Beach

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Introduction

A geological investigation of the route of a proposed inlet pipeline to the 4.5 ML water storage reservoir to be constructed at Clives Hill, Old Beach (522750 mE, 5264300 mN) (fig. 1) was undertaken at the request of the Hobart Regional Water Board. This report is one of a series of similar investigations carried out by the Division of Mines and Mineral Resources over the past few years.

The investigation of this 600 m long section sought to provide the following baseline information:

(1) the nature and range of subsurface materials likely to be encountered en route to a depth of 2.0–3.0 m (reported average excavation depth);

(2) the rippability or ease of excavation of materials;

(3) soil corrosivity along the route.

The investigation involved surface geological mapping, continuous resistivity traversing and subsequent seismic refraction work at selected locations along route.

Survey details

Resistivity

Continuous resistivity traversing was carried out along the entire route so that a guide to the soil corrosivity could be determined. The traversing was done using the constant electrode spacing Wenner configuration; electrode spacings of 4.0 m were used.

Seismic refraction

Five spreads were fired at locations selected on the results of the surface geology and resistivity survey. These spreads were designed to determine a typical range of excavation conditions likely to be expected from the two rock types noted. Traverses were carried out both in areas of outcrop or sub-outcrop and soil cover only.

A Nimbus 12-channel seismograph was used; spread lengths of 24. 0 m were employed with 2.0 m geophone spacings. Shots were fired from both ends and also from the centre of spread 2. Calculations were by the critical distance, intercept time, and where appropriate, the reciprocal time methods.

Results

Every effort has been made to predict, as accurately as possible, the likely nature and range of materials to be encountered along the proposed route. It is stressed that in any investigation employing geophysical methods, the results are an interpretation (based largely on experience) of the physical properties measured. No amount of investigative work at this preliminary survey level can accurately predict the extremes or rapid variability of materials (both laterally and vertically) that may exist over short distances.

Contractors should view the results as a guide to conditions anticipated along the route. A series of trial excavations should preferably be undertaken to test the validity of the information inferred from the geophysical results. This would also enable contractors to assess the capability and suitability of their machinery for varying rock conditions.

Geology

The Hobart 1:50 000 scale geological map sheet (Leaman, 1972) indicates that the inlet pipeline will be underlain by Jurassic dolerite and Triassic sedimentary rocks. The site investigation confirmed this to be the case. The rock distribution is indicated in Figure 2. The dolerite–sediment boundary is estimated to be at about chainage 180 metres.

The surface geology along the part of the route underlain by dolerite (70%) consists of dark brown high plasticity clay with scattered dolerite float (boulders) and probable areas of sub-outcrop.

Figure 1

Several recently excavated test pits in the vicinity of the route and associated with the proposed Clives Hill subdivision exposed brown high plasticity clay with associated gravel size fragments of dolerite overlying highly weathered, closely fractured dolerite bedrock at generally less than 1.0 m depth. Bedrock, where noted, appeared to be generally closely jointed, with dolerite kernels not an uncommon feature.

The soil over the Triassic sedimentary rocks (30% of the route) was essentially brown sandy clay with scattered mudstone and sandstone float. Some rock fragments were partially baked from the effects of the nearby dolerite body.

Further comments relating to the general characteristics and properties of these materials are discussed later.

Geophysics

The seismic refraction survey results (Table 1) clearly indicate the variability of excavation conditions likely to be encountered along the route. The velocity plots are typically symmetrical in the broad sense but had stepped segments throughout, indicating that variable conditions can be anticipated across the site. This stepping effect is considered to represent either variations in the weathering characteristics of the rock mass (i.e. from MW–SW) and/or variations in the intensity of jointing. In general terms, the more fractured or closely jointed the rock mass, the lower the velocity, given the same degree of weathering.

The velocity segments, with the exception of the V_1 velocity figures, tend to vary considerably between spreads. This highlights the likely variability in conditions along the route over relatively short distances.

