NORTHERN TERRITORY GEOLOGICAL SURVEY

REPORT GS 79/9

REPORT ON THE FEASIBILITY OF A DAM ON THE TODD RIVER

(Alice Springs 1: 250 000 Sheet SF 53-14)

by

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GEOLOGICAL REPORT

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1. SUMMARY

Investigations into the feasibility of dam about 15m high on the Todd River near Alice Springs have included geological mapping, drilling and water pressure testing of eight shallow boreholes over the river section, and the drilling of two boreholes at the proposed spillway/quarry (Saddle 4). Refraction seismic surveys used to supplement borehole information at the proposed dam and spillway sites respectively and for a reconnaissance of the remaining two saddles are described in Part II of the report.

The proposed dam and spillway sites are located within granite-gneiss and gneiss-granite. The rock generally shows shallow weathering and moderate to wide spacing of discontinuities which include four faults on the right abutment and one open fault in the centre of the river section. Up to 5.5 m of unconsolidated, highly permeable, and water-saturated alluvial sediments overlie solid rock over the river section.

To achieve an acceptable degree of water-tightness,curtain grouting or a full cut-off trench will be required through the highly permeable jointed rock zones to a depth of 10 m. Information on the permeability of the upper part of the abutments is only speculative but similar remedial measures are expected to be necessary to achieve water-tightness.

Cut material from the proposed spillway excavation at Saddle 4 is considered to be suitably resistant and durable for use as rockfill in the dam embankment.

Results obtained by the investigation indicate no major geological hazards and no construction problems which could not be handled by conventional methods.

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2 INTRODUCTION

Following a request from the Department of Transport and Works - 78/111 dated 9 May, 1979 - engineering geological investigations into the feasibility of a dam on the Todd River near Alice Springs were done between May and September 1979. (Plate 1, Fig 1-3).
The investigations were aimed at determining:

- permeability of the dam foundation
- engineering geology characteristics of the saddles
- location and suitability of quarry sites for rockfill.

They have included diamond drilling and water pressure testing, shallow refraction seismic works, and geological mapping.
The proposal to build a dam immediately upstream of the Old Telegraph Station at Alice Springs is not new and considerable investigation of the present site was done by the N.T. Administration in 1965, then with the aim of utilising the storage capacity to recharge the declining water supply in the Town Groundwater Basin. These investigations are of limited value now because information on permeability is totally lacking.

Present investigations were primarily directed towards the feasibility of a recreational lake formed by a rockfill dam with an impervious upstream or central membrane. This dam could be possibly 15 m high, but details of foundation layout and overall design levels had not been finalised and neither had a final choice of spillway been made before the investigation began.
Consequently, at this stage it would have been impracticable to investigate all alternatives in details. Partly because of the inherent limitations of a National Park and partly because of drilling restrains,

the following approach has been adopted for the feasibility study. As discussed with the Department of Transport and Works, it is that:

a) Saddle 4 be considered first choice of spillway and quarry for embankment material.
b) Drilling and permeability testing be concentrated along the narrowest section of the proposed dam.
c) No undue disturbance of the investigation area be allowed and no trial blasting, trenching, or costeaning be done before construction of the dam is approved.
d) Concrete, filter material, and crusher run for special purpose placing within the dam structure be purchased or sub-contracted locally.
e) Investigations for core materials or for alternative sites for spillways be at reconnaissance level only.

3 HISTORY OF INVESTIGATION

Between April and May 1965 the then Water Resources Branch of the N.T. Administration conducted a geological investigation of the Todd River Dam Site (also referred to as Old Telegraph Station Dam Site and as National Park Dam Site). At that stage it was proposed that the dam would be used to impound water during times of high flow and recharge the Town Groundwater Basin during drought. With the subsequent use of the Mereenie Sandstone aquifer for town water supply and possible high sedimentation rate into any storage basin, interest in the project had lapsed for almost 14 years.

During the 1965 investigation a total of 71 boreholes were drilled using a Hydromaster 750 percussion rig (24 holes), a Hydromaster 2000 percussion rig (4 holes), an Edeko MK 6 rotary drill (9holes), an Edeko MK 8 rotary

drill (19 holes) and water and air jetting methods (1 and 13 holes respectively). Most of the above holes were only a few metres deep and were aimed at determining the depth of groundwater or the thickness of channel alluvium and were terminated on striking 'bedrock'.
This drilling totalled 206 m: it enabled construction of a reliable isopach map of channel alluvium (Plate 2) near the proposed dam site. In addition three diamond drill holes totalling 75m were cored - two vertical holes in the channel (DS 56 and DS 60) and a 45^{o}- inclined hole (DS 75) into the right abutment. Geological logs of these holes are contained in the report by Faulks (1965) but unfortunately no permeability testing was done. However high water losses during drilling were reported in DS 59 below a pitched depth of 7.5 m; back calculations indicate a hydraulic conductivity of the order of 10^{-3}cm/sec or higher in on section.

Further, a detailed backhoe pitting programme was carried out in the channel alluvium upstream of the proposed dam to prove reserves and to test quality of sand/ gravel for use as concrete aggregate. It is understood that reserves were estimated to be greater than requirements for a concrete gravity dam but no qualitative tests are available to prove the suitability of the material for mass or structural concrete.

4 PRESENT INVESTIGATIONS

The different phases of the investigation by the Geological Survey were:

4.1 Diamond drilling

Diamond drilling was carried out between 14 June and 27 July 1979 mainly for testing the permeability of the river section. The program consisted of eight (8) boreholes with depths ranging from 16.45 m to 22.80 m, totalling 155 m. The drill used was a Mindrill F 130 rig operated by S. Berger (Senior Driller) and was under the continuing technical supervision of E. Kingdom (Technical Assistant).

To obtain maximum intersection of discontinuities and also maximum cover over the river section (which is considered the most likely location for a major fault) all the holes except DDH 3A vertical (90^{o}) and DDH5 inclined at (55^{o}) were drilled with the maximum possible inclination (45^{o}). DDH 3 was terminated prematurely owing to drilling difficulties and failure to obtain a proper seal for permeability testing. Elsewhere the holes were terminated after a reasonable impervious section (commonly of the order of two full test sections) was penetrated and tested for water loss under surcharge pressure conditions. The holes were generally advanced through channel alluvium using roller bits or an HQ barrel to insert and cement casing pipes properly into 'bedrock' for permeability testing. Thereafter the boreholes were advanced using NQ-or, in two holes, BQ-barrels. Except for the alluvial channel deposit, core recovery was generally good throughout. Two shallow vertical holes (DDH 1 and DDH 2) were drilled at the proposed spillway site. (Fig 4).

No drilling was undertaken on the upper parts of the abutments as this would have involved undue disturbance in the National Park and close to its main attractions. Logs of boreholes are given in Appendixes 1-10 and photographs of core are shown in Figures 5-14.

Drillholes 1,2,3, and 4 have been back-filled with cement; the remainder have been capped and left open for water-level monitoring.

