Section

Rept. Bk. No. 63/35
G.S. No. 3514

R/B 63/35

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

ENGINEERING DIVISION

BLACKWOOD RAILWAY CUTTING

GEOLOGICAL INVESTIGATIONS, PROGRESS REPORT NO. 1

Railway Reserve, Hundred Adelaide

Client: South Australian Railways

by

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65-12

12th August, 1966. D.M. 65∅/65

63/35

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept. Bk. No. 63/35
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INTRODUCTION

A request to investigate slope stability problems in a railway cutting at Blackwood was received in a letter dated 6th May, 1965, from Mr. R. J. Bridgland, Chief Engineer, South Australian Railways, following discussions with Mr. Reed, Design Engineer.

The cutting is located 11 miles from Adelaide on the main line to Melbourne, between the level crossings at Brighton Parade and Coromandel Valley Road (Fig. 1). Recurrent failure of the cutting, mainly during winter, has resulted in minor land-slides of up to 30 cub. yards.

SCOPE OF THE INVESTIGATION

The behaviour of the materials forming the cutting has been observed during the winters of 1965 and 1966. Geological logging of the cutting has been carried out on scales of 1in. = 20ft. and 1in. = 40ft., and detailed sections have been made on a scale of 1 in. = 10ft. (Fig. 1). Two backhoe trenches were dug at the top of the cutting and four were dug by hand methods on the cutting sides. Several hand auger holes were drilled.

OUTLINE OF REGIONAL GEOLOGY

The geology of the region is outlined on the Echunga 1-mile Geological sheet (published 1954). Blackwood is situated in the Mount Lofty Ranges, on the uplifted Eden Fault Block.

Basement rocks are of Proterozoic (Sturtian) age and consist of calcareous slates with occasional siliceous limestones and thin quartzites. Tertiary freshwater gravels and sandstones, lateritised in part, occur as remnants on the dissected high level erosion surface of the basement rocks.

DETAILED GEOLOGY

The geological sequence is fairly constant for most of the length of the cutting. An idealised geological section is summarised below:-

Depth (ft.)	Age	Description
0 - 3	Recent	Topsoil. Whitish brown to grey sand overlies brownish grey mottled clay and sandy clay.
3 - 13	Tertiary	Laterite. Essentially fine to medium grained sand, very strongly cemented. Coarse polyhedral structure with units up to 3in. size, not readily separable. Less well cemented towards base.
13 - 22	"	Sand. Whitish, fine to medium grained, poorly graded, containing up to 15 per-cent silt and clay fines. Very dense, but non-cemented and friable when dry. (Hand augering extremely difficult). Low permeability, readily softened and eroded

		by surface waters.
22 - 31	Tertiary	Clays. Essentially clay, grading in parts to sandy clay and clayey sand. Subject to expansion and contraction on wetting and drying, with consequent development of cracks, often infilled with sand. Several water seepages observed from this horizon during winter months.
31 - 42	Proterozoic	Bedrock. Slate, calcareous, laminated, with a well developed cleavage dipping steeply north-east, interbedded with felspathic Quartzite.

STABILITY CHARACTERISTICS

The bedrock is stable, and the topsoil is of no consequence in the stability problem. It is evident that initially failure has occurred in the sand and clay horizons, resulting in eventual failure of the overlying laterite.

The factors considered to be of major importance in the individual failure of each horizon are listed below:-

Laterite: .... removal of lateral support, resulting in the formation of near-vertical joints or cracks more or less parallel to the length of the cutting.

.... water pressures in pores and joints

.... removal of basal support by failure of the underlying sand.

Sand: .... removal of lateral support

.... water pressures in pores and joints

.... softening and erosion on exposed surfaces and along and near joints by surface run-off waters.

Clays: .... seasonal shrinking and swelling, making the jointed mass less compact near the ground surface

.... lower shearing resistance during winter due to increase in moisture content

.... water pressures in joints

.... removal of lateral support

<u>Bedrock</u>: .... stable

DISCUSSION

It is considered that failure of the cutting will continue slowly until stable slope angles (probably 35° to 40°) are attained, unless some form of remedial action is taken. During discussions at the site with Mr. Reed, several possible methods of treatment were considered and are summarised on Fig. 1. A summary of geological conditions in the cutting shewing the sections which require treatment is given on Fig. 2.

Failure of the Blackwood cutting has occurred mostly during winter, and it seems certain that the seasonal increase in moisture content in the materials is an important contributing factor. For long term stability, the provision of adequate drainage is considered necessary. Subsurface drainage of the geological materials, and of any backfill material used, may be determined by the form of treatment. However, improvement of the existing surface drainage, by interception and diversion of surface run-off in lined catch drains, should be carried out as part of any type of treatment decided upon.