The resistivity survey results (fig. 3) can be interpreted with caution in a qualitative manner to indicate areas of substantial soil development as distinct from areas of probable bedrock close to the surface. Although the correlation is crude, deep soil profiles tend to have resistivity values less than 5000 ohm-m, whilst shallow hard rock conditions are probably present above 10 000 ohm-m. However it does not follow that the high resistivity areas necessarily indicate hard rock conditions close to the surface. It is stressed therefore that these categories are, until further evaluation, only broad approximations. Nevertheless the resistivity survey does give an indication and guide to those areas where either soil or rock conditions are likely to be prevalent.

Excavation conditions

The mapping, together with the geophysical survey results, indicate the probability of rapidly varying conditions along sections of the route. The majority of the materials that will be encountered during excavation (say 2–3 m average depth) are likely to be the soils and weathered materials of the parent bedrock. There will be sections of slightly weathered to fresh hard bedrock encountered.

It is the weathering, strength and joint (defect) characteristics of the rock mass that will ultimately determine the ease of excavation of those areas of bedrock encountered along route.

Triassic sandstone/mudstone sequences characteristically show a gradational weathering profile that produces sandy clay soils (SC–CH) grading down into a highly weathered low to medium strength rock. Because of the likelihood of some baking of the sediments, the materials may be relatively hard and of higher strength.

The dolerite typically has highly variable weathering characteristics which result in rapid changes in the nature and strength of the rock mass over short distances.

The rippability guide chart (fig. 4) relates the excavation capability of heavy machinery (D9 or similar) to seismic velocities over a range of rock types. The chart indicates that dolerite is rippable for velocities up to 1800 m/s. Between 1800 and 2500 m/s, ripping is considered marginal and ultimately depends largely on the orientation and intensity of fracturing of the rock mass.

Whilst conditions are likely to vary across the site, the majority of the material to be excavated to a depth of around 3.0 m should be rippable. The extensive use of a rock breaker would be anticipated for the materials representing the higher velocity ranges where ripping may be marginal. Because of the variable nature of the weathering patterns associated with dolerite, materials are likely to range from a more highly weathered low strength rock (1350 m/s) through to a hard, high strength, slightly weathered dolerite (2500 m/s).

It is probable that blasting will be necessary where slightly weathered to fresh dolerite kernels are encountered but this would depend on their relative size and relationship with the surrounding material.

Soil corrosiveness

The resistivity plot (fig. 3) indicates the relationship between resistivity and the degree of soil corrosivity. The classes used are based on information obtained from the Board.

Overall, the materials appear to be basically mildly corrosive (2000–10 000 ohm-m) on the Triassic sedimentary rocks but less so on the dolerite. No comment is made on the degree of protection required to ensure the longevity of the pipes.

Summary

The route is underlain by an irregularly weathered dolerite body (70% of route) and a partially baked sandstone/mudstone sequence.

The geophysical survey results, together with the geology, indicate a highly variable soil/rock mass in terms of strength and the degree of weathering. Some zones within the dolerite are considered to be marginal for ripping and workability will ultimately be a product of the joint geometry and weathering characteristics of the rock mass. It is envisaged that there will be some need for explosives.

It is recommended that contractors take time to view some of the exposures along the route and follow up with a series of trial excavations to confirm, and if necessary, modify the above findings and predictions.

Reference

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

[12 July 1991]

