

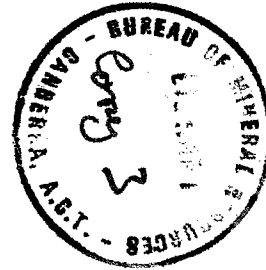
**GEOLOGICAL SURVEY OF UPPER COTTER DAM**

**SITES A AND B1, A.C.T.**

by

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## SUMMARY

Detailed geological investigations were made of two previously selected dam sites, B and A, in the Upper Cotter Valley. Site B1 is geologically suitable for the construction of a dam, but subsequent to the investigation it was found that the storage capacity of this site would be insufficient for Canberra's estimated requirements; hence the site is unlikely to receive further consideration.

Site A appears suitable for the construction of a stable dam, though less suitable geologically than site B1. Five recommendations are submitted for consideration.

## INTRODUCTION

Geological investigation of two dam sites, A and B1, on the Upper Cotter River was made in April-May, 1953, in response to a request from the Department of Works. The writer accompanied Messrs. K. Jack and M. Vonick, engineers concerned with the investigation, on a preliminary examination of site B1 on April 16th. Field work was carried out by Messrs. J. Perry and D. Belford in two periods, April 27th to May 3rd, and May 11th to May 18th, owing to interruption of the work by rain. An account of the general geology of the area has been given previously by L. C. Noakes (Report No. 1946/2), and therefore the present investigation was limited to detailed surveys of the sites. The geology of the sites was mapped by telescopic alidade and plane table at a scale of 50 feet to an inch.

The two sites are located on part of the Upper Cotter River between Bushranger's Creek and Cow Flat Creek as shown on the plan accompanying L. C. Noakes' report (loc. cit.). Access to the area is by Forestry road from a turn off along the Mt. Franklin road 3 miles south-west of Uriarra homestead. Access roads are shown on a topographic map of the A.C.T. and Environs produced by the National Mapping Section, Department of the Interior, in 1952 (Preliminary Edition). Ordinary vehicles may be driven within a quarter of a mile of a hut which is approximately half a mile west of the Cotter River and 570 feet above river level. For the present survey a jeep was used and equipment and stores were thus taken right to the hut, where camp was established. A good walking track extends from the hut to both dam sites, the one to Site B1 being on the eastern bank of the river.

## GENERAL GEOLOGY

The general geology of the area has been investigated and discussed previously by L. C. Noakes (loc. cit.). Briefly, the Cotter Valley between Bushranger's Creek and Cow Flat Creek is made up of phyllites of the Ordovician Franklin Formation on the west side of the valley and the Tidbinbilla Quartzite of probably Silurian age on the east side. These formations are separated by a major normal fault, the Cotter Fault, which has in part controlled the course of the Cotter River. The downthrow of the fault is to the east thus preserving the Silurian Tidbinbilla Quartzite only on the east side of the fault. The faulting is thought to have taken place in late Silurian time, and this event was probably associated with the intrusion of the Cow Flat Granite; from evidence at dam site A it appears that some faulting occurred in this area later than the consolidation of the granitic rocks.



## ENGINEERING GEOLOGY

### Site B1

#### General

This aspect of the geology has been considered previously by L. C. Noakes (loc. cit.) from a regional viewpoint and, for Site B, in a detailed manner also. Site B1 is approximately 220 feet upstream from site B so that the geological considerations for site B apply in general to B1.

#### Line of Dam Wall

The survey work was begun with the assumption that the dam wall would be 220 feet upstream from site B and parallel to the line of B. On the contour plan ACT/10/31 site B1 is thus shown by the line AB. However, it is apparent from the plan and the sections AB and CD that the line CD will give a more economical wall section than AB.

#### Foundations

Site B1 is entirely in a porphyritic phase of the Cow Flat Granite. Only two specimens of the rock were examined microscopically and there were found to be adamellite porphyry, a granitic type in which orthoclase and plagioclase are present in approximately equal amounts. The porphyry should be a suitable foundation rock; the proportion of flaky minerals such as biotite and chlorite to the rest of the minerals present is small; in the fresh rock the amount of weathering of the felspar should not affect the strength of the rock to an appreciable extent.

