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GEOLOGICAL INVESTIGATION OF BURBONG DAMSITE, MOLONGLO RIVER, A.C.T., 1965-66

by

G.A.M. Henderson

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SUMMARY

A dam about 70 feet high on the Molonglo river above Queanbeyan, is proposed to store water for irrigation and to maintain the level of Lake Burley Griffin. The site selected for investigation is 1¾ miles west-north-west of Burbong railway siding and is known as Burbong damsite. The Molonglo river in this area, is entrenched and the surrounding country side becomes progressively steeper to the west, towards the Queanbeyan Fault scarp.

Geological mapping of the numerous outcrops at the damsite has shown a complexity folded sequence of silicified metasediments, sandstone and interbedded sandstone, siltstone and phyllite. The axes of the folds plunge gently north-north-east over most of the damsite area, except at the western end where they are steeper and some are overturned. Outcrops of similar lithology and structure occur in the surrounding area; most are along the river. Quartz porphyry intrudes the metasediments and generally crops out along lines trending roughly east-west.

Weathering of the rocks is slight at river level but increases with height above the river; the depth of soil and scree also increases with height above the river.

Most faults at the damsite are near-vertical axial plane faults of small displacement; they contain little or no crushed rock. A near-vertical fault is suspected along the river at the proposed dam axis. The most persistent joint direction is parallel to the axial planes of folds; other joint directions are prominent locally.

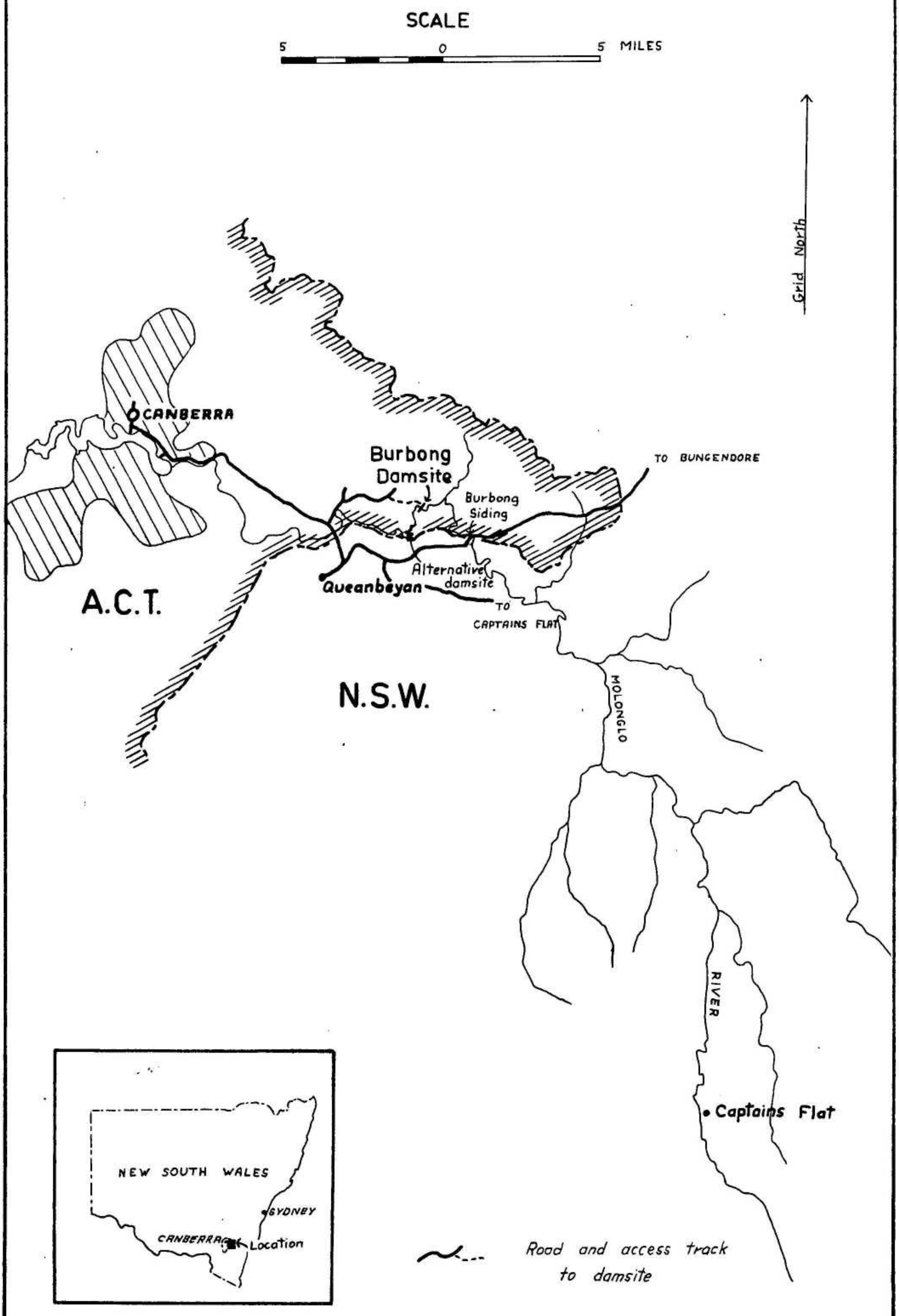
The south bank is composed almost entirely of sandstone which is very hard and strong close to river level; higher on the bank it is weaker due to weathering and contains abundant feldspar. The thickness of the sandstone and the succession below it are not known. The north bank consists of interbedded sandstone, siltstone and phyllite; the sandstone and silstone are quite hard and strong but the phyllite, which shatters easily, may compress more than the sandstone under the load of a dam, thereby setting up stresses.

The site appears suitable for a concrete, earth and rockfill or earth dam, although a concrete dam would require less smoothing of the uneven, hard sandstone cropping out near river level on the south bank. Adequate resources of concrete aggregate and rockfill are undoubtedly available within one mile of the damsite, but a quarry site has not been selected nor resources proved. Possible sources of impermeable earth core material include the slope wash along the Queanbeyan Fault scarp and weathered porphyry upstream from the damsite; the former appears to be a more likely source of adequate easily worked material. No obviously suitable deposits of sand or gravel are known to occur along the river near the damsite and commercial deposits near Canberra may provide the most economical source of supplies.