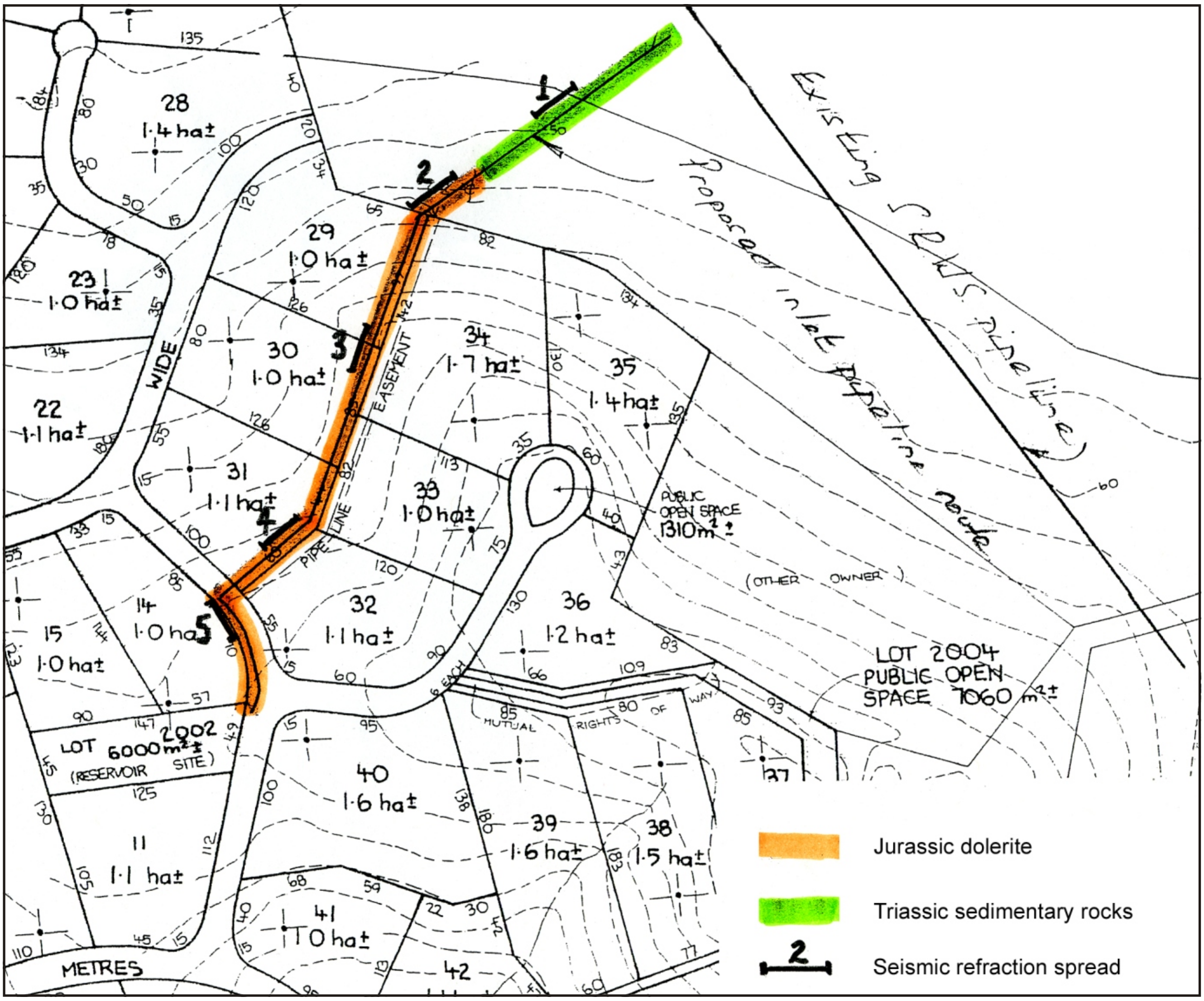

Figure 2

Geology of proposed pipeline route.

TABLE 1

Seismic refraction survey results

Distance (m)	Rock type	Velocity (m/s)		Layer depth (m)	Geological interpretation
Spread 1					
95–119	Sandstone/mudstone	V_1	300–330	0.5–0.8	Soil profile — brown sandy clay
		V_2	615–1140	2.3–4.5	Consolidated clay — HW bedrock
		V_3	2200–2500	–	SW bedrock
Spread 2					
188–212	Dolerite	V_1	300–500	0.7–1.0	Soil profile — red-brown clay (CH)
		V_2	900–1000	2.1–3.0	Clay and boulders and/or EW–HW bedrock, low strength
		V_3	1680–2000	–	MW–SW bedrock; joints open-closed
Spread 3					
302–326	Dolerite	V_1	310–350	0.7–0.9	Soil profile — red brown clay (CH)
		V_2	1550–1700	–	MW bedrock; joints generally open. (pockets of 2000+ m/s)
Spread 4					
440–464	Dolerite	V_1	300–400	0.9–1.0	Soil profile — red brown clay (CH)
		V_2	1800–2100	–	MW–SW bedrock; joints open-closed
Spread 5					
540–564	Dolerite	V_1	350–500	0.7–0.8	Soil profile — red brown clay (CH)
		V_2	1330	1.8–2.4	EW–HW bedrock, low strength
		V_3	2200–2500	–	SW bedrock