#### Weathering

Subsequent to the geological survey, six test pits were dug at the site in order to determine the depth of the zone of weathering. The approximate locations of the pits are shown on the plan (ACT10/31). Little excavation will be necessary in the stream bed at this site, for the porphyry presents a relatively smooth unweathered surface. Away from the stream bed up the valley walls, the depth of the zone of weathering may be expected to increase, as it is dependent on the depth of the water table. On the plan (ACT10/31) three types of weathering are shown:-

- (a) areas of large porphyry boulders; here solid rock is probably close to the surface but in places there may be pockets of deeper weathering between boulders;
- (b) areas of loose cobbles and small boulders; probably deeper weathering than (a);
- (c) area of deeply weathered porphyry and soil, with cobbles and small boulders in places; probably deep weathering of the order of 10 feet or more.

On the south-western bank of the river, that part of the slope on the line AB between contours 2400 and 2450, is in weathered porphyry soil and therefore the necessary excavation is likely to be deep. Test pits Nos. 2 and 3 in this area went to 6 feet and 7 feet respectively and encountered only very weathered fragmental porphyry. Above the 2430 contour the proportion of small boulders in the soil increases, and although this area does not come into category (b) it is probable that the depth to solid rock is less than that on the slope below. Test pit No. 1 in this area was abandoned at a depth of 6 feet in very weathered porphyry.

On the north-eastern bank there is a scree slope extending from approximately 2400 feet to 2435 feet; test

pit No. 4 was sunk to 5 feet in this area and was in firm friable weathered porphyry when excavation was discontinued. Above 2435 feet are porphyry boulders and some outcrops which extend up to 2500 feet. Test pit No. 5 was sunk in a pocket between large boulders and was abandoned at 6 feet in very weathered porphyry. From 2500 feet to the top of the proposed wall is soil cover derived from the weathering of porphyry, and as shown in the profile AB, the angle of slope decreases markedly at the 2500 contour; deep weathering is thus to be expected here, and test pit No. 6 was still in very weathered porphyry at a depth of 15 feet.

It is evident from the preliminary testing of the site that a considerable amount of excavation will be necessary before a firm foundation is reached and to enable an accurate estimate of the average depth of excavation to be made the test pits should be carried down to solid rock. Consideration should also be given to the possibility of using drilling methods to determine the configuration of solid rock along the line of the dam, as drilling may prove cheaper than the digging of test pits.

#### Jointing

The disposition and dip of joints at the site is shown on the plan (ACT10/31). In direction the joints fall into two broad groups, one which ranges from 283 to 335 degrees and the other from 25 to 80 degrees. Most joints in the first group are vertical while in the second group the dip ranges from 70 degrees to the north-west to 70 degrees to the south-east. It is unlikely that these joints will prove troublesome from an engineering viewpoint, with the possible exception of two low dipping surfaces; one on the south-western bank which strikes 310 degrees and dips 10 degrees to the north-east, and the other on the north-eastern bank which strikes 305 degrees and dips 25 to 30 degrees to the south-west. Such joints may cause rock slips during excavation, as their dip is less than the slope of the valley walls.

#### Sources of aggregate and sand.

The essential properties required in a rock to be used as aggregate have been summarised by L. C. Hoakes (loc. cit.). He has also dealt with the sources of aggregate and sand for site B, and the same considerations apply to site Bl.

#### CONCLUSIONS

Geologically, site Bl is quite satisfactory for the building of a dam. The porphyry provides a good foundation, though much excavation would be necessary to expose the unweathered rock, jointing is unlikely to cause difficulty, and the site is over  $\frac{1}{2}$  mile from the Cotter Fault. However, it is understood that re-calculation of the storage capacity of site Bl by Works Department engineers has shown that a dam in this position would store insufficient water for Canberra's future requirements. Hence this site is not likely to receive further consideration.