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4.2 Permeability testing

To check on potential leakage paths beneath the foundation, 32 conventional water pressure tests using mechanical packers were conducted. Test length was commonly 3.15 m and water loss was generally measured over a period of 10 minutes under increasing and decreasing pressure where feasible. Hydraulic conductivity was calculated in Lugeon units using the approach outlined by Houlsby (1976); details of each pressure test are presented accordingly in Plates 3 - 10.

4.3 Refraction seismic survey

All saddle areas were covered by shallow refraction seismic spreads; intergeophone spacing ranged from 2 m at Saddles 1,2 and 4, to 15 m at Saddle 3. In addition, 5 seismic spreads cover the actual dam site - two on the right abutment, one on the left abutment, and two over the river section upstream of the centre-line. Results of the seismic refraction survey form Part II of this report.

4.4 Geological mapping

Geological mapping of the dam site was done at a scale of 1:500 and of Saddle 4 at a scale of 1:000. At both locations plane table and alidade were used. The reservoir was mapped at a scale of about 1:5500 using Alice Springs 1978 (Film Number NT497) airphotos as a base.

4.5 Minor investigations

These included a reconnaissance soil sampling programme, a dye tracer test in borehole DDH 5, and a low yield pumping test by the Water Division, Department of Transport and Works.

Maps and sections illustrating the investigation have been drawn or copied from surveys at varying scales, many still in imperial units. Detailed contours for the dam site and the spillway area were not available during the investigation.

5. GENERAL GEOLOGY

The dam site and the reservoir area are underlain by metamorphic rocks of the Arunta Complex;the Alice Springs Granite (muscovite-biotite granite) and the Sadadeen Range Gneiss (biotite-quartz-feldspar gneiss). The boundary between these units is conformable but it has been enhanced locally by pegmatite intrusions (Plate 1). The Sadadeen Range Gneiss is strongly foliated and is therefore considered as 'schist' with all the mechanical characteristics of such a rock type. It is not encountered below the principal dam structures as presently proposed.

The Alice Springs Granite consists of two rock types: well foliated granite-gneiss with moderately wide - spaced (0.10 - 0.30 m) foliation plane partings, and indistinctly-foliated crystalline gneiss-granite. Boundaries between the two types are transitional but mineralogy is similar with coarsely crystalline feldspar (estimated 50%),quartz (40%) and mica (10%) grains and with prominent macrocrystals (or augen).

Very coarse grained pegmatite intrusions, irregular in attitude, are common. Thin dolerite dykes are scattered over the area; one such dyke was encountered in DDH 3A.

Foliation over the entire area forms a well-defined pole point maximum which indicates simple large-scale low-angle folding in the area (Plate 11).

Bedrock lineaments are commonly well defined on air-photos showing one preferred direction of 145° in an otherwise random scatter. They appear to document foliation partings in the main and, to a lesser extent, master joints or faults.

Alluvium is largely restricted to the channel and floodplains of the Todd River and its tributaries. It comprises channel alluvium (sand/gravel), floodplain alluvium (sand/silt), and reworked talus and is generally thin.

6 WEATHERING

The Arunta Complex has been exposed to weathering since Cretaceous/Tertiary time. Despite this, the available borehole data indicate that weathering has penetrated only a few metres below the surface. Outcrop is generally moderately to slightly weathered except where freshly exposed by river flow. Residual soils are shallow. The physical features typical of granite weathering in arid zones i.e. boulder - controlled slopes, exfoliation features, domed shapes - are present.

7 ENGINEERING PROPERTIES - ARUNTA COMPLEX ROCKS

7.1. Construction Materials

Because of the intense foliation, the 'schist' is unsuitable for high quality rockfill, but highly to moderately weathered, rippable material could be considered for low grade fill, provided the mica content were not too high.

All other rocks including granite-gneiss are suitable for high quality rockfill as it is considered the proportion of weathered material would not be deleterious. Although no mechanical tests have been conducted, fresh granite-gneiss, gneiss-granite, pegmatite and dolerite can be considered as strong, durable, and mechanically resistant rocks, based on visual inspection.

7.2 Foundation materials

Only gneiss-granite (at the damsite) and granite-gneiss (at the spillway) will be encountered as foundation materials.

Suitability of foundation rock for dams is mainly dependent on the degree of weathering and the intrinsic permeability. A classification of engineering properties in relation to degree of weathering is given in Appendix 11. Most rock encountered at the dam and spillway sites is slightly to moderately weathered near the surface and becomes fresh at shallow depth; in-situ bearing strength is thus more than adequate for the foundation of a 15 m high rockfill dam. Fresh to slightly weathered rock is also resistant to scour.

Permeability of the slightly weathered to fresh rock is entirely within rock discontinuities (joints, master joints, and faults) whereas a certain matrix permeability characterises the moderately to completely weathered rock. For this will be excavated for foundation of the hydraulic structures, only the tightness and quality of the discontinuities is of significance. Basically these consists of two types described below.

Joints: Most of the discontinuities measured in the boreholes and outcrops are either tension joints or foliation breakage. Both commonly have very rough surfaces and a low degree of continuity, and variable wide joint openings. Clay fillings and linings are common, and, judging from core of DDH1 - 7, are present to 13 m below ground surface: iron staining reaches to the same depth.

Below 13 m, chlorite linings are common; they appear to characterise tight joint condition. Core breakages range from 4 to 16 or more per metre but show a general tendency to wider spacing with depth. Joints with more than 10 m continuity are designated master - joints; they can be recognised only in outcrop at the abutment where they are commonly open, rough surfaced, and slope parallel. They can be seen to be potential major leakage paths.

The depth to which they are open has not yet been established.

Faults

At least four faults (A1, A2, B1, B2, on Plate 12) intersect the right abutment; of the faults B1 and B2 may be continuous with faults observed in boreholes DDH 3A and DDH 7. In DDH 3A the fault cuts a thin dolerite dyke. Their intersection with master joints could explain the high permeability (>100 Lugeons over the fault in DDH 3A) recorded in this area. Weakness caused by such an intersection may also have given rise to the formation of the southeast trending shallow basin in which the channel alluvium was deposited (Plate 2).

7.3 Permeability

Results of permeability testing are summarised on the geological cross-section (Plate 13).
Generally an increase in permeability in an easterly direction from about 1 Lugeon (10^{-5}cm/sec) in DDH 1 to more than 100 Lugeon (10^{-3}cm/sec) in DDH 3A on the eastern part of the river section is indicated. In one instance, in DDH5, water losses were so high that constant pressure could not be maintained. Outwash phenomena were observed in at least six test sections (DDH 3, 3A, 4, 5, 6) and dilation has possibly occured in two tests (DDH3,6). Outwash was so complete that water flowed freely from DDH 3A during testing of DDH 5, and also from DDH 6 during testing of DDH 7. It is likely that one of the previously mentioned faults B1 and B2 is the main water conduit.

To measure the permeability after complete outwash a dye tracer test was conducted using DDH 5 as a feeder hole and DDH 3A as an observation hole. A head of 120 kPa was applied during the test; assuming laminar flow a hydraulic conductivity of more than 4.0 cm/sec was calculated.