EW = extremely weathered, HW = highly weathered, MW = moderately weathered, SW = slightly weathered, FR = fresh

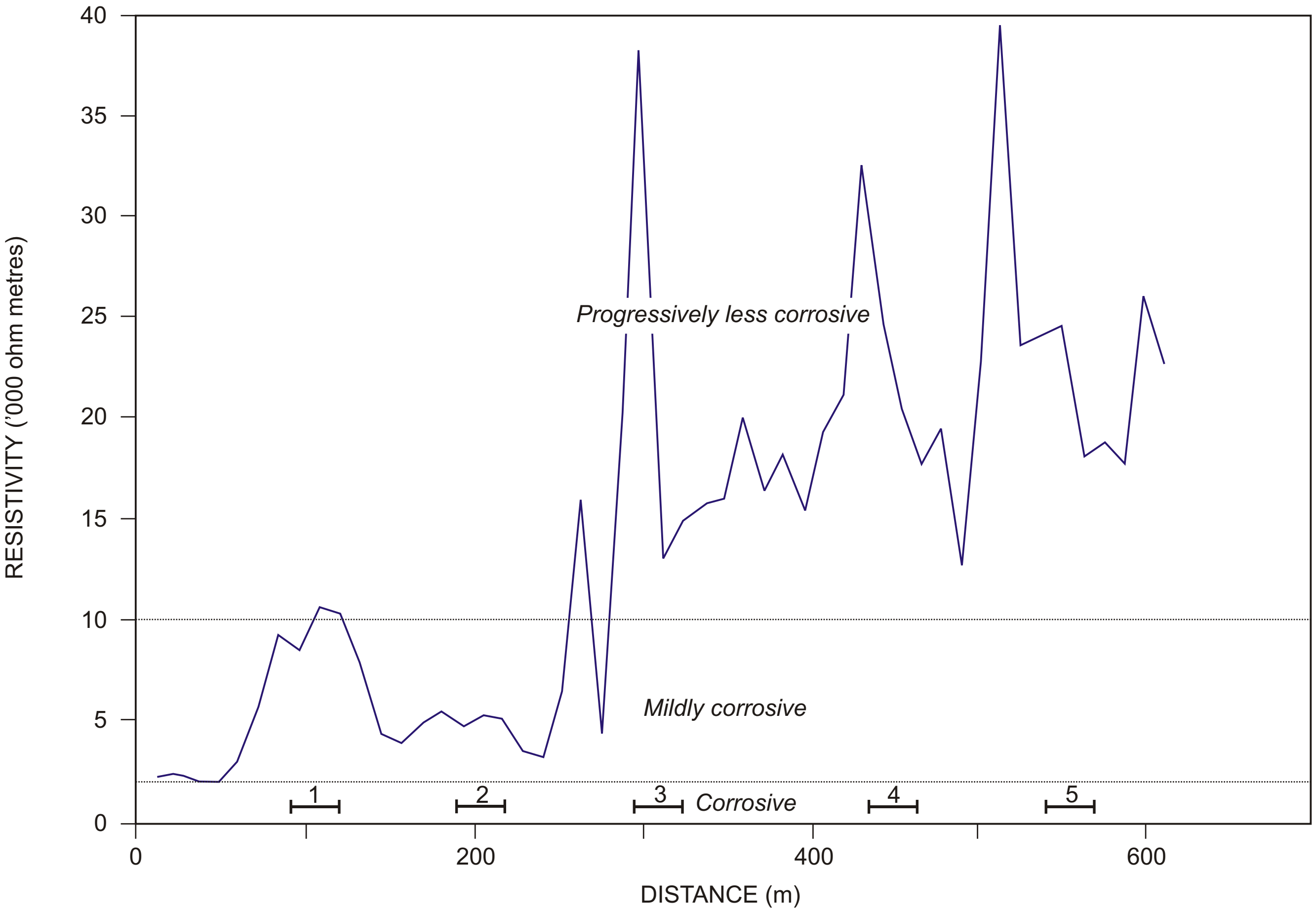

Figure 3

