Section 2 – Engineering Geology

TR12-48-54

11. PRELIMINARY REPORT: GEOLOGICAL INVESTIGATION OF THE EASTERN REALIGNMENT ROUTE OF THE MIDLAND HIGHWAY OVER CONSTITUTION HILL, DYSART

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INTRODUCTION

At Caves Cliffs on Constitution Hill the proposed Eastern Realignment Route deflects 300 feet E from the present Midland Highway and passes through a cutting 38 feet deep.

The following geological information was required by the road planning section of the Public Works Department:—

(1) Type of rock likely to be encountered along the proposed route.

(2) The effect of rock hardness on construction methods and costs (Table 1).

(3) The angles of repose of the rock types and the recommended batter angles of cutting (Table 2).

(4) Any other geological factors likely to affect construction and maintenance.

GEOLOGY

Constitution Hill is composed mainly of Triassic sandstone and mudstone. Quaternary alluvium, talus and slump deposits occur in the valleys of the tributaries of Bagdad Rivulet which drains the S slopes of the hill. A small dyke of Jurassic dolerite outcrops in a quarry on the S slopes near the present road. No other outcrops of dolerite were found in the area although there were large dolerite boulders on the surface. The Triassic sediments which form most of the outcrops along the present route have been subdivided into three lithological units:—

(1) Dominantly sandstone.

(2) Interbedded sandstone and mudstone.

(3) Dominantly mudstone.

Unit (1) Dominantly Sandstone

This subdivision includes massive hard brown quartzo-micaceous sandstone and soft yellow to white quartzo-feldspathic sandstone which weathers to produce spheroidal surfaces.

At Caves Cliffs the massive quartzo-micaceous sandstone caps the high cliff section of the present road. Individual beds are 4 to 10 feet thick, and are separated by thinner sandy mudstone and sandy mudstone and sandstone beds.

The proposed route avoids all the large outcrop areas of hard thick sandstone except for two corners on the S slope of the hill. The first of these at 2,200 feet has to be trimmed back 10 to 15 feet and involves the removal of only a small amount of material. There are no construction problems. The second corner at 2,800 feet entails a 14-foot cutting with the removal of 9,000 cubic yards of material. Here a sandstone bed 10 feet thick is underlain by 12 feet of sandstone with minor mudstone beds and is overlain by 20 feet of hard mudstone. It should be posible to remove the hard mudstone by ripping with heavy bulldozers but the sandstone will require blasting. The distinct bedding in the sandstone and the vertical jointing present at this locality will allow the wedging out of large blocks after blasting.

As a hardness difference exists between the overlying hard sandstone bed and the underlying mudstone and sandstone, differential weathering could in time produce rock falls if the walls of the cutting were left at the steep natural angle of repose of the hard sandstone (75° to vertical) (Table 2). No rock falls have been reported on the present road at the foot of Caves Cliffs but here the mudstone underlying sandstone is very hard and the difference in hardness between the sandstone and the mudstone is very small.

The yellow and white feldspathic sandstone outcrops at the following localities on the present highway:—on the lowest corner on the southern side of Constitution Hill, near the Dysart Post Office, and from the summit down to the 10,000 feet peg. The sandstone is well bedded and when deeply weathered is soft Most of it would be easy to excavate, but it contains hard cemented bands which would need blasting.

On the proposed route blasting will be required on the lowest corner of the S side of Constitution Hill where the present corner is to be removed by cutting back a distance of 40 feet. Here an 8-foot band of siliceous cemented sandstone overlies 8 feet of the softer cemented sandstone.

Unit (2) Interbedded Sandstone and Mudstone

These beds are intermediate in lithology and other properties between the dominantly sandstone and mudstone subdivisions. They vary from mudstone interbedded with minor sandstone to sandstone interbedded with minor mudstone. The thickness of individual beds varies from 3 to 36 inches but both the sandstone and mudstone are well bedded and this will allow easier ripping by heavy machinery.

In weathered outcrops both the sandstone and mudstone are soft but in fresh outcrops, such as those in the small rivulets that cross the present road above and below Caves Cliffs, they are hard and compact. In a deep cutting where unweathered interbedded sandstone and mudstone could be encountered blasting may be required, but on the proposed route this is only likely to occur on the N end of the 34 feet high cutting to be excavated S of the Caves Cliffs (4,000 feet peg).

Deeply weathered outcrops of interbedded sandstone and mudstone form the low banks of the present road from S of the Dysart Post Office (7,700 feet) almost to the summit. They should present no excavation difficulties.

The angle of repose varies in the interbedded sediments depending on whether the mudstone or sandstone is dominant. If the mudstone is dominant the angle of repose is low but if the sandstone is dominant, the angle is high (Table 2).