In addition a low yield pumping test was conducted by Water Division, Department of Transport and Works, in DDH 3A using DDH5 as an observation hole and simultaneously recording water levels in the overlying alluvial sediments.
The pumped bore and the observation hole produced almost identical drawdown and recovery, indicating that both are in the same zone of high permeability, possibly a fault. Otherwise the test was not successful in determining transmissivity, possibly because boundary conditions were encountered instantaneously during the test (A. Macqueen, Water Division written communication).

All the above tests as well as the high water losses recorded in DS 59 in 1965 essentially agree in characterising a zone of high permeability over the central and eastern parts of the river section. In all boreholes this zone was terminated about 10 m below ground level.

8 ENGINEERING PROPERTIES - UNCONSOLIDATED SEDIMENTS

Unconsolidated sediments at the dam site are of three types: channel deposits, floodplain deposits, and talus.

8.1 Channel Deposits

The maximum recorded thickness of channel deposit in the area is 5.5 m. Near the surface it is composed of well to gap-graded gravelly sand/ sandy gravel (GW-GP,SW-SP) with disseminated large boulders of gneiss-granite near the abutments. A layer of clayey silty sand (SM), possibly up to 1 m thick, forms the base.

8.2 Floodplain Deposits

One well-defined floodplain level is present at about 2.5 m above the river bed; it is covered by a blanket of sandy silt. Elsewhere floodplain deposits have a veneer of alluvial sand.

8.3 Talus

Talus forms boulder beds on lower slopes or gravelly footslopes and is commonly thin.

All unconsolidated sediments are highly permeable. During the investigation the groundwater table was 0.35 m below the channel surface.

9 DETAILED DESCRIPTION OF DAM SITE

9.1 Left Abutment (Fig.1)

Description

The left abutment is a boulder protected slope with talus accumulations at the foot. The slope angle ranges from 40^{o} to 50^{o}. The boulder veneer is generally shallow allowing bedrock structures to be seen through it on airphotos. Individual detached boulders range up to 3 m, and generally form a single layer mantle. Outcrop is scattered.

Weathering

Although the outcropping gneiss-granite is commonly moderately to slightly weathered near the surface, it appears likely from the results of DDH 7 that fresh rock will be shallow.

Discontinuities and Permeability

Plate 14 shows the distribution of joint poles on a Schmidt Equal Area Net (which affords a simple means of showing strike and dip by a single pole). A random distribution is indicated; however only 29 features have been plotted. Their influence on the hydraulic conductivity is not known, but most of the joints appear to be tight near the surface or to have a low frequency of intersection. No major discontinuities, except one master-joint, have been located so far.

9.2 River Section (Fig. 3).

The river section is about 60 m wide and consists of a well-incised channel 40 m wide and narrow well-defined floodplains on either side of the channel. The channel alluvium has already been described and is a maximum of 5.5 m thick. The entire alluvial section will require dewatering and excavation to the level shown in the geological cross-section (Plate 13) for the foundation of the plinth. The necessity for excavating the entire alluvial section below rockfill has not been investigated and will largely depend on the in-site density.

9.3 Right Abutment (Fig. 2)

Description

The right abutment consists of a complex joint and talus controlled slope with some vertical slightly overhanging faces. Except for small talus accumulations near the foot of the slope, rock surfaces are bare with large boulders and well-exposed structural discontinuities. Minor intrusions of pegmatite and narrow zones of recemented brecciated material are present within the otherwise homogenous gneiss-granite.

Weathering

The gneiss-granite is generally moderately to slightly weathered in outcrop; narrow zones of slightly weathered rock are recorded as deep as 24 m (pitched depth at 45^{o}) in core from DS 75 (Faulks 1965). In DDH 1 highly weathered material (detached boulders?) extends to about 2.8 m (pitched depth at 45^{o}). Generally weathering is shallow and restricted to structural discontinuities.

Discontinuities and Permeability

The types of discontinuities intersecting the face - joints (including master joints) and faults-are briefly described below.

a) Faults: Four major discontinuities labelled A1,A2, B1, and B2) intersect the abutment and these have been classified as faults although displacement is only recognisable in A1. A1 and A2 are low angle overthrust faults (030/130); B1 and B2 are vertical faults (90/095) subparallel to the investigated dam axis. All faults are open near the surface (up to 200 mm wide) but the overthrust faults appear to close at shallow depth.

b) Joints: Joints exposed on the abutment are generally widely spaced (1 m +); they show a low frequence of intersection and,except for a number of master joints, have only a short strike and dip continuity. Most of the minor joints appear to be tight near the surface. The statistical distribution of attitude is illustrated in Plate 15. This indicates a scattered distribution with two poorly defined maxima almost normal to the dam axis - system J1 dipping 80^{o} E or W and system J2 dipping 65^{o} NE. System J2 includes distinct master joints which locally control the slope and possibly extend across the river section.

Despite the above and a comparatively high frequency of core breaks, DDH 1 drilled to a depth of 22.8 m was remarkably tight during water pressure testing with no significant water loss anywhere in the borehole.

10 SADDLE WEIR SITES

Along the reservoir rim there are four depressions (or saddles) which will require low auxiliary dam structures (Saddles 2 and 3) or are potential spillway sites (Saddles 1 and 4). All the saddles were covered by seismic spreads. Saddle 4, in addition, was tested by two shallow diamond drillholes, DDH1 and DDH2. Seismic interpretation and spread layouts are dealt with in detail in Part II of this report.

10.1 Saddle 1

Saddle 1 is located about 300 m SE of the dam site. Because its long axis is parallel to the reservoir rim, the saddle is well suited as the site for an emergency spillway. The site is covered by rubble with scattered granite-gneiss outcrop. As no major discontinuity is visible and hydraulic gradients under full reservoir level are expected to be low, leakage is unlikely.

10.2 Saddle 2

This is a narrow saddle some 150 m west of the dam site and it will possibly require a low weir. The southern part of the saddle is underlain by granite-gneiss in scattered outcrops below a shallow cover of rubble. The northern part of the saddle is covered by soil. The presence of a major cross-fault cannot be excluded at this stage and there could therefore be some leakage beneath the proposed weir.

10.3 Saddle 3

Saddle 3 is a complex feature of residual soil in depressions and patchy outcrops of bedrock. Possibly several small saddle dams are required, all of which will lie within the zone of freeboard of the dam.

Saddle 4

Saddle 4 is located above reservoir level and consists of a plateau slightly tilted southwest and flanked by higher ground on either side.

A geological map of the saddle area is shown in Plate 16. The site was investigated by two diamond drillholes totalling 22 m and two seismic lines comprising 6 spreads of 2 m geophone spacing and 3 spreads of 4 m geophone spacing.

The saddle is underlain by scattered outcrops of granite-gneiss which is slightly weathered to a depth of about 5 m. The borehole data confirm that moderately to highly weathered material is restricted to the topmost 2 m. Foliation is moderately steeply dipping in a westerly direction and is the major discontinuity exposed. The granite-gneiss is underlain by thinly-foliated schist below the excavation grade.