Figure 1

BURBONG DAMSITE

LOCALITY MAP



Bureau of Mineral Resources, June 1966 I55/A16/274

To accompany Record 1966/212

1 INTRODUCTION

Geological investigations were begun in October 1965 for a proposed dam on the Molonglo River between Burbong and Queanbeyan. The purpose of this dam is to store water for irrigation along the Molonglo River between Queanbeyan and Canberra, and to provide some control of the volume of water flowing into Lake Burley Griffin. The work was carried out at the request of the Commonwealth Department of Works.

The presence of the railway line ruled out possible dam sites in the Molonglo gorge about two miles upstream from the Queanbeyan - Sutton Road. Further, because of the steeper grade and narrow confines of the river along this stretch of its course, the storage capacity of a low dam here would be fairly small.

One site, above the gorge, was at first considered and some geological mapping was done there (Fig. 1 and Plate 3). Later, another site, about a mile upstream from the first, was inspected; this second site was subsequently favoured because of the narrower profile. It is at present proposed to construct a 70 foot high dam at the second site.

Geological mapping of the damsite was carried out between November 1965 and February 1966. The mapping was related to marked control points which were established by plane table tacheometry. A reconnaissance survey up the river to Burbong, to provide information in the prospective storage area was also made; information was plotted on an enlarged aerial photograph.

LOCATION AND ACCESS

The damsite is 1¾ miles west-north-west of Burbong railway siding (see Fig. 1), on a westerly-flowing section of the Molonglo River; it is within the Kowen Forest Reserve, close to its eastern boundary. The site is about 12 miles by road from Canberra. Access is via the Kowen forest road and forest tracks. One of the tracks passes within 200 feet of the north bank of the river at the damsite. The tracks have been formed by a bulldozer and are passable for ordinary cars at most times. Only after heavy rain would a four-wheel-drive vehicle be advisable.

PHYSIOGRAPHY

The Molonglo River near the damsite flows in a general westerly direction; it is entrenched to form a valley in valley in an old land surface which changes from moderately undulating in the east to steep in the west. For short stretches the river, and some of it's tributaries, follows the regional north-north-east strike of the strata. Many of the tributary creeks have not degraded thin beds as rapidly as the river and form steep gullies where they join the river. There are cliffs in several places along the river. The valley floor is nowhere very wide and there are no large alluvial flats.

REGIONAL GEOLOGY

The general geology of the Kowen district has been described by Carter (1949). Outcrops in the immediate area of the proposed reservoir are dominantly sandstone, siltstone and phyllite intruded by quartz porphyry (See Plate 3). The sediments have undergone low grade regional metamorphism (greenshist facies) and are referred to in this report as metasediments. The beds, which are generally less than 6 feet thick, are strongly folded about north-north-east trending axes to form numerous small folds which plunge both north and south. The porphyry occurs as irregular east-west trending lenses; it is abundant to the east of Burbong railway siding and diminishes westwards.

Numerous axial plane faults, of small displacement, occur in most large outcrops of the metasediments. The faults are clean or contain only narrow crushed zones; a few contain quartz.

No fossils have been found but the metasediments are considered to be of Ordovician age (see Canberra 1:250,000 geological map) by comparison with rocks of known Ordovician age in the vicinity.

DAMSITE GEOLOGY

LITHOLOGY

Outcrops at the damsite consist mainly of silicified quartz sandstone, siltstone and phyllite, with some feldspathic and micaceous sandstones. As elsewhere in the region, the rocks have been affected by regional metamorphism associated with the folding.

The coarser grained sandstone is almost all extremely hard and strong where fresh, owing to silicification. In a few places, silicification was seen to be confined to the surface. The finer grained sandstone and coarse siltstone are also hard. Some of the siltstone has laminations caused by compositional changes; the laminations are commonly intensely folded on a small scale. A few of the sandstone beds are rich in mica which is oriented parallel to the axial planes of the folds, indicating that the mica is a product of metamorphism. Occasional sandstone beds close to the river have a spotted appearance, due to the presence of white grains of feldspar. On the upper part of the south bank most of the outcrops of sandstone contain abundant feldspar.

The phyllite occurs as distinct beds, or at the top of beds grading from sandstone or siltstone. Axial plane clearage becomes progressively more developed as the grain size decreases in the graded beds. In the finest grained phyllite cleavage is very well developed, particularly in the cores of tight folds, and the rock shatters easily when struck with a hammer.

WEATHERING

Outcrops in the damsite area can be divided broadly, on the basis of weathering, into two zones. The first zone extends along the river and to about 25 feet above it; rock is mostly fresh, or only slightly weathered, and outcrop is very extensive. On both banks, around 25 feet above the river, there is a change of slope from about 35^{o}, up from the river floor, to about 20^{o}. This change of slope roughly defines a transition from the zone of fresh rock to a zone of weathered rock; it represents an older valley into which the river has cut to its present level. Above the change of slope the rock is generally weathered to some extent and outcrop is much sparser. Some sandstone blocks in this zone have cores of fresh rock, but they are weathered at the surface and along joints. A small block of fresh sandstone has been exposed by construction of the track on the north bank. It is therefore expected that fresh rock (but perhaps with weathering along joints, bedding and clearage) occurs at a shallow depth.

STRATIGRAPHY

The rock types at the damsite can be separated, on the basis of lithology and thickness of beds, into two main groups:- massive quartz sandstone in which the beds are 5 or more feet thick; and interbedded sandstone, siltstone and phyllite ranging in thickness from less than an inch to about 2 feet, with occasional beds up to 3 feet thick. The interpreted distribution of these two groups is shows in Plate 7.

The apparent base of the succession at the dam axis consists of massive quartz sandstone, at least 20 feet thick, which crops out at river level on the south bank. The two uppermost beds are very distinct; they form part of a large outcrop beside the river. The upper part of the south bank consists of feldspathic sandstone which could be a continuation of the sandstone beds observed at river level. Section AB, Plate 6, shows that this is likely, particularly if the plunge maintains the attitude seen at river level. No reliable bedding readings could be obtained on the upper part of the south bank; the structure may be more complex than is indicated in Section AB.

Overlying the massive sandstone is about 45 feet of interbedded sandstone, siltstone and phyllite. A few of the sandstone beds are rich in feldspar and others in mica, but these do not persist throughout the area mapped, and so cannot be used as marker beds. Comparisons of stratigraphic sections from several large outcrops of the interbedded metasediments show only a general similarity in lithology and thickness of beds; individual beds can be correlated with certainty, only over short distances. The top of the interbedded sequence is exposed at the axis, on the north bank; it comprises about 58% sandstone and 42% siltstone and phyllite. About 80 feet upstream from the axis the whole of the interbedded sequence is exposed; the upper two-thirds contains 54% sandstone and 46% siltstone and phyllite, while the lower third consists of graded beds of siltstone and phyllite.