#### SITE A

##### General

The approximate distribution of rock types at the site is shown on the accompanying plan (ACT10/30). Field work and the examination of rock sections under the microscope has led to the conclusion that the probable sequence of events in the area was as follows, after the deposition of the Tidbinbilla Quartzite came the intrusion of the Cow Flat Granite, a porphyritic phase of which outcrops at site A. Four slides from the actual site indicate that the rock is a granodiorite porphyry, a granitic type in which plagioclase predominates over orthoclase.

This porphyry intrusive may have caused contact metamorphism of the quartzite and introduced some silica. Subsequent to this however, faulting occurred with resultant crushing and brecciation of the porphyry, and fracturing of the quartzite; associated with this movement or with a later one, was the introduction of much silica, which has filled cracks and fissures in the quartzite and cemented the crushed porphyry in places. The large amount of silica deposited is evident particularly on the north bank of the river, where quartz can be seen as a filling in fissures and also as a covering on the quartzite so that it presents the appearance of a wall of massive quartz. It seems probable therefore that part of the proposed site is a silicified fault zone, which may represent the position of the Cotter Fault in this locality. On the other hand it may be a subsidiary fault a few hundred feet east of the main Cotter Fault.

### Foundations

The foundation rocks at the site are granodiorite porphyry, silicified porphyry, and quartzite. The granodiorite porphyry outcrops at river level about 50 feet downstream from section line AB; the unweathered rock is massive, shows large feldspar phenocrysts in places and is not much jointed; it has a rough uneven fracture and should bond well with concrete. In the area shown on the plan as silicified porphyry, the rock appears to have been fractured or brecciated to some extent and the fragments cemented together by silica. Under the microscope the original quartz phenocrysts show fracturing and shadow extinction, and fissures are filled with vein quartz. The rock surface has a smooth silicified appearance and the rock itself is very tough.

The quartzite is a grey, fine-grained, and normally well-jointed rock; it has a fairly smooth uneven surface but should bond quite well with concrete.

The granodiorite porphyry, silicified porphyry, and quartzite should all be suitable as foundation rocks.

### Weathering

The quartzite in the vicinity of the dam site is resistant to weathering, particularly where it has been reinforced by the deposition of silica. No excavation should be necessary in areas of quartzite outcrops, but removal of loose blocks and some grouting of open joints may be necessary. On the line of the dam wall (Section AB), the north bank will require little excavation, but east of the zone of silicified porphyry some excavation will be necessary, though the depth to solid rock may be expected to be less than 10 feet in view of the information from test shaft No. 6. Here solid porphyry was struck at a depth of  $6\frac{1}{2}$  feet. The depth to solid rock in test shaft No. 2 was 2 feet.

On the lower slope of the south bank between contours 2280 and 2310 is a zone of silicified crushed porphyry, and here excavation may be expected to be of the order of 5 feet or less. Solid silicified porphyry was struck at a depth of 4 feet in test shaft No. 5. From 2320 to 2390 feet on the line of the dam is an area characterised by quartzite boulders and cobbles in the soil; here also the depth to solid rock is likely to be about 5 feet. Quartzite outcrops from 2390 to 2427 feet, the highest point on the south bank on the line of the dam wall.

In this area the quartzite is traversed by numerous open joints, and some removal of loose rock and probably grouting may be necessary. Should it be necessary to build a wall along the saddle on the south bank (Section CD), much excavation will be necessary before solid rock is reached. Test shafts No's. 1, 2, and 3 were sunk to depths of  $7\frac{1}{2}$ , 12, and 4 feet respectively, and each hole showed only very weathered



friable porphyry at bottom.