Excavation will be in fresh, hard, strong, and scour-resistant granite-gneiss which will require blasting. Bulldozer ripping, if feasible at all, will be restricted to the topmost 1 to 2 m.

11 CONSTRUCTION MATERIALS

11.1 Concrete and Bituminous Concrete Aggregate

The small amount of concrete or bituminous concrete aggregate required for the contract and the proximity of established sources of production would possibly make the use of local resources uneconomic.

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If required the most suitable local source would be the sand/gravel in the channel of the Todd River upstream of the dam site or processed gneiss-granite. Extensive testing would be necessary if the gneiss-granite is proposed for use.

11.2 Rockfill

Initial investigations were directed towards using excavation material from Saddle 4 for rockfill. The granite-gneiss from this location is of acceptable quality and will yield durable rockfill even if a certain proportion of weathered material is included. Other sources of rockfill could be developed during abutment re-grading and from outcrops within the reservoir and rim area.

11.3 Core Materials

Although clay materials are generally scarce within the Arunta Complex, a brief reconnaissance soil sampling programme was undertaken to locate potential core material for possible use within the saddle dams. Six samples were collected from the locations shown on Plate 17 and tested for grading and plasticity. Of the tested samples only two (Nos. 2 and 3) warrant further interest and detailed laboratory testing.

12 CONCLUSIONS AND RECOMMENDATIONS

1 Based on the results of drilling and permeability testing the plinth excavation over the river section will be 5 to 6 m through water-saturated, highly permeable channel alluvium with scattered large boulders. A zone of high permeability showing locally a hydraulic conductivity of more than 100 Lugeon ($+10^{-3}$ cm/sec) extends to about 5 m below the proposed plinth excavation line.

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It is thought that the high permeability is caused by the intersection of one or two open narrow faults and a set of clay-lined master joints. The clay readily washes out under low surcharge pressure. To obtain an effective seal, curtain grouting or a concrete cutoff will be required to about 5 m into fresh gneiss-granite below the proposed plinth excavation line.

2 If a grout curtain is chosen, this will probably require a multi-row arrangement of grout holes over the highly permeable section. It is commonly not practicable to wash out clay from joints by water pressure prior to grouting. However in this case, because of the ease with which outwash occurred it is considered imperative to attempt to clean the joints. The maximum pressure used should however not exceed the head exerted by the height of water under discharge conditions in the dam.

3 For the upper parts of the abutments, depth of excavation or the influence of discontinuities on the foundation rock cannot be given at this stage of investigation. Observations on distribution, orientation, and quality of discontinuities are restricted to what is evident from surface exposure. Open master joints and four faults persist over the right abutment for its full width and to an unknown depth. Joints are of short continuity with a low degree of intersection and two weak maxima of attitudes across the proposed centre-line.

4 The Gneiss-granite underlying the dam site is mechanically strong with only a shallow depth of surface weathering and it is more than adequate for founding a 15 m high dam. Both faces will require regrading for construction access and placement of rockfill; this will allow for a more detailed appraisal of structural discontinuities and their potential influence on the permeability.

5 Rock from the proposed spillway at Saddle 4 is suitable for rockfill in the embankment dam and will require blasting for excavation. No lining of the spillway or of the downstream discharge channel appears to be required but some river training works will be necessary where the discharge enters the channel of the Todd River. Other sources of rockfill are available within the reservoir or on its margins as are other sites for a spillway. (Saddle 1). None of these have been tested in detail, except for a seismic reconnaissance at all four saddles.

6 Leakage through Saddle 1 is unlikely owing to low hydraulic gradients but it could occur through Saddle 2 if a major cross-fault is present. Unless demonstrated to be unnecessary by water pressure testing before or during construction a grout curtain across Saddle 2 should be considered.

7 Without doubt the major problem will be the dam watertighness. However, investigations so far have indicated that this problem could be overcome even in the worst case by multiple row grouting, or by a complete cut-off through the permeable rock over the river section. A degree of uncertainity prevails on the need for and the extent of curtain grouting over the upper abutment, and Saddle 2.

8 If approval is given for dam construction to proceed it is recommended that water pressure testing be carried out prior to grouting along the abutments, at selected sites for the plinth, and at Saddle 2.

13 REFERENCES

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PART II

GEOPHYSICAL REPORT

C. HORSEFALL

1 SUMMARY

Shallow seismic refraction investigations have been carried out on the dam site and on possible weir and spillway sites for the proposed Todd River Dam. Assuming a 1750 m/s seismic velocity cut off, most of the area will be rippable by D8 bulldozer to a depth of 3 to 4 metres.

2 INTRODUCTION

The seismic investigations were carried out by the Northern Territory Geological Survey to supplement drilling information in investigating the nature and properties of the subsurface - the depth and strength of the bedrock, the type of overburden and its rippability, and the positions of shear zones and other zones of weakness.

The Field work carried out by a party from the geophysical section in late May 1979. The party consisted of P.M. Ryan and field assistants under the supervision of geophysicist P. Woyzbun. Twenty-one spreads totalling 640 m were hammered and shot.

The seismic records were plotted by the Engineering Geophysics Section of the Bureau of Mineral Resources, Geology and Geophysics in Canberra using their computer plotting facilities. The geophysical interpretation of the seismic data was made in late September 1979.

3 METHOD AND EQUIPMENT

3.1 Seismic Refraction Technique

The velocity with which a vibration is transmitted through rock varies with rock type and in general increases with the strength of the rock. Seismic velocity generally increases with the degree of water saturation of the rock and discontinuities (Domzalski, 1956). The velocity of transmission of vibrations through underground rock can be determined in a seismic refraction survey, and the depths and thicknesses of the various rock types and weathered zones calculated.

Sites were investigated using a 12-geophone spread generally with 2-m intergeophone spacing. The spreads were linked on traverse by two common geophone positions.

A twelve channel RS4 seismograph manufactured by Dresser-SIE of Houston, Texas, was used. A hammer was used as a seismic source on most spreads; detonators were occasionally used on long shots; and gelignite was used on the spread of 15-m intergeophone spacing on Saddle 3.

Seven records were hammered on each spread. Short "shots" were 2 m from the end geophone; An additional "shot" was used to determine the reciprocal time using a reciprocal geophone.

The intercept method was used for interpretation at each shot-point (Heiland, 1946). Where possible the reciprocal time method (Hawkins, 1961) was used to determine the depth to bedrock under each geophone.

The poor quality of the records made accurate interpretation difficult and the surface profile of the deepest refractor was generally not calculated owing to the uncertainty in the reciprocal time values and in the first arrival times on the long shots. However, most errors in depth and velocity are expected to be less than 25 percent for the deeper layers and of the order of 50 percent for the topmost soil profile layer.

The ground surface is generally represented on the seismic sections as a straight line where topographic survey data was not available.

4 RESULTS

4.1 Seismic Velocities

The seismic profiles in all areas examined generally show three layers. However, most seismic profiles did not show the deepest near-surface refractor present as long shots were not placed far enough away from the spreads.