At the western end of the area no division can be made between sandstone with siltstone and phyllite, and siltstone and phyllite only.

Above the interbedded sequence are two six-foot beds of thick massive sandstone; they form the top of a prominent bluff at the axis on the north bank. Thick sandstone also crop out both upstream and downstream from the bluff and is thought to be part of the same two beds.

At the top of the succession, overlying the two sandstone beds, rock fragments in the soil above the bluff indicate more interbedded sandstone, siltstone and phyllite, probably at least 100 feet thick. Interbedded rocks occur immediately above the massive sandstone on two outcrops upstream from the axis.

STRUCTURE

Folding

The general trend of the fold axes at the damsite is north-north-east as elsewhere in the region. However the plunge and small amplitude of the folds cause the beds to follow an overall east-west trend. The folds are very irregular, both in size and degree of closure. Over nearly all the mapped area at the damsite the folds plunge gently to the north-north-east; axial planes dip steeply to the east. The structure of a particular bed may be likened to a piece of rather irregular corrugated iron sloping gently in the direction of the corrugations (See Plate 7).

By close observation of dips and strikes, and the use of stereographic projections, it is possible to divide the area into zones of slightly different plunges of folds. For a large part of the area the plunge is close to 15° towards bearing 015°*. Upstream from the axis are two small zones where the plunge is aroudn 35° towards 017°. These zones may be blocks which have rotated between two axial plane faults. On the massive sandstone outcrop on the south bank at the axis the plunge is 28° towards bearing 024°.

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* All bearings are magnetic bearings at time of investigation.

Apart from these small variations of plunge a much larger variation takes place about 130 feet downstream from the axis. From that point the plunge abruptly steepens, and 40 feet westwards the folds are overturned to give a reverse plunge of about 75° towards bearing 165°.

The squeezing of phyllite into the cores of tight folds has caused some micro-folding which is readily visible where laminations occur. Micro-folds are commonly in the form of chevron or kink folds.

Faulting

Numerous faults, parallel to the axial planes of the folds, occur in the area. The faults contain up to 3 inches of crushed rock; some of them are virtually free of broken material. The displacement of the faults, where it can be observed, is not more than one or two feet - on most it is only a few inches.

Apart from the axial plane faults, other small faults are developed locally, as shown on Plate 5. One of these faults, striking 110°, cuts across the prominent anticline about 180 feet upstream from the axis. A fault or very prominent joint, which strikes 020° dips 53°E, occurs 110 feet downstream from the axis on the south bank.

A near-vertical fault in the river at the dam axis striking about 150°, is suspected. The sandstone on the south bank can be seen to slope down gently, under the water, to a point where it is abruptly at off to form a near-vertical face. The attitude of the face appears to be parallel to a joint set observed in the sandstone nearby which strikes at 150° and dips at 77° south-west. (See Plate 5).

Jointing

Joints are most strongly and consistently developed parallel to the axial planes of folds. On the prominent anticline upstream from the axis other sets of near-vertical joints are also developed; these include cross joints and two sets of diagonal joints. The diagonal joints are not symmetrical to the axis of the fold and, at their extremities where the dips steepen, they are curved and make a smaller angle with the axial plane. Both these features indicate two periods of folding - one which distorted them. The logitudinal and cross joints, however, are almost exactly parallel and normal respectively to the axial plane of the fold.

A prominent set near the river on the south bank, and close to the axis, strikes 150° and dips 77°S.

ENGINEERING GEOLOGY

FOUNDATIONS

South Bank

The massive sandstone on the south bank should provide strong foundations, particularly near river level where there is very extensive outcrop of hard, strong, fresh rock. However, the surface of the outcrop is very uneven; it would need to be smoothed, particularly for an earth or earth and rockfill dam. Away from the river, up to about R.L. 2215 feet, the rock is strongly jointed in a north-south direction and many of the joints are open; closer to the river are two 5 foot high vertical faces, each extending for about 100 feet. The only dislocations are along several axial plane faults, but the displacements are small and the faults are clean-cut.

The upper part of the bank has only a few weathered outcrops of feldspathic sandstone. Although soft in relation to the hard, fresh sandstone, the feldspathic sandstone is a fairly hard, strong rock. Since the main field investigation of the site, the upper part of the bank has been cleared for forestry purposes and a track constructed. This has revealed that the soil contains numerous rock fragments, mostly sandstone, and it is likely that a continuous bedrock surface occurs at shallow depth. About fifty feet upstream from the axis is a shallow watercourse where the bulldozer has unearthed some siltstone; the watercourse appears to follow the soft siltstone.

No evidence is available to indicate how deep the sandstone extends anywhere on the south bank, or what underlies it.

River

The upstream part of the proposed dam would cover a section of the river where the water is shallow and the bottom mostly bedrock. From the presumed site of the upstream toe of the dam the river follows a sequence of relatively soft (i.e. compared with the sandstone) siltstone and phyllite before it enters into a deep pool; about 50 feet upstream from the axis pool gradually shallows downstream from the axis.

In the pool is an underwater ledge, the edge of which faces north-east, and abruptly cuts off the massive sandstone which continues underwater from the south bank. The face of the ledge may represent a fault along which the northern block has been downfaulted, or may be a joint plain from which the northern block has been by the river. A rotational movement of the massive sandstone about the plane could account for the slightly different plunge of the folds in it from the plunge of folds on the north bank. The structure, whether fault or joint, could provide a leakage path through the foundations of the dam, but the leakage path would be narrow and the structure is not likely to be a source of serious foundation weakness. It will need investigation by drilling and water pressure testing.

North Bank

Bedrock is mostly interbedded sandstone, siltstone and phyllite, with two successive thick beds of sandstone exposed at roughly RL 2205 to 2220. The sandstone, where fresh, is as hard and strong as that on the south bank; the siltstone is also quite hard and strong. The phyllite, owing to the prominent axial plane cleavage, probably has rather less compressive strength than the siltstone and sandstone and would behave rather differently from them under the load of a dam. Although in outcrop the weak phyllite forms only a small proportion of the sequence there is an area immediately west of the prominent anticline 160 feet upstream from the axis where slatz phyllite scree is common.