Unit (3) Dominantly Mudstone

Mudstone forms a high percentage of the outcrops on the existing highway and probably underlies much of the area where no outcrop exists. The rock varies lithologically from soft brown micaceous mudstone to well bedded compact hard grey mudstone. An occasional thin sandstone bed is present within the mudstone. The mudstone beds are usually 4 to 5 feet thick but an exceptional thickness of over 20 feet outcrops above the sandstone at the 2,800 feet peg.

In the two deep cuttings on the new route, unweathered compact mudstone beds could be encountered beneath the Quaternary clay. Heavy machinery will be required to rip this mudstone. Blasting should not be necessary as the two cuttings will be excavated in the the approximate direction of the dip of the mudstone beds. Even though this dip is at a low angle the bedding will be a plane of weakness and will aid in its removal. The thick mudstone overlying the sandstone bed at 2,800 feet on the present road should be excavated easily because it is soft and deeply weathered.

Quaternary Clay

These sediments outcrop along the present highway above and below Caves Cliffs, forming banks 15 to 20 feet high. Very good exposures with outcrops up to 20 feet high are exposed in the creeks that cross the present highway N and S of Caves Cliffs.

The sediments consist of a top layer of brown clay 6 to 8 feet thick overlying a white and yellow clay which frequently contains Triassic mudstone fragments. In several exposures it overlies Triassic mudstone. The top brown clay contains large blocks of unweathered dolerite, often over 6 feet in diameter and frequently angular in shape. In some outcrops the top layer of brown clay appears to grade down to the white clay through a normal weathering layer. The dolerite boulders are derived from the steep high country immediately to the E of the proposed highway (fig. 14). Outcrops of the clay containing Triassic mudstone fragments were traced to the old logging track which crosses the face of these steep hills. Only above this track were definite

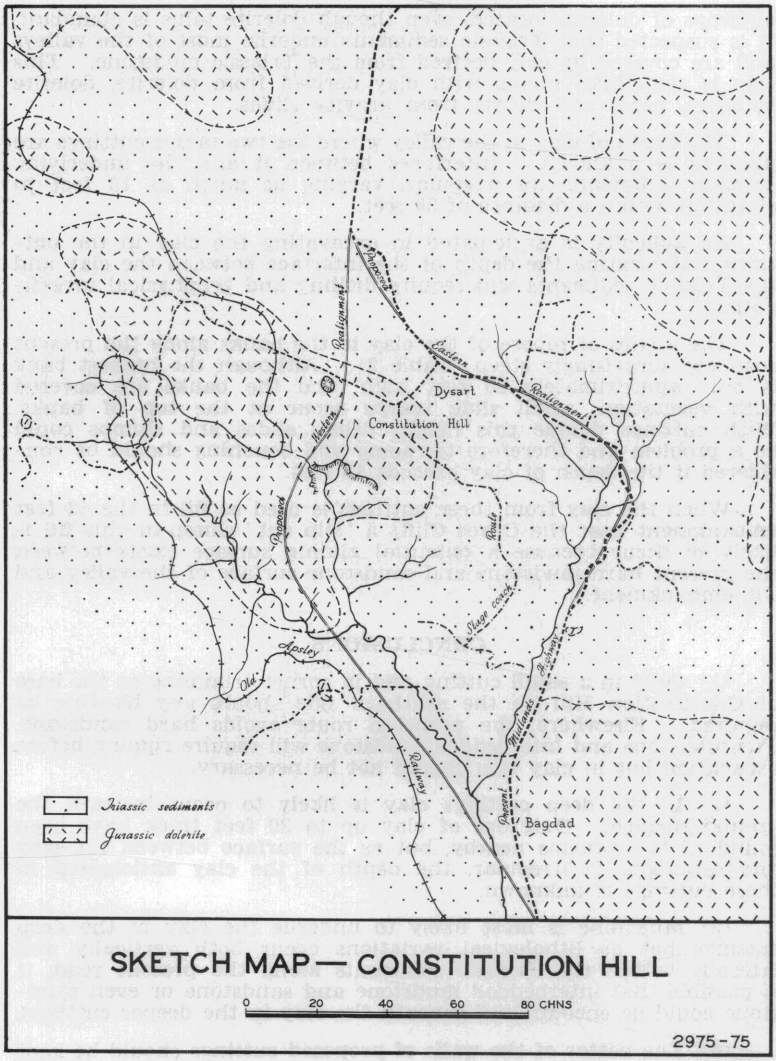

FIGURE 14

5 cm

outcrops of dolerite located, even though dolerite talus is abundant. It is suspected that Triassic sediments underlie most of the valleys and are covered by clay derived from the Triassic mudstone. This clay is sometimes mixed with clay derived from dolerite, dolerite boulders, talus and debris from gravity slides.