200 - 600 m/s:	Soil and unconsolidated alluvium completely weathered unsaturated material, generally 1 m deep.
600 - 1750 m/s:	Completely to highly weathered rock or consolidated alluvium, generally to 3 to 4 m depth. (Rock Condition Number 6).
1750 - 3000 m/s:	Highly weathered soft rock to moderately weathered strong rock. Partings are open and wide or closely spaced and usually containing clay materials accompanied by fissure water. Individual zones of this velocity in higher velocity rock probably represent sheared or faulted zones. (Rock Condition Number 5).
3000 - 3700 m/s:	Rock substance is slightly weathered to fresh with its surface weathered. Joints and cracks are moderately or closely spaced, partly open, with or without clay. (Rock Condition Number 4).
3700 - 4600 m/s:	Moderately spaced joints and cracks with only sligh parting. Rock substance is rather fresh with weathering on the surfaces of partings. (Rock Condition Numbers 3 and 2).

4600 - Fresh or fresh with stained joints. Any defects are tight with little or no clays. (Rock Condition Number 1).

A seismic velocity of 1750 m/s is considered to be the upper velocity limit for rock material to be rippable with a D8 bulldozer Caterpillar Tractor Company, 1966).

4.2 Dam Site Area

Lines A and A1 on the western abutment show a refractor of 2000 m/s at depths of 3 m in line A1 and ranging from 0 - 3 m in line A1. The absence of a deeper higher velocity refractor in line A suggests that moderately to slightly weathered rock is a depth greater than 6 m there. This may be a result of shearing and deeper weathering associated with faults A1 and A2 (Plate 12). The greater depth of the 2000 m/s refractor at the northern end of line A1 is similarly likely to be related to these faults. This suggests that at 6 m depth the rock is likely to be highly weathered within 7 m of the indicated positions of the faults. Faults B1 and B2 do not appear to extend further eastwards than indicated in Plate 12. The depth to fresh rock of 4.9 m encountered in DDH 1 (Plates 12 and 13) compares with the depth of 5.7 m to the 3700 m/s refractor in line A1.

Line B on the eastern abutment shows a depth to slightly weathered rock ranging from 3.3 m.

This compares with a depth to fresh rock of 3 m in nearby DDH 7 (Plates 12 and 13).

Lines C1 and C2 in the river bed imply a depth to water saturation of about 1.2 m and show a depth to slightly weathered rock of 4.6 m to 5.4 m.
This depth to bedrock closely agrees with the range of 4.5 m to 5.7 obtained by drilling (Plates 12 and 13). The differences in bedrock velocity obtained by lines C1 and C2 may be due to anistropy in seismic velocities caused by differences in the frequency of partings in the two directions. However, the seismic data is of poor quality and the bedrock velocities are approximate only.

4.3 Saddle 1

The seismic spreads were shot with a 2 m overlap. The sections indicate a depth to slightly weathered rock of 2 to 3 m. (Plate 18)

4.4 Saddle 2

The seismic spreads (Plate 18) were shot with a 2 m overlap. The sections (Plate 21) indicate a depth to slightly weathered rock of 2 to 4 m. The bedrock seismic weathered rock of 2 to 4 m. The bedrock seismic velocity of 5400 m/s shown in spread 2 is considered too high for a depth of 3 m;, it is probably caused by a topographic effect on the path of travel of the shock waves; the material A seismic velocity of about 3400 m/s is considered more likely.

Saddle 3

This spread (Plate 18) was shot with a 15 m intergeophone spacing for information on the seismic velocities of deeper refractors.
The near surface seismic record is of poor quality.
The section (Plate20) indicates fresh rock with few defects (seismic at a depth of 16 to 20m. velocity 5400 m/s).

Saddle 4

The seismic spreads were shot with a 2 m overlap.
The quality of the data from seismic line 4A of 4-m intergeophone spacing was so poor that the results have not been included with this report.

The seismic sections for line 4B generally indicate a depth to moderately to slightly weathered rock (seismic velocity greater than 2400 m/s) of 3 to 4 m.
Near the overlap of spreads 4 and 5 an increase in the depth to the 2400 m/s refractor implies deeper weathering or thicker alluvium, is possibly associated with the scarp shown in Plate 16.

Higher third refractor seismic velocities were recorded below the crest of the ridge in spreads 2 and 3 DDH2, near the junction of spreads 3 and 4 recorded no core recovery to a depth of 1.9m and a depth of 3m to fresh to slightly weathered rock.
These results correspond with depths of 0.7m to the 1200-1500 m/s refractor and 3.6m to the 3200 m/s refractor in spread 3.

5 CATERPILLAR TRACTOR COMPANY, 1966 - Handbook of Ripping: A guide to greater profits. *Caterpillar Tractor Company, Peoria, Illinois*

DOMZALSKI, W., 1956 - Some problems of shallow refraction investigations. *Geophysical Prospecting*, 4 (2), 140-166.

HAWKINS, L.V., 1961 - The reciprocal method of routine shallow seismic refraction investigations. *Geophysics*, 26(6), 806-819.

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A P P E N D I X 1

LOG OF DDH 1, SADDLE 4

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT TODD RIVER DAM SITE

TYPE QUARRY – SPILLWAY

LOCATION SADDLE 4

GRID CO-ORDS 1:250,000 ALICE SPRINGS 164 053

ANGLE FROM HORIZON 90° DIRECTION

E L COLLAR

DATUM

HOLE No. DDH 1

TEMPORARY No. 1

DESCRIPTION OF CORE	CORE DEPTH (m)	DESCRIPTION OF STRUCTURE
N.C.	0–1.0	
Granite gneiss discoloured, stained, grey-white, coarse-grained with augen, sl. foliated 80° very micaceous 45% fel, 45% qtz, 10% mica.	1.0–2.8	90° Very broken and 50mm clay (2×) fractured. 0° st, open, clay. 80° finely broken 1.40-2.50; 80°; 80° (2×); 80° (3×); 80° (2×); 30° 5mm clay, fault. 90° 5mm clay. fault. 80° (4×)
N.C.	2.8–3.4	
Granite gneiss (as above)	3.4–5.0	70° st. 70° st. 25° st. 85° 85° 10°, 85° (2×) 80° st. 30° + 45° st. 70° st, clay, 0° clay.
N.C.	5.0–5.6	
	5.6–6.2	10° st. 30° st.
quartz-feldspar pegmatite	6.2–7.2	slsd epidote
Note: Massive, fresh, strong, hard, widely fractured between 10m and 12m.	7.2–12.0	70° 70° 75° 75° 80° (2×) 80° st. 45° st. 20° st. 70° st. (2×) 80° 60° st.

RQD: n.a. (1.0–4.0 m). Frequency: n.a. (2.5–3.0 m, 5.0–5.6 m).