The depth of soil near proposed top water level is unknown. Weathering is probably deeper than on the south bank because siltstone and phyllite are less resistent to weathering than the sandstone. The access track is cup up to 3 feet into the hillside through soil containing numerous rock fragments.

CONSTRUCTION MATERIALS

Rockfill

Sandstone, similar to that occurring at the damsite, is to be found at many places along the river. Sandstone is the most suitable material for use as rockfill; it is amply hard and strong and should break into blocks of desirable shape and size, with a small proportion of fine fragments. The extreme hardness of the sandstone, particularly where fresh, may prove a limiting factor, however, in its use as rockfill, since quarrying costs would be high, sandstone which is weathered to some extent would not be as hard. From observation at the damsite and elsewhere it appears that the sandstone is fresh close to the river, where slopes are steep, and weathered higher up where slopes are gentler.

Several possible quarry sites along the river both upstream and downstream from the damsite have been noted. From about 100 yards to 300 yards upstream from the damsite on the south bank, extensive outcrop, predominantly sandstone, forms a steep rock slope near the river. Similar steep rock slopes occur further upstream and downstream from those mentioned. Detailed mapping and probably drilling would be needed to establish the most suitable site for a quarry.

Excavation of a spillway in the south bank could provide some rockfill for the dam. Drilling of the damsite foundations and spillway area would provide useful information on the likely depth of soil and weathered rock for the suggested quarry 100 yards to 300 yards upstream from the damsite.

Impervious Material

Decomposed weahtered porphyry resembling decomposed granite, occurs in several places not far from the damsite; it is a strong, cohesive material, probably of low permeability. However, owing to the shallow depth of weathering it is doubtful if enough workable weathered material could be found near the site.

Another possible source of core material for a rockfill dam is the deposits of scree and slope-wash along the Queanbeyan Fault scarp, half a mile east of the Queanbeyan - Sutton road and about three miles to the west of the damsite. A specimen of the material examined in the field appeared strong, cohesive and of low permeability. Where the material is exposed in a cutting in the Kowen Road it contains small rock fragments but the proportion of these appeared acceptable.

Filters

Deposits of gravel suitable for use as filters are sparse and small along the river near the damsite. It may be found economical to obtain filter material by crushing and screening sandstone from the rockfill quarry, by working gravel deposits elsewhere, or by buying material from commercial sources near Canberra or Queanbeyan.

Concrete Aggregate

The sandstone suitable for rockfill could also be used as concrete aggregate where sufficiently fresh. As far as it is known the sandstone contains no minerals which would react with the cement and weaken the concrete. Specimens from the damsite, which were examined petrographically, contain no pyrite or opaline silica. Porphyry could also be used as concrete aggregate. Normal suitibility tests should be conducted on any material proposed for use.

Sand

No large deposits of clean sand occur along the river near the damsite. It is expected that sand will have to be obtained from known deposits elsewhere or bought from commercial sources.

CONCLUSIONS

(1) The proposed site appears suitable for a 70-foot high dam of concrete, earth-cored rockfill or earth materials. Additional investigations are needed to verify this conclusion and provide design data.

(2) A concrete dam would probably be less costly than a rockfill or earth dam for the following reasons :-

(a) Foundations generally are strong; they would need very little excavation near the base of the dam and only shallow excavation for the abutments.

(b) In view of the flow characteristics of the river it should be possible to build a concrete dam without diversion works.

(c) An over-dam spillway would eliminate the need for an excavated spillway.

(3) The south bank appears to be largely underlain by sandstone to an unknown depth, the north bank by interbedded sandstone, siltstone and phyllite.

(4) The rocks at the damsite are strongly folded, with fold axes plunging gently north-north-east; at the extreme western end of the damsite area the plunge steepens and is overturned.

(5) Faults are minor; most of them are near-vertical and strike north-north-east. There is a possible fault in the river bed at the axis.

(6) The cover of soil and scree on the lower parts of each bank is shallow or non-existent; the cover is deeper on the upper parts from about 25 feet above river level.

(7) There is no danger of leakage from the reservoir other than at the damsite.

(8) Adequate supplies of rock suitable for concrete aggregate or rockfill are present close to the damsite. Material which is apparently suitable for an earth core is available but suitability and quantity remain to be proved. Filter gravels and sand would probably have to be obtained from outside the area.

(9) A spillway and diversion works for an earth or earth and rock dam could be excavated in either bank. Possibly, excavation in the softer interbedded rocks on the north bank (i.e. compared with the sandstone on the south bank) would be less costly per unit volume of material removed.

(10) Siltation studies on the Molonglo River indicate that there is very little suspended sediment in times of normal flow. A substantial amount of sediment is undoubtedly carried in times of flood but no large floods have occurred since sedimentation studies began. If a dam is constructed the tailings dumps of the Lake George mine, at Captains Flat, would need to be maintained in a sound condition, to avoid failure and consequent siltation and pollution of the reservoir.

(11) The site is in a region of low seismicity and stable slopes, and no special precautions are needed to protect any dam and reservoir.

RECOMMENDATIONS

Additional geological information will be needed before a dam, whether concrete, earth and rock, or earth, can be designed for the site. While surface geological information is plentiful on the lower part of the foundations close to the river relatively little is known about foundation conditions to be encountered on the upper parts of each bank. The supply of construction materials must also be established with greater certainty. The following additional testing is recommended :-

(i) Costeaning and sluicing along the entire length of the dam axis to reveal the depths of soil and scree and to provide information on the nature of the underlying rock.

(ii) Permeability, depth of weathering and physical properties of the foundations should be established by drilling, water pressure testing and laboratory testing of drill core. Seismic testing of the foundations is also desirable. Drill holes should be designed to test known or suspected faults and any zones of low seismic velocity.

(iii) After drilling on the south bank has indicated the thickness of sandstone and depth of weathering, a decision should be made as to whether a quarry for rock-fill and aggregate upstream on the south bank is worth investigation by drilling.

Possibly one of the other proposed quarry sites would provide better prospects if much phyllite occurs at depth on the South bank. Samples of drill core from any quarry site selected should be submitted to laboratory tests for strength and hardness. Reactivity tests for any proposed concrete aggregate should also be carried out.

(iv) It appears that the slope-wash and scree on the Queanbeyan Fault scarp offers the most promising source of impermeable earth core material. Pattern testing of a selected area will be needed to prove adequate resources and to provide representative samples for laboratory analysis.

(v) A systematic evaluation of all deposits of sand and gravel along the river, both upstream and downstream from the damsite, should be made. The information gained should establish whether any economically worthwhile local deposits exist for use in the construction of the dam.