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SKETCH SECTIONS SHOWING SUGGESTED TREATMENTS
APPROXIMATE SCALE: 1 INCH = 40 FEET
SECTION C—C′
1. OPEN TUNNEL
-Steel arches, seated on bedrock on both sides of cutting
-Lagging from base of arch for sufficient height to retain fill
-Pervious fill to cover base of laterite
-Drainage
SECTION D—D′
2. GUNITE
-Scale down and clean up face of cutting
-Install mesh, pinned by dowels or rock bolts, apply gunite
-Drainage - Include weep holes through gunite
SECTION B—B′
3. RETAINING WALL
-Concrete or masonary wall
-Pervious fill to cover base of laterite
-Drainage
-Steel or timber beams rock bolted to bedrock at base of cutting
-Pervious fill to cover base of laterite
-Drainage
SECTION F—F′
4. EXCAVATION
-Flatten slopes of cutting to stable angle (1½:1)
-Protect faces by grassing or other means
-Drainage
5. CLEAN-UP
-Remove loose materials, boulders, etc.
-Protect faces by grassing, etc.
-Drainage
NOTE - DRAINAGE 1 Surface Lined catch drains along the top of the cutting. Improvement of the existing drainage system should be adequate
2 Sub-Surface Drainage of the geologicals materials by a system of spears, located particularly at the sand/clay and clay/bedrock interfaces. Drainage of fill material
PLAN
LONGITUDINAL ELEVATIONS
NORTH SIDE (DOWN)
SOUTH SIDE (UP)
OVERWAY BRIDGE
CROSS SECTIONS LOOKING UP LINE
SECTION F—F′
SECTION D—D′
SECTION A—A′
SECTION E—E′
SECTION B—B′
SECTION C—C′
LOCALITY PLAN
LEGEND
RECENT
TOPSOIL Greyish clayey sand overlies mottled silty and sandy clay.
SLOPEWASH Topsoil, sand & laterite debris
TERTIARY
LATERITE Essentially sand, fine grained, few silt & clay fines. Very hard & strongly cemented, iron stained at surface. Exhibits typical nodular lateritic structure.
SAND Fine to medium grained, contains up to 30% silt & clay fines. Whitish. Compact to very dense, high dry strength. At the surface a very hard irregular iron cemented "cap-rock" is developed.
CLAYS Very variable, consists of interbeds and lenses of clay, silty & sandy clay and clayey sand. Generally grey to khaki and brownish. At the surface a very hard, irregular iron-cemented "caprock" is developed.
PROTEROZOIC
SLATE Thin bedded, well developed cleavage. Calcareous. Highly to moderately weathered.
QUARTZITE Fine to medium grained, mainly massive. Highly to moderately weathered.
Geological Boundary - definite
Geological Boundary - approximate, inferred
Surface drain
DEPARTMENT OF MINES — SOUTH AUSTRALIA
RAILWAY CUTTING — BLACKWOOD
STABILITY STUDIES
GEOLOGICAL PLAN AND SECTIONS
ENGINEERING GEOLOGY SECTION
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Drn. J.A.C.P.
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SCALE: As Shown
L66—10
Ha 6
DATE: 14-1-66
FIG 1

CHAINAGE (Ft.) (1) From.	To.	DISTANCE Ft.	NOTES ON GEOLOGY	SUGGESTED TREATMENTS (2)	PRIORITY (3)
			NORTH SIDE		
0	200	200	Low cutting height, entirely in clay or topsoil. No signs of slope movement – apparently stable angles.	None (5)	C
200	350	150	Cutting mainly in clay; bedrock exposed at base in parts. Several small landslide scars.	4, 5	A
350	725	375	Clay and sand horizons relatively thick, both showing signs of recent failure. Laterite undercut, with stress-relief joints.	1, 2, 3.	A
725	800	75	BRIDGE	None	–
800	875	75	As for Chainage 350 to 725	1, 2, 3	A
875	925	50	Bedrock high above base of cutting. Clay and sand horizons well cemented.	1, 2, 3.	B
925	985	60	Clay and sand horizons relatively thick, both showing signs of recent failure. Laterite undercut, with stress-relief joints.	1, 2, 3.	A
985	1030	45	Bedrock high above base of cutting, sand and clay horizons relatively thin. Few signs of recent failure in sands.	4, 5	B
1030	1260	230	Bedrock high above base of cutting. Sand, clay and laterite wedging out. No signs of slope instability.	None (5)	C
			SOUTH SIDE		
0	300	300	Low cutting height, mainly in clay or topsoil. Several erosion gullies. No sign of slope instability.	None (5)	C
300	355	55	Full height of cutting in partly cemented clay. Several erosion gullies.	4, 5	B
355	730	375	Clay and sand horizons relatively thick, both showing signs of recent failure. Laterite undercut, with stress-relief joints.	1, 2, 3.	A
730	780	50	BRIDGE	None	–
780	830	50	Clay and sand horizons relatively thick, but generally well cemented.	1, 2, 3	B
830	965	135	As for Chainage 355 to 730	1, 2, 3.	A
965	1260	295	Bedrock high above base of cutting. Sand, clay and laterite wedging out. No signs of slope instability.	None (5)	C

NOTES.

1. Chainages are shown on Dwg. No. L 66-10
2. Possible types of treatment as discussed on site with officers of Railways Department, shown diagramatically on Dwg. No. L 66-10.
3. Priorities defined as follow:
   A. Recent failure obvious, continued failure certain unless treated.
   B. Treatment definitely required for long term stability.
   C. May be left without any form of treatment.

FIG 2

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
RAILWAY CUTTING — BLACKWOOD STABILITY STUDIES 63/35 GEOLOGICAL CONDITIONS, SUGGESTED TREATMENTS			
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