12·0 m

ROCK SUBSTANCE

Strength Term: SO Soil Properties; VW Very Weak; W Weak; MS Medium Strong; S Strong; VS Very Strong

Condition Term: Fresh; Slightly Weathered; Moderately Weathered; Highly Weathered; Completely Weathered

ROCK QUALITY DESIGNATION (R.Q.D.): 0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS: Angle between feature and core axis
- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- × Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	10 / 6 / 75
Driller	S. BERGER	Traced	B.T.
Start	4 / 6 / 75	Checked	
Finish	6 / 6 / 75	Sheet	1 of 1

APPENDIX 2

LOG OF DDH 2 SADDLE 4

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION: SADDLE 4.

HOLE No. D.D.H. 2.

GRID CO-ORDS 1:250,000: ALICE SPRINGS 164 053

TEMPORARY No. 2

PROJECT: TODD RIVER DAM SITE

ANGLE FROM HORIZON: 90°

DIRECTION

TYPE: QUARRY - SPILLWAY.

E L COLLAR

DATUM

Core depth (m)	Description of core	Description of structure
0–2.0	N. C.	
2.0	Granite gneiss, weakly foliated, coarse grained, qtz, fel, muscovite.	finely broken to pieces.
	sl. foliated, qtz 50%, fel 40% mica 10% (biotite) grey mottled, discoloured.	45° some clay very broken (50-125mm)
3.0	light grey, very coarse grained, felspar 'augen' very slightly foliated.	
4.0	strongly discoloured.	finely broken
	friable, stained, discoloured.	
	light grey, very coarse grained with 'augen' sl. foliated, biotite-mica.	20° very broken; 70° 70° stained; 70°, 30° traces of clay.
5.0		45° mod. weathered 50mm
8.0–9.0		40° st.; 70° slickensided.
9.0		70° (2×); 30° st.; 45° st.
10.0	10.0 m.	

Column headings: GROUP SYMBOL; Strength Term (SO, VW, W, MS, S, VS); CORE DEPTH; GRAPH LOG; RQD % (25, 50, 75); FREQUENCY (1 4 16 64); ATTITUDE; % CORE LOSS; CASING (NX); Water level. RQD noted "n.a." at about 2.5 m.

ROCK SUBSTANCE

Strength Term
- SO Soil Properties
- VW Very Weak
- W Weak
- MS Medium Strong
- S Strong
- VS Very Strong

Condition Term
- Fresh
- Slightly Weathered
- Moderately Weathered
- Highly Weathered
- Completely Weathered

ROCK QUALITY DESIGNATION (R.Q.D.)
- 0-25% Very poor
- 25-50 Poor
- 50-75 Fair
- 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis
- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	10/6/79
Driller	S. BERGER	Traced	B.T.
Start	6/6/79	Checked	
Finish	7/6/79	Sheet	1 of 1

APPENDIX 3

LOG OF DDH 1 DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION	RIGHT ABUTMENT
HOLE No.	DDH 1
GRID CO-ORDS 1:250,000	ALICE SPRINGS
TEMPORARY No.	
PROJECT	TODD RIVER DAM SITE
ANGLE FROM HORIZON	45°
DIRECTION	265
TYPE.	FOUNDATION, PERMEABILITY
E L COLLAR	3·54 m.
DATUM	A.H.D.

Column headings: DESCRIPTION OF CORE | GROUP SYMBOL | Strength Term (SO VW W MS S VS) | CORE DEPTH | GRAPH LOG | RQD % (25 50 75) | DESCRIPTION OF STRUCTURE | FREQUENCY (1 4 16 64) | ATTITUDE | % CORE LOSS | CASING | Water level

Description of core

Depth (m)	Description of core
0 – 0.6m	Core loss. Reported soil
0.6 – 0.68m	Gneiss Granite
0.68 – 1.54m	Core loss
1.54 – 3.24m	Gneiss Granite. Grey and pink. Foliated. 45% Quartz, 45% feldspar (K), 10% mica and other accesory minerals
3.24 – 3.5m	Core loss.
3.5m –	Gneiss Granite. as above.

Description of structure

- 80° rough stained
- 90° "
- Broken sp ~ 40mm
- 90° very rough
- 45° stained
- 40° minor clay
- 80° foliation break
- 80° " "
- 45° minor clay
- 80° very rough foliation
- 08° Moderately rough
- Broken - foliation sp ~ 30mm.
- 30° foliation very rough
- 70° foliation break
- Very broken
- 30° calcite and chlorite.
- 45° stained.
- 75° foliation. smooth.
- 40° smooth, slickensides
- 50° 2mm clay - Rough
- 60° stained. minor clay
- 85° stained. smooth.
- 80° stained
- 30° stained
- 45° Rough
- 60° stained, smooth.
- 35° stained, Rough
- 46° stained, Rough
- 75° stained, Rough
- 40° stained, Rough
- 50° stained - slickensides
- Broken. 45°.
- 75° stained and minor clay
- 43° stained moderately rough
- 10° calcite and minor clay
- 75° stained foliation
- 80° "
- broken
- 30° chlorite. smooth
- 46° " "

Casing / hole size: HQ (to ~3.5m), NQ (to ~7.7m), BQ

1st Packer Test L=1

2nd Packer Test L=6.5

Legend

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)
0-25% Very poor, 25-50 Poor, 50-75 Fair, 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis
- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No. Mindrill	LOGGED S.P
Type	Date / /
Driller S. Berger	Traced
Start 24/7/79	Checked
Finish 27/7/79	Sheet 1 of 3

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION: RIGHT ABUTMENT

HOLE No. DDH 1

TEMPORARY No.

GRID CO-ORDS 1:250,000

PROJECT: TODD RIVER DAM SITE

ANGLE FROM HORIZON

DIRECTION

TYPE: FOUNDATION, PERMEABILITY

E L COLLAR

DATUM

DESCRIPTION OF CORE	CORE DEPTH	DESCRIPTION OF STRUCTURE
Gneiss Granite See previous sheet 12.15m	10m – 12.15m	40° 5mm chlorite 90° foliation break. 49° rough stained 50° foliation break. 55° chlorite. 40° chlorite + slickensides 50° rough 40° stained + slickensides Broken - foliation sp 10mm 20° chlorite and clay 70° foliation break. Broken. sp. 5mm
Core loss 12.92	12.15m – 12.92m	
Gneiss Granite See previous sheet	12.92m – 20m	Broken sp 25-40mm 25° + 80° smooth chlorite. 30° minor clay 65° Foliation break. 37° stained - chlorite. 32° stained. 45° " Broken sp. 5mm Broken sp 15mm 60° very rough Broken sp 20mm 35° smooth with chlorite. 40° chlorite. x3. 40° chlorite. Broken sp 20mm foliation Broken sp 45mm 35° stained. Very Broken 28° + 00°. Broken stained. 80° Foliation break. 30° chlorite. 70° very rough. 60° stained 60° " + chlorite 40° slickensides. 80° foliation breaks. 75° chlorite. Broken 80° Foliation sp. 100mm 40° chlorite 40 " 40 " 40 " 40° minor slickensides. 80° Foliation break. 40° 5mm chlorite. 40° 5mm chlorite.