REFERENCE

CARTER, E. K., 1949 - Report on the geology of the Kowen District, Australian Capital Territory. Bur. Min. Resour. Aust. Record 1949/51 (Unpublished).

APPENDIX

PETROGRAPHY OF ROCK SPECIMENS FROM BURBONG DAM SITE, MOLONGLO RIVER, A.C.T.

by

Celia Newbigin

Five specimens from the Burbong dam site were submitted, for petrographic description, by G.A.M. Henderson. They were selected to represent the range of metasediments exposed at the site.

A systematic description of each specimen is given in the accompanying table, and brief notes follow.

GENERAL COMMENTS

There are two rock types, phyllite and recrystallized quartz sandstone. The metamorphic grade is uniformly of the greenschist facies. The difference in the development of the foliation appears to be directly related to grain size and mineral content: the fine-grained rocks show strong deformation, but the coarser-grained rocks are only weakly foliated. The fine-grained rocks also contain a greater percentage than the coarser rocks of the layer silicate minerals - mica and chlorite, which are readily cleaved.

The sandstone specimens contain no minerals that would render them unsuitable or suspect for use as concrete aggregate. Specimens 66360016 and 66360017 are foliated and material of this type would need to be subjected to crushing tests to ensure that fragments of satisfactory shape are obtainable.

None of the specimens contained minerals which would result in rapid breakdown if used for rock-fill. The phyllite is fairly soft and tends to part along foliation planes; it is therefore probably unsuitable for use as rockfill.

REFERENCE

CROOK, K.A.W., 1960 - Classification of arenites. Amer. J. Sci., 25, 419-428.

Specimen 66360015

In hand specimen this rock is a grey compact medium-grained sandstone and from thin section examination it has been identified as a sub-labile feldspathic arenite (Crook, 1960). The tourmaline in the slide is distinctive and appears also in 66360016. It is green to brown, with bands of blue.

Specimen 66360016

In hand specimen this rock is a grey-green fine-grained schistose rock, with a preferred orientation of micas defining deformation on a very small scale. Quartz veins dissect the rock and in thin section it is apparent that these transect the foliation.

The rock is weakly metamorphosed (greenschist facies), but sedimentary nomenclature has been used, with a qualifying adjective. The rock is named a fine-grained foliated feldspathic quartz sandstone.

Specimen 66360017

In hand specimen the rock is a light grey-green schistose fine sandstone containing disseminated larger grains of mica, quartz and pyrite.

Specimen 66360018

In hand specimen the rock is a greenish-grey phyllite. In thin section the grain size can be seen to be less than 0.01 mm. The minerals identified are closely intergrown chlorite and mica, but grains are too small to make any further determination. The rock is intensely sheared and the closely-spaced shear planes are delineated by iron-rich material.

Specimen 66360019

In hand specimen this rock is a moderately deformed grey-green phyllite. The trace of small irregular chevron folds with discontinuous axial planes is visible on some surfaces; these folds give the rock an irregular cleavage. In thin section both chevron folds and larger flexures are visible. The mica flakes follow the folded surfaces of flexures and open folds, but are parallel to the axial planes of chevron folds. On weathering the rock becomes a mottled black or brown.

		66360015	66360016	66360017	66360018	66360019
TEXTURE	Grain Size.	Sand size.	Fine sand size.	Fine sand size.	SEE NOTES	Generally silt size.
	Fabric.	Sand size grains separated by silt sized matrix, well cemented with no pore space, grains generally angular.	Angular grains separated by cement and very fine matrix. Elongate quartz grains weakly define a preferred orientation.	Angular grains separated by a network of cement.		A few large grains set in a matrix of finer material with veins and patches of quartz. Preferred orientation weakly defined by mica.
	Sorting.	Poor.	Moderate.	Moderate.		Good to poor, apparently with structure as the control; sorting appears to improve with appression.
MINERALOGY	Cement.	20% chloritic, partly sericitic, partly replacing the matrix.	15% chloritic, partly sericitic, partly replacing the matrix.	20% chlorite and sericite.		25% chlorite and sericite.
	Matrix.	15% (<0.02 mm) quartz and feldspar, both altered by cement.	10% (<0.02 mm) quartz, may be some feldspar.	10% (<0.06 mm) quartz and feldspar. Some alteration by cement.		5-10% (<0.01 mm) rounded.
	Quartz.	50% (av size 0.5 mm, max. 1.0mm) angular grains, many showing undulose extinction, some recrystallized.	60% (av 0.04, max 0.3 mm) subangular grains, many with undulose extinction, some recrystallised, some with cement altering the margins.	45% (av 0.02 mm, max. 0.2 mm) subrounded grains some showing undulose extinction.		35% (av 0.01 mm max. 0.1 mm). The large grains are composite with sutured boundaries, undulose extinction common.
	Feldspar.	Oligoclase with very minor microcline, 10% (av 0.2 mm, max. 0.5 mm). Angular grains that have been partly sericitized.	Sodic andesine, some albite 5% (av 0.06 mm). K. feldspar possibly present. Albite is probably result of alteration of the original plagioelase. The andesine grains are sericitized and calcitised.	5% (av 0.1 mm) sodic oligoclase; irregular sub angular, mildly sericitized, grains rarely twinned.		< 1% microcline (av 0.1 mm) irregular grains 15% sodic oligoclase, irregular sub angular grains, slightly sericitized.

Continued Overleaf.