### Jointing

The distribution and attitude of joints is shown on the accompanying plan. There are three major joint systems. The strike of the first system ranges from 330 to 10 degrees, and the dip of the joint surfaces ranges from 23 degrees west to vertical. Joints of this system striking 355 and dipping 50 degrees west are prominent in the quartzite particularly on the north bank. The strike of the second system ranges from 65 to 85 degrees and the majority of the joints dip vertically though a few joints dip steeply north or south, and one dips 10 degrees to the south. The third system strikes from 285 to 310 degrees and the dip ranges from 42 to 52 degrees north with the exception of one joint which is vertical.

Both jointing and irregular fracturing are present at the site, joints may provide a leakage path for water unless grouted, but they are not closely spaced, and should not present any serious leakage problems. Most of the fractures visible in surface outcrops have been filled with vein quartz and should be water-tight.

### The Cotter Fault

Though the site is close to the Cotter Fault and probably on a subsidiary fault, it is not considered that there are any serious drawbacks to the construction of a dam because of this situation. Any fracturing of rocks due to faulting has probably been sealed by the subsequent introduction of silica; in the event of these being open fractures or joints, these should be evident during excavation for the dam foundations, and can be sealed by grouting. L. C. Hoakes has indicated previously (loc. cit.) that none of the seismic activity experienced from time to time in the Canberra-Goulburn region can be referred to movement along the Cotter fault; as far as is known there is no record of such movement nor is it considered that movement is likely to occur in the future.

Leakage of water from the storage along the main fault is a possibility, but it is unlikely to occur, as the fault line appears to cut tributaries of the Cotter downstream from the site, at an elevation higher than that of the proposed wall. Should leakage occur, the water will find its way back into the river and be impounded in the existing reservoir.

### Sources of aggregate and sand

Of the rock types available near the dam site, only the granitic rocks and the quartzite are suitable for aggregate. Stream gravel could also be used provided that the quantity of phyllite present was investigated; the phyllite is unsuitable for use in aggregate because of its tendency to break into small flat smooth-sided fragments, due to its pronounced lineation. The nearest source of stream gravel is the Top Flats about  $\frac{1}{2}$  mile upstream from the site; here the gravel consists of granitic rocks and quartzite with a small proportion of phyllite.

Quarry sites for granitic rocks and quartzite will probably be determined by the course of the access roads. Quartzite is the more suitable rock for aggregate and should be readily obtainable by constructing a road from the south side of the site to outcrops about  $\frac{1}{2}$  mile to the east. On the other hand granitic rocks are suitable and may be preferred because less difficult to crush than quartzite.

Sand is probably best obtained by crushing quartzite as there is no natural sand available near the proposed site. Care should be taken to remove the fine fractions and rock flour, as these may cause expansive reactions with concrete.

### Conclusion and Recommendations

Site A appears suitable for the construction of a stable dam, though less suitable geologically than site B1.