Resistivity survey at proposed inlet pipe site, with seismic spread locations shown.

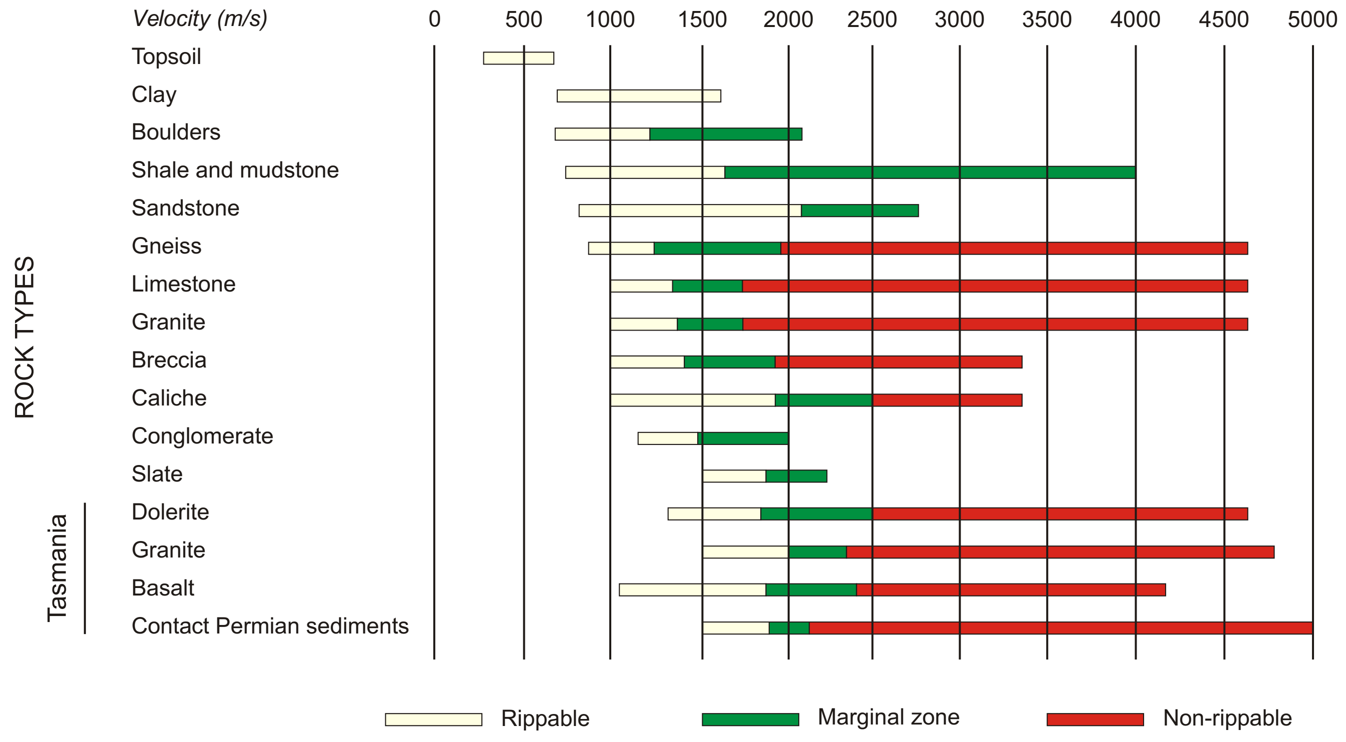

Figure 4

Guide to rippability (adapted from Soil Test Inc.).