	66360015	66360016	66360017	66360018	66360019
Mica.	Muscovite with some biotite 1-2% (av 0.07 mm max. 0.5 mm). Biotite bleached.	5% muscovite (av 0.2 mm max. 0.3 mm), long fine flakes 1-2% biotite (av 0.07 mm), short fat flakes, extensively altered to chlorite.	<1% biotite (av 0.02 mm) altered to chorite along cleavage. 3-5% muscovite (av 0.05 mm max. 0.3 mm) long thin flakes.		2-3% muscovite (av 0.03 mm max. 0.1 mm).
Chlorite.		<1% (av 0.1 mm).	<1% (0.5 mm) (?) penninite often kinked.		5% forms a fibrous mat.
Opaques.	Magnetite, ilmenite →leucoxene, 2-3%. Grains have irregular shape, some skeletal.	Pyrite, hematite, limonite 1-2% (a 0.05 mm) irregular grain shape some overall staining.	(?) pyrite ilmenite → leucoxene <1% (av 0.01 mm) irregular grain shape.		(?) limonite, hematite 1% (av 0.05 mm) irregular grains.
Rock Fragments.	<1% (0.4 mm) shale fragment, elongate, compacted.	<1% chert (0.8 mm av) irregular, subrounded. and shale (0.5-1 mm) elongate, contains excess opaques.	-		-
Accessories.	<0.1% zircon (0.05 mm), tourmaline (0.2 mm), apatite (0.02 mm, inclusions in plagioclase).	<1% zircon, rounded; tourmaline - 2 varieties green-brown, and blue with brown zones; rutile needles in plagioclase.	-		1% apatite (0.005 mm) needles, in quartz in ground <0.1% tourmaline (0.01 mm) rounded.
Authigenic Minerals.	Sericite, in cement; calcite, altering quartz and feldspar; quartz, occurring as overgrowths.	Quartz, as rare overgrowth; chlorite, intergrown with sericite in cement and intergrown with quartz in veinlets.	Sericite and chlorite as cement.		Sericite, in cement; chlorite, in cement and intergrown with quartz in veins possibly during recrystallization.
Name.	Sub-labile feldspathic arenite.	Foliated feldspathic quartz sandstone.	Schistose fine sandstone.	Phyllite	Phyllite.

Bureau of Mineral Resources, June 1966

To accompany Record 1966/212

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PLATE 1

Fig. 1: View of south bank. Plunge of folds in sandstone outcrop in foreground is about 28° towards camera. Proposed dam axis passes along a nearly vertical line running through centre-right of photo.

PLATE 2

~~Plate~~ Fig 1: View, looking downstream to the west, from a point about 150 feet upstream from proposed dam axis. Proposed axis passes from just beyond large tree trunk breaking skyline, across behind reeds in middle distance, and up to a point near top, left hand corner of picture.

Fig. 2: View of north bank and part of massive sandstone near river on south bank. Plunge of folds in foreground is about 28° away from camera. Proposed dam axis passes along a line running from apparent top of hill to bottom left hand corner of photo.