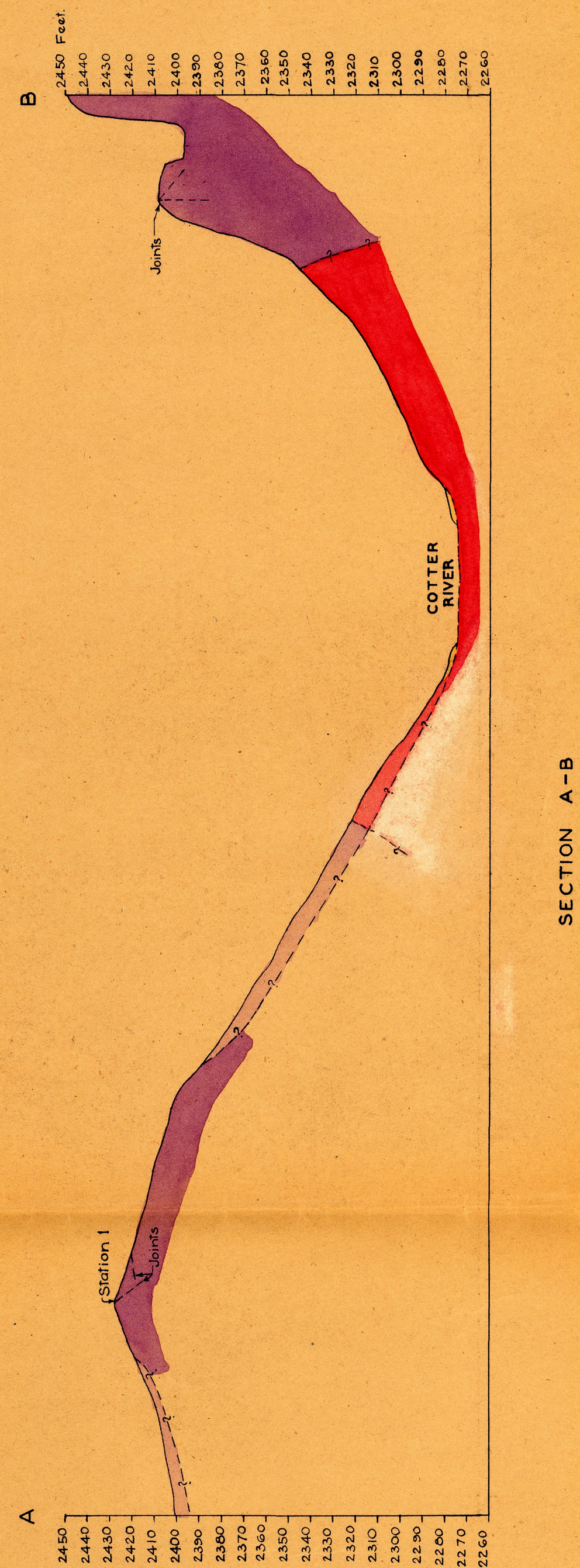
The following recommendations are submitted:-

1. In view of the situation of the dam site in relation to the saddle CD, consideration should be given to the possibility of constructing a rock fill dam at AB, using the saddle CD as the spillway. Considerable excavation along C-D in part thereof would be necessary to provide a spillway but this construction in conjunction with a rock fill dam would probably be cheaper than a masonry wall at AB. Furthermore the height of a wall at AB is limited by the height of the saddle CD, and unless the saddle were protected by concrete, the spillway of a masonry wall at AB would need to be much lower than 2405 feet, the minimum height along the saddle, to avoid the possibility of a break-through during floods.
2. If it is decided to build a dam at site A, detailed geological examination of excavations should be made from time to time to map structures, with particular reference to faulting, shattering of rock, and degree of silicification. A detailed map of the completed excavations should be made.
3. Geological examination of proposed quarry sites is recommended, together with testing of rock types for their suitability for use in aggregate. If stream gravel is to be used, the quantity available and proportion of each rock type present should be estimated.
4. After completion of the dam a check of the valley walls downstream should be made from time to time to see if any springs develop along the line of the Cotter Fault, indicating leakage from the storage.
5. If a site other than A is preferred, a detailed geological investigation of the site should be made.

### REFERENCE

- Noakes, L. G., 1946 - Dam sites in the upper Cotter Valley between Bushrangers and Collins Creeks, Bur. Min. Resour. Aust. Rep. No. 1946/12.





SECTION A-B

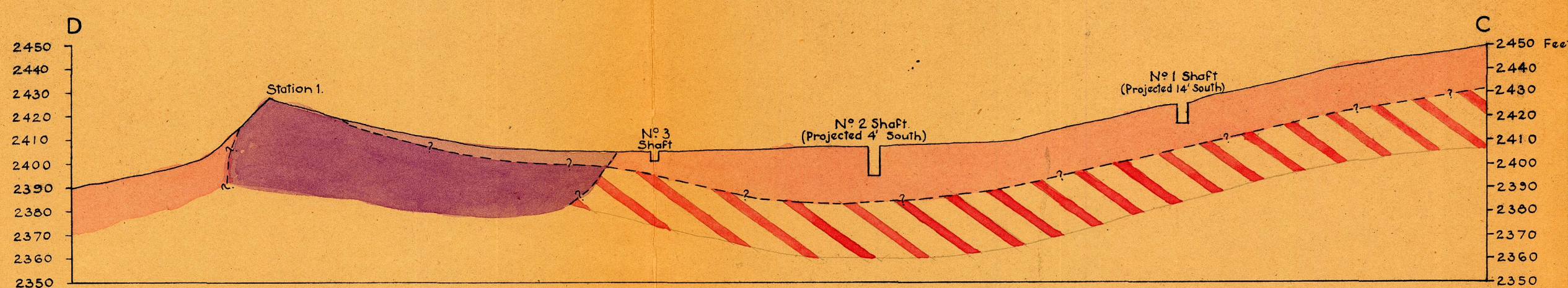
# DAM SITE A UPPER COTTER RIVER A.C.T.

SCALE  
50 40 30 20 10 0 50 100 150 FEET

## REFERENCE

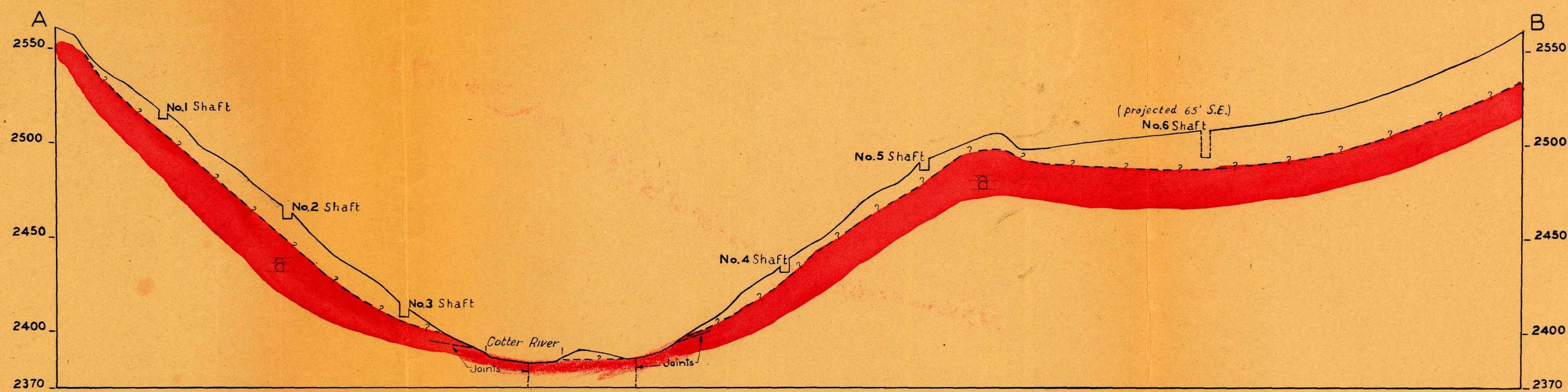
- Alluvium.
- Mostly soil with weathered Porphyry fragments in places.
- Mostly soil with boulders and cobbles of Quartzite in places.
- Porphyry.
- Quartzite.
- Established geological boundary: position approximate.
- Indefinite boundary.
- Strike of vertical joints
- Strike and dip of inclined joints.
- 10 foot contour line.
- Test shaft, showing depth in feet.

Datum: Survey Station 2427.00 feet from Plan RIX 44 H, A.C.T. Survey Section, Dept. of Interior.



SECTION C-D





Datum Survey Station No. 10  
2388.88

Line of Dam Site B



# DAM SITE B.I UPPER COTTER RIVER, A.C.T.



## REFERENCE

- a Porphyry.
- b Large porphyry boulders
- c Porphyry scree
- d Deeply weathered porphyry and soil with cobbles and small boulders in places
- No. 1  
6' Test shafts showing depth in feet
- Joints - vertical
- Joints - inclined
- Contour interval
- Established geological boundary - position approximate
- ?--- Inferred geological boundary