Core depth scale: 10m, 11m, 12m, 13m, 14m, 15m, 16m, 17m, 18m, 19m, 20m

Water level / packer tests: 3rd Packer Test L=0; 4th Packer Test L=0; 5th Packer Test L=0

Column headings: GROUP SYMBOL | Strength Term (SO VW W MS S VS) | CORE DEPTH | GRAPH LOG | RQD % (25 50 75) | DESCRIPTION OF STRUCTURE | FREQUENCY (1 4 16 64) | ATTITUDE | % CORE LOSS | CASING | Water level

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	LOGGED
Type	Date / /
Driller	Traced
Start / /	Checked
Finish / /	Sheet 2 of 3

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT SEE PAGE 1.

TYPE

LOCATION

GRID CO-ORDS 1:250,000

ANGLE FROM HORIZON

DIRECTION

E L COLLAR

DATUM

HOLE No. DDH 1

TEMPORARY No.

DESCRIPTION OF CORE	GROUP SYMBOL	Strength Term (SO VW W MS S VS)	CORE DEPTH	GRAPH LOG	RQD (25 50 % 75)	DESCRIPTION OF STRUCTURE	FREQUENCY (1 4 16 64)	ATTITUDE	% CORE LOSS	CASING	Water level
Gneiss Granite			m 20	+							
See previous sheet				+		0° smooth					
						40° smooth.					
				+		27° Very rough					
				+		22° minor calcite.					
						45° rough					
			21	+		40° chlorite.					
						30° chlorite rough					
				+		36° smooth slickensides.					
				+		50° mod. rough chlorite.					
				+		70° smooth.					
			22	+		90° very rough					
				+		40° Smooth slickensides					
				+		60° " "					
				+		60° " "					
						40° Manganese oxide					
22.80				+		90° foliation break - rough					
End of Hole.			23								

ROCK SUBSTANCE

Strength Term
- SO Soil Properties
- VW Very Weak
- W Weak
- MS Medium Strong
- S Strong
- VS Very Strong

Condition Term
- Fresh
- Slightly Weathered
- Moderately Weathered
- Highly Weathered
- Completely Weathered

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis
- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	LOGGED
Type	Date / /
Driller	Traced
Start / /	Checked
Finish / /	Sheet of

APPENDIX 4

LOG OF DDH 2 DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT: TODD RIVER DAM SITE

TYPE: FOUNDATION, PERMEABILITY

LOCATION: RIGHT BANK OF CHANNEL

GRID CO-ORDS 1:250,000: ALICE SPRINGS 164 052

ANGLE FROM HORIZON: 45° DIRECTION: 265°

E L COLLAR: 1·74 m DATUM: m. A.H.D.

HOLE No. 2

TEMPORARY No.

Description of core	Group symbol	Core depth (m)	Description of structure	Casing	Notes
Reported: sand, gravel		0		PK	*Roller bit.*
N.C.					
		3·0		NX	*HQ*
Loose, rounded polymictic gravel-fragments.		3·7–8·0			
		~6·5			*H*
		~7·5			*NQ tripple-tube*
N.C.		8·0			
Gneiss granite ? clayey gravel	GC				
N.C.		9·0			
Gneiss granite, coarse-grained, altered, discoloured unfoliated.			*very close jointed, green clay, open, generally accomp. by tones of weathering*		

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- − Horizontal 0-5°
- ⁻ Inclined 6-30°
- ⁄ Inclined 31-60°
- I Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	R.T.
Type		Date	/ /
Driller	S. BERGER	Traced	B.T.
Start	11 / 7 / 79	Checked	
Finish	15 / 7 / 79	Sheet 1 of 2	

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION	HOLE No. 2
GRID CO-ORDS 1:250,000	TEMPORARY No.
PROJECT SEE SHEET 1.	
ANGLE FROM HORIZON	DIRECTION
TYPE	
E L COLLAR	DATUM

CORE DEPTH (m)	DESCRIPTION OF CORE	DESCRIPTION OF STRUCTURE
	Weathered and chloritised.	55° Fe-st. (2x)
		25° Irregular, stronglyst.
		15°, 90°, st chlorite, open.
	Chloritised	45° st. fracture zone
		30° weathered.
		finely broken topieces.
11·0		45°, 90°, 45°
		finely broken chlorite
		45° (2x)
		60°
	fine-grained	65° clay (2x)
12·0		45°
	50-60cm biotite pods	75° st. altered clay (2x)
		90°
		45°
		90° open 50° clay (3x)
		40° clay st.
13·0		45° clay (2x)
		55° clay (3x)
	rich in orthoclase.	60° clay (2x)
14·0		90°
		45° st.
		clay filled
		55°, 35°
		55°
15·0		45° clay (2x)
		45° clay
		45° clay
		alteration, clay
16·0		50° clay
		45°, 45°, clay (2x)
		65°, 90° clay.
		45° clay
17·0		40° clay
		60° clay
		35°
18·0		45° clay
		45° clay
		60° clay, 70° clay
		50° clay (2x)
		18·70 m.
19·0		

1st Packer Test L = 1·3

2nd Packer Test L = 3

3rd Packer Test L = 0

Column headings: DESCRIPTION OF CORE; GROUP SYMBOL; Strength Term (SO VW W MS S VS); CORE DEPTH; GRAPHIC LOG; RQD (25 50 % 75); DESCRIPTION OF STRUCTURE; FREQUENCY (1 4 16 64); ATTITUDE; CORE LOSS; CASING; Water level

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis
– Horizontal 0-5° | Steep 61-90°
– Inclined 6-30° x Intersecting
⁄ Inclined 31-60°

ENGINEERING GEOLOGY SECTION	
Drill No. MINDRILL	LOGGED R.T.
Type	Date / /
Driller S. BERGER	Traced B.T.
Start 11 / 7 / 79	Checked
Finish 15 / 7 / 79	Sheet 2 of 2

A P P E N D I X 5

LOG OF DDH 3   DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT: TODD RIVER DAM

TYPE: PERMEABILITY - [illegible]

LOCATION: CENTRE OF CHANNEL

GRID CO-ORDS 1:250,000: ALICE SPRINGS 164052

ANGLE FROM HORIZON: 45° DIRECTION: 265

E L COLLAR: 1·89 m DATUM: m. A.H.D.