Bureau of Mineral Resources, June 1966

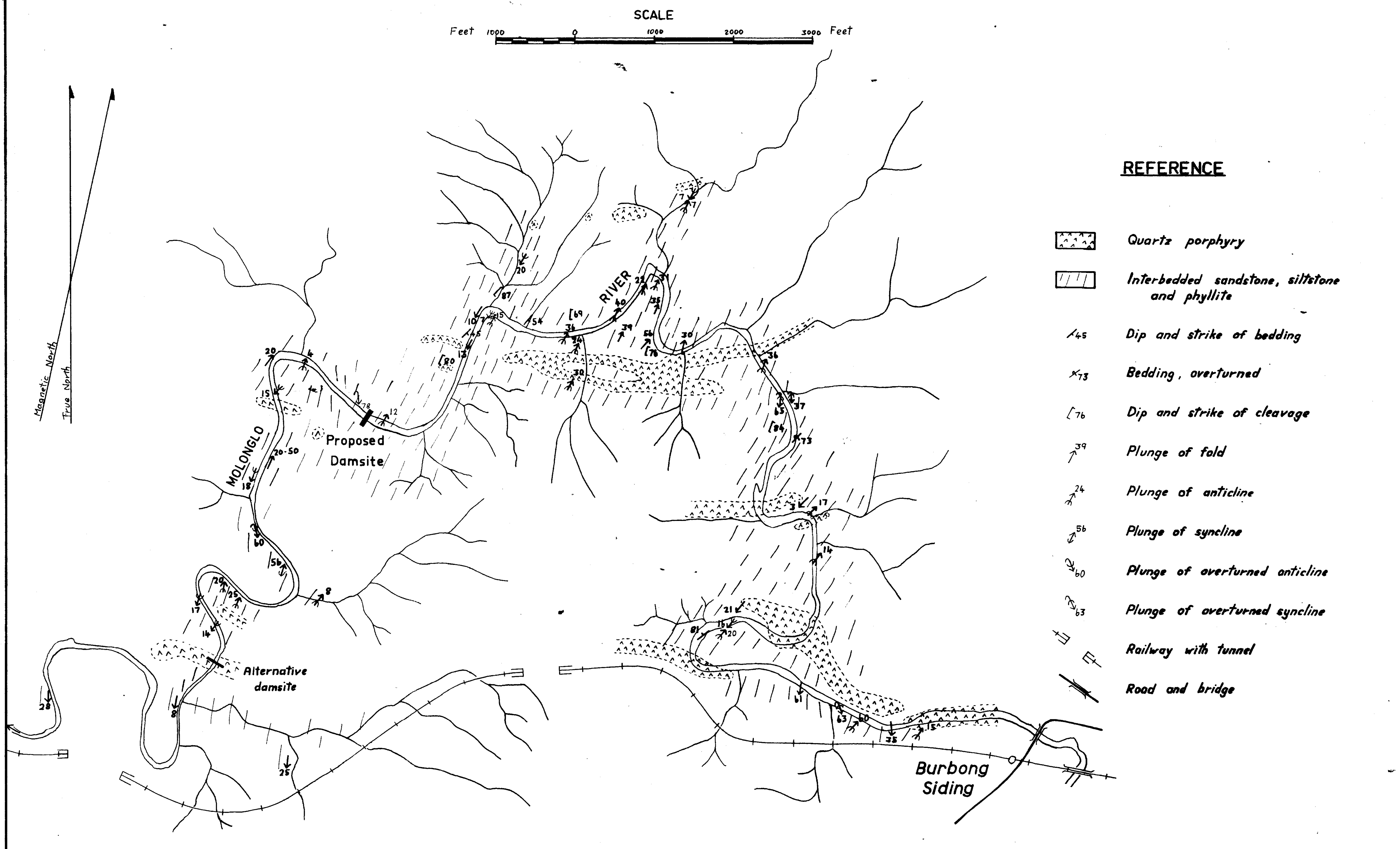
155/A16/280

To accompany Record 1966/212

PLATE 3

BURBONG DAMSITE

GEOLOGICAL MAP OF RESERVOIR AREA



Bureau of Mineral Resources, June 1966

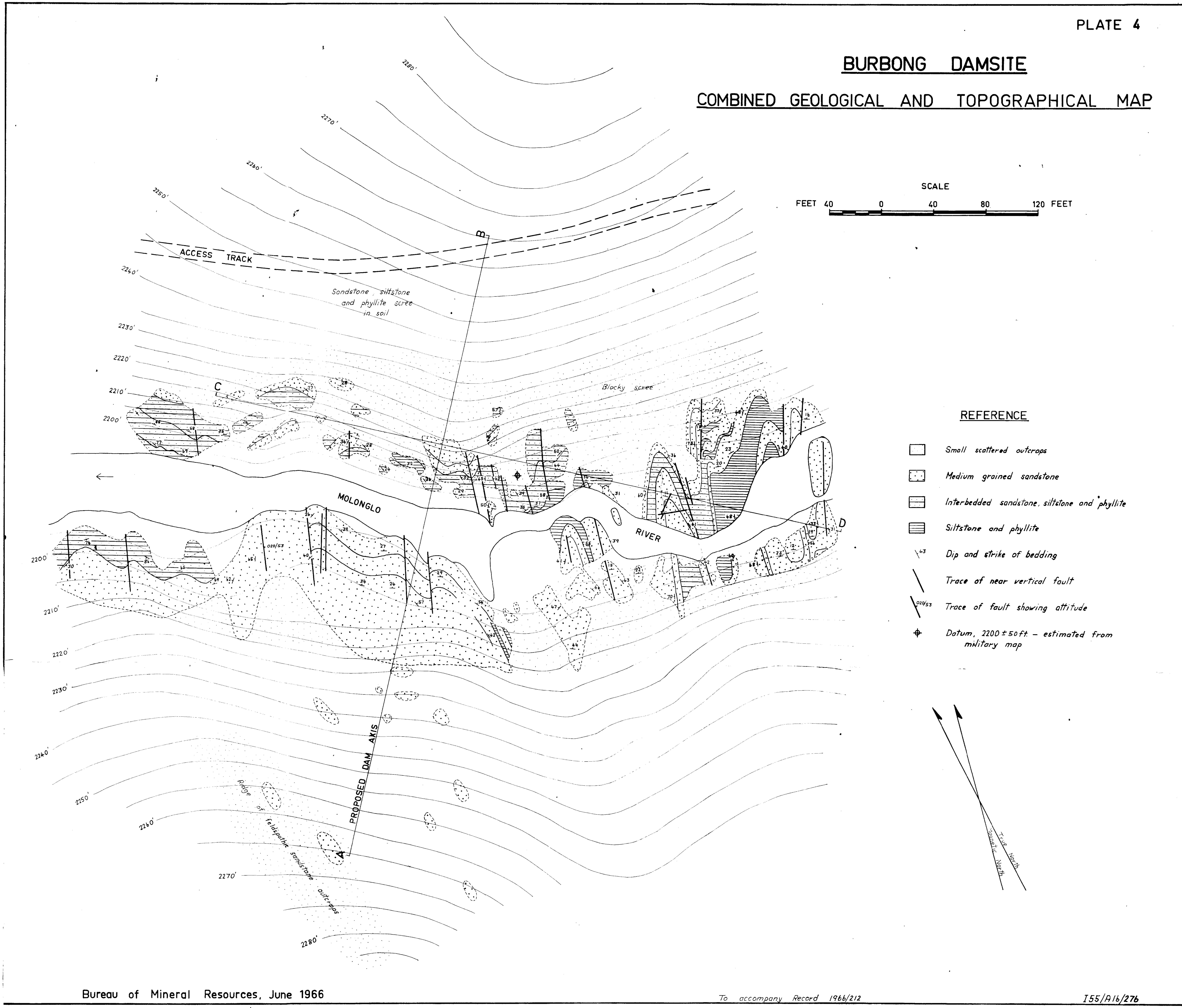
To accompany Record 1966/212

I55/A16/275

PLATE 4

BURBONG DAMSITE

COMBINED GEOLOGICAL AND TOPOGRAPHICAL MAP



Bureau of Mineral Resources, June 1966

To accompany Record 1966/212

I55/A16/276

PLATE 5

BURBONG DAMSITE

GEOLOGICAL MAP OF OUTCROPS ALONG RIVER

Bureau of Mineral Resources, June 1966

To accompany Record 1966/212

I55/A16/277

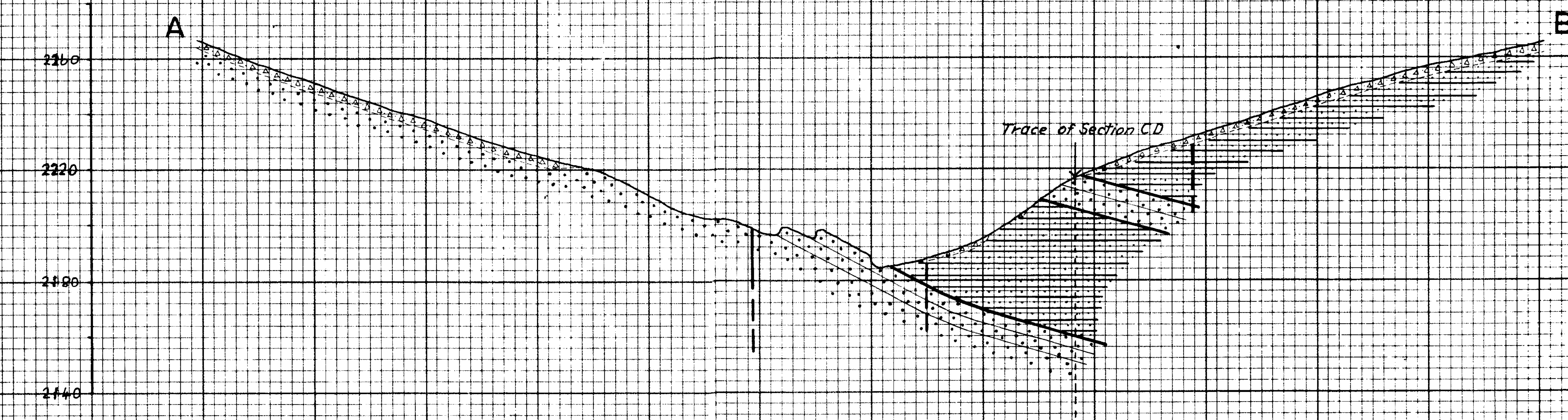
PLATE 6

BURBONG DAMSITE

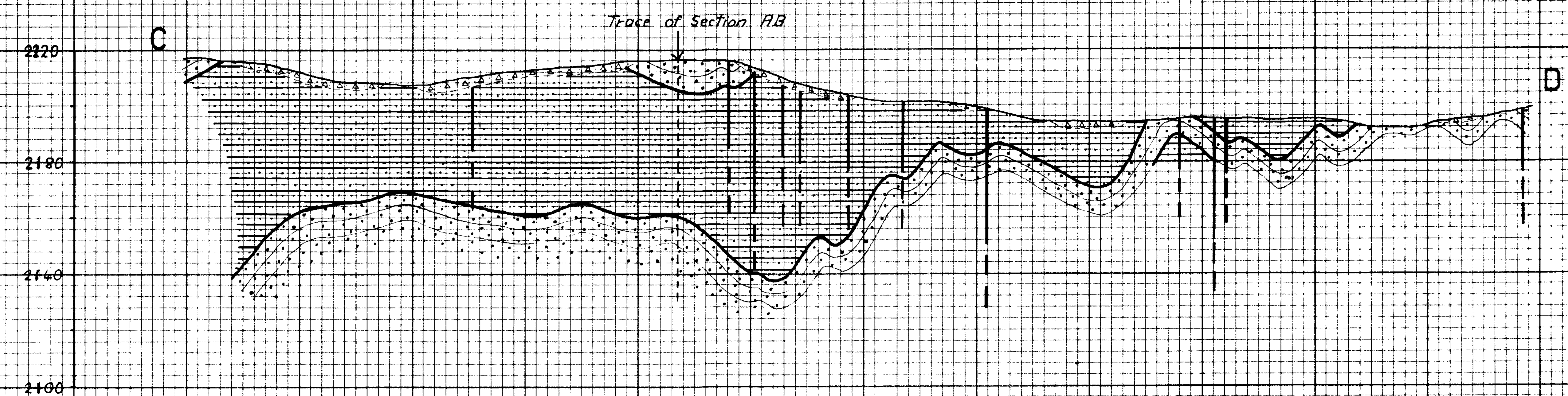