The depth of clay in the valley where the two major cuttings are planned is unknown. Interfaces between it and the underlying Triassic sediments are irregular, varying as much as 10 feet in elevation within a distance of 30 feet.

No difficulty is anticipated in excavating the clay in the cuttings, but locating the depth of the interface between the clay and the Triassic sediments will require drilling and geophysical investigation.

The angles of repose of the clay in the banks along the present road are surprisingly steep (Table 2). Although the highest bank is only approximately 20 feet high, and the banks are covered with vegetation, small slide scarps occur at the top of banks. With cuttings double this height debris slides and slumps could be a problem and therefore terracing and benching should be considered if the depth of clay exceeds 15 feet.

When the clay from these cuttings is used as fill in the 42 feet embankment near the Caves Cliffs a 'slip out' slump of this fill is likely to occur because a potential gliding surface exists between the present hard mudstone and sandstone surface of the valley and the embankment.

CONCLUSIONS

(1) Only in a small cutting and in corner trimming at the base of Constitution Hill on the southern side should any blasting be required. Elsewhere, the proposed route avoids hard sandstone. The mudstone and interbedded sandstone will require ripping before excavation but in clay this should not be necessary.

(2) In the deep cuttings clay is likely to occur beneath the ground surface. Outcrops of clay up to 20 feet thick have been found in the streams nearby, but as the surface between the clay and sandstone is irregular, the depth of the clay anticipated in these cuttings is unknown.

(3) Mudstone is most likely to underlie the clay in the deep cuttings but as lithological variations occur both vertically and laterally within the Triassic sediments along the present road, it is possible that interbedded mudstone and sandstone or even sandstone could be encountered beneath the clay in the deeper cuttings.

(4) The batter of the walls of proposed cuttings should be kept as close as possible to the angle of repose of the rocks encountered except in the clay where the angle should be lower because of the danger of slumps.

RECOMMENDATIONS

(1) A series of holes should be drilled along the line of the deep cuttings to a depth of 30 to 40 feet.

TABLE 1

Distance in feet	*Description of the construction*	*Anticipated lithology*	*Hardness Description*	*Type of machinery required**
0– 900	Along present route	....	....	....
900– 1,200	Corner trimming	Mudstone	Compact	Heavy bulldozer
1,200– 1,350	Corner trimming	Sandstone	Medium hardness	Explosives and air tools
1,350– 2,000	18′ embankment	....	....	....
2,000– 2,300	Corner trimming	Sandstone	Medium hardness	Explosives and air tools
2,300– 2,700	17′ embankment	....	....	....
2,700– 2,800	14′ cutting	Sandstone	Medium hardness	Explosives and air tools
2,800– 3,100	14′ cutting	Mudstone	Compact	Heavy bulldozer
3,100– 3,900	32′ embankment	....	....	....
3,900– 4,100	34′ cutting	Mudstone	Compact	Heavy bulldozer
4,100– 4,500	34′ cutting	Clay	Soft	Light machinery
4,500– 4,700	34′ cutting	Interbedded mudstone and sandstone	Compact	Heavy bulldozer
4,700– 5,300	40′ embankment	Interbedded mudstone and sandstone	Compact	Heavy bulldozer
5,300– 6,800	28′ cutting	Clay and probably mudstone	Soft and compact	Light and heavy bulldozer
6,800– 7,800	10′ embankment	....	....	....
7,800– 8,400	Along present route	....	....	....
8,400– 9,000	24′ embankment	....	....	....
9,000–11,000	Along present route	....	....	....
12,000–12,350	Corner trimming	Mudstone	Compact	Heavy bulldozer
12,350–12,700	Along present route	....	....	....

* As recommended by P. Meyer, P.W.D. Engineer.

TABLE 2

Measured Angles of Repose

Lithology	*Outcrop slope*	*Talus slope*	*Recommended batter slope*
Sandstone	75°–90°	55°	75°
Interbedded sandstone and mudstone	55°–80°	30°–40°	65°
Mudstone	40°–50°	30°–35°	35°
Clay	45°–55°	30°–35°	40° with terracing and benching if over 20′ deep

(2) Geophysical methods should be used to trace the profile of the interface of the clay and the unweathered sediments between the drill holes.

(3) In any cutting where the depth of clay exceeds 20 feet, the batter should be terraced and benched.

References

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DUNCAN, N., 1966.—Stability of Natural Rock Slopes and Excavations in Rock—Stability of Natural Rock Slope. Rock Mechanics and Earthworks. *Engineering Muck Shifter*, pp. 33-51, 51-55.