HOLE No. DDH3

TEMPORARY No. 1

DESCRIPTION OF CORE	DEPTH (m)	DESCRIPTION OF STRUCTURE
Channel Alluvium: sandy gravel.	0 – 6·0	
Gneiss granite, coarse-grained, grey mottled pink, slightly discoloured where sl. weathered. 45% felspar, 45% quartz, 10% biotite, muscovite, sl. foliated (30°), microfractured where sl. weathered, dense, hard.	6·0 – 10·0	*NQ bit. very broken.*
	7·0	*20° (st, chlorite), 45° st traces of clay.*
		65° 30° st clay 30° st.
		45° st.
		45° st. 5° chlorite, clay
	8·0	*60° st. 40° sl. st. chlorite.*
		90° heavily st.
		10° st.
	9·0	*5° st.*
		25° heavily st.
		30°, 45° st.
		30° (2×) chlorite
		30° (2×) chlorite
	10·0	*30° (3×) chlorite*

Depth scale: 1·0, 2·0, 3·0, 4·0, 5·0, 6·0, 7·0, 8·0, 9·0, 10·0

Frequency: *n.d.*

Packer Test 1. *L > 6.*

Column headings: GROUP SYMBOL | Strength Term | CORE DEPTH | GRAPHIC LOG | RQD | DESCRIPTION OF STRUCTURE | FREQUENCY | ATTITUDE | CORE LOSS | CASING | Water level

ROCK SUBSTANCE

Strength Term
- SO Soil Properties
- VW Very Weak
- W Weak
- MS Medium Strong
- S Strong
- VS Very Strong

Condition Term
- Fresh
- Slightly Weathered
- Moderately Weathered
- Highly Weathered
- Completely Weathered

ROCK QUALITY DESIGNATION (RQD)
- 0-25% Very poor
- 25-50 Poor
- 50-75 Fair
- 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis
- – Horizontal 0-5°
- – Inclined 6-30°
- ⁄ Inclined 31-60°
- | Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No. MINDRILL	LOGGED B.W.
Type	Date 22/6/79
Driller G. BERGER	Traced B.T.
Start 14/6/79	Checked
Finish 22/6/79	Sheet 1 of 3

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION	CENTRE OF CHANNEL
HOLE No.	DDH3
TEMPORARY No.	
GRID CO-ORDS 1:250,000	
PROJECT	TODD RIVER DAM
ANGLE FROM HORIZON	45°
DIRECTION	265
TYPE	PERMEABILITY – E
E L COLLAR	
DATUM	

Column headings: DESCRIPTION OF CORE | GROUP SYMBOL | Strength Term | CORE DEPTH | GRAPH LOG | RQD 25 50 75 | DESCRIPTION OF STRUCTURE | FREQUENCY | ATTITUDE | CORE LOSS | CASING | Water level

Description of core: see sheet 1.

Core depth (m): 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0

Description of structure:

- 80° 3mm clay
- 60° st, traces of clay
- 45° chlorite
- 60° chl. 15° chl.
- 65° chl, 45° chl, 60°, 70°
- 70° (2×)
- 40° traces of clay
- 70° st. chl.
- 60°, 45° st.
- 30°, st. clay
- 30°, st, clay (2×)
- 60° st, clay
- 60° st, chl.
- 60° st, chl.
- 70° st, chl.
- 30° chl, clay (2×)
- 60° / 30° ground core.
- 30°
- 30°
- 30° (2×)
- 30° (2×)
- 30°
- 10° chl, clay.
- 30°
- 30° (2×)
- 40° chl.
- 45° traces of clay
- 40° chl
- 30° chl, clay.
- 5°/70° clay.
- 30°
- 70°
- 60°

Packer tests: Packer Test 2. L < 4. — Packer Test 3. L = 0 — Packer Test 4. L = 0

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	22/6/79
Driller	S. BERGER	Traced	B.T.
Start	14/6/79	Checked	
Finish	22/6/79	Sheet 2 of 3	

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION: CENTRE OF CHANNEL

HOLE No. D.D.H.3

TEMPORARY No.

GRID CO-ORDS 1:250,000

PROJECT: TODD RIVER DAM

ANGLE FROM HORIZON: 45° DIRECTION: 265

TYPE: PERMEABILITY -

E L COLLAR

DATUM

DESCRIPTION OF CORE	GROUP SYMBOL	Strength Term (SO VW W MS S VS)	CORE DEPTH	GRAPH LOG	RQD 25 50 75	DESCRIPTION OF STRUCTURE	FREQUENCY 1 4 16 64	ATTITUDE	% CORE LOSS	CASING	Water level
see page 1.			m	+							
			210	+		60°					Packer Test 5
				+		65°					
			220	+		60°					
				+		35°, 20°, 5°					
						22·80 m.					

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W
Type		Date	22/6/79
Driller	S. BERGER	Traced	B.T.
Start	14/6/79	Checked	
Finish	22/6/79	Sheet 3 of 3	

APPENDIX 6

LOG OF DDH 3A DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT	TODD RIVER DAM
TYPE	FOUNDATION – PERMEABILITY.
LOCATION	CENTRE OF CHANNEL
GRID CO-ORDS 1:250,000	ALICE SPRINGS 164052
ANGLE FROM HORIZON	90°
DIRECTION	
E L COLLAR	1.65m
DATUM	m A.H.D.
HOLE No.	DDH 3A
TEMPORARY No.	3

DESCRIPTION OF CORE	GROUP SYMBOL	CORE DEPTH (m)	DESCRIPTION OF STRUCTURE	CASING	Remarks
Channel Allumium sandy gravel / gravelly sand.	GW / SW	0–1.0		NX	HQ-bit.
		1.0–5.0			
loose boulders.		5.0			
Gneiss granite, grey, mottled pink, sl. foliated (30°), coarse grained, felspar 50%, quartz 40%, mica 10%, with felspar "augen" up to 20 mm ø		5.3–6.0	60° traces of clay. 80° st. 45° st, clay. 3x intersecting, stained.		NQ - split tube.
		6.0–7.0	45° st, 35° st (2x). 80° st, 45° st (2x). 70° st, 85° st. 60° st, 70° st, 85° st. 60° (2x) st, 80° chlorite.		
		7.0–8.0	70° st, 60° st (Chl.). 60° st. 70° st. finely broken to pieces. 60°, 80° st, 70° st.		1st Packer Test. L > 100
		8.0–9.0	70° (2x). 10° st, chl, 70° (2x) st. 10° st. 80° st. 90° chl. 70° st.		
chloritic		9.0	90° (2x) brecciated and 70° recemented.		
Dolerite, microfractured.			finely broken to pieces.		
Granite gneiss (as above)			70°		

Strength Term columns: SO, VW, W, MS, S, VS. Frequency: 1 4 16 64. Other columns: RQD % (25, 50, 75), ATTITUDE, CORE LOSS, Water level.

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- ı Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No. MINDRILL	LOGGED B.W.
Type	Date 2/7/79
Driller S. BERGER	Traced B.T.
Start 28/6/79	Checked
Finish 30/6/79	Sheet 1 of 2

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT TODD RIVER DAM

TYPE FOUNDATION - PERMEABILITY

LOCATION CENTRE OF CHANNEL

GRID CO-ORDS 1:250,000

ANGLE FROM HORIZON 90° DIRECTION

E L COLLAR 1·65m DATUM m A.H.D.

HOLE No. D.D.H.3A

TEMPORARY No. 3

DESCRIPTION OF CORE | GROUP SYMBOL | Strength Term | CORE DEPTH | GRAPH LOG | RQD 25 50 75 | DESCRIPTION OF STRUCTURE | FREQUENCY | ATTITUDE | CORE LOSS | CASING | Water level

see sheet 1.

Core depth (m)	Description of structure
	90°
	25°, 35°, 70°
	80°, 70°,(2x) chl.
	75° chl.
	70°, 55°
	25° chl, clay, 60° chl.
11·0	brecciated, recemented.
	30°, 20° chl, 15° chl.
	15° chl, clay, 