For locations of sections see Plate 4

INTERPRETIVE CROSS SECTION ALONG PROPOSED DAM AXIS

Assumed R.L. in feet



INTERPRETIVE CROSS SECTION NORMAL TO PROPOSED DAM AXIS



REFERENCE

- *Soil and scree - thickness unknown*
- *Massive thickly bedded sandstone showing bedding trends*
- *Interbedded sandstone, siltstone and phyllite*
- *Near-vertical fault*

SCALE

Bureau of Mineral Resources, June 1966

To accompany Record 1966/212

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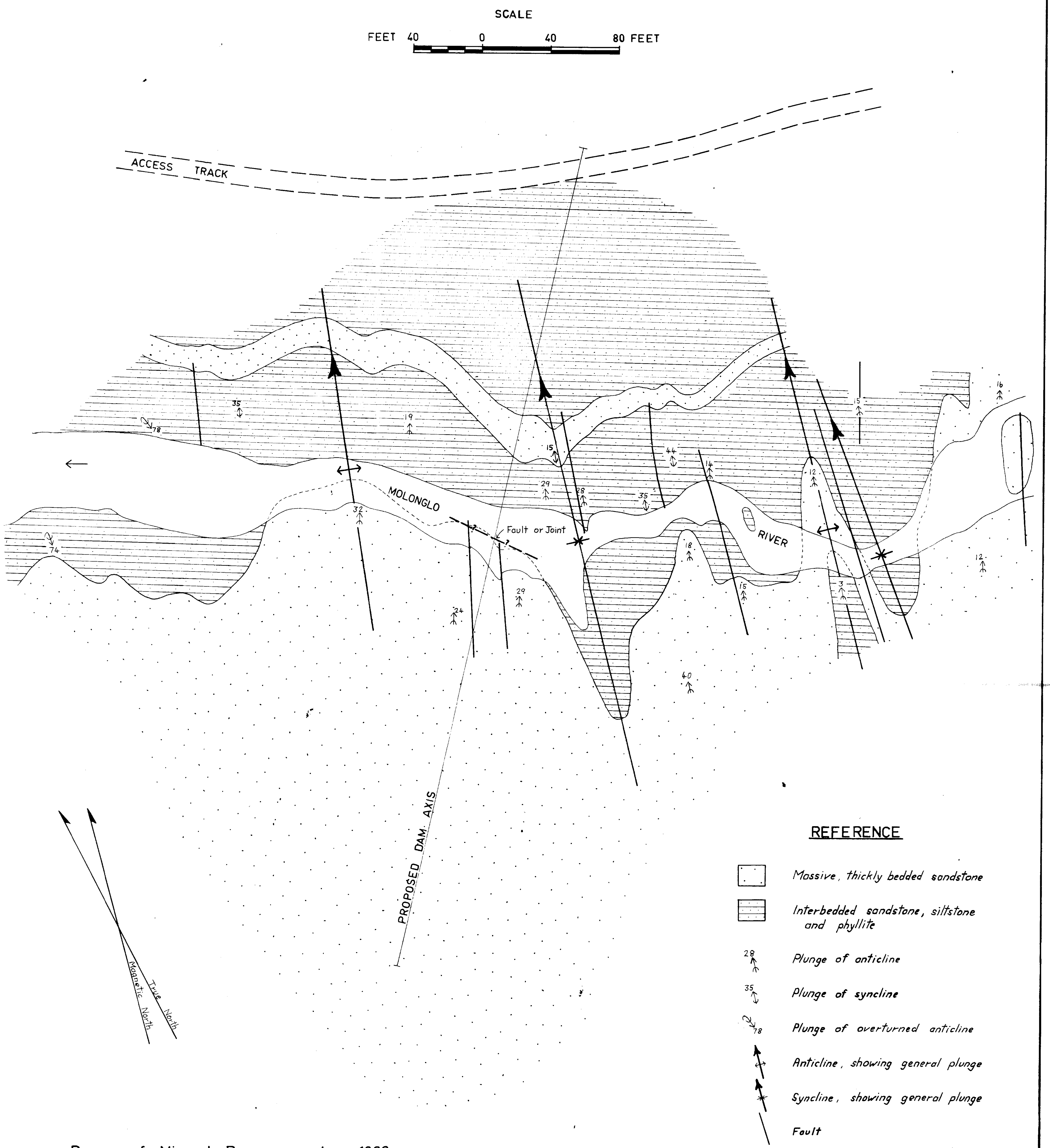
BURBONG DAMSITE

PLATE 7

INTERPRETATION OF STRUCTURE



Bureau of Mineral Resources, June 1966

To accompany Record 1966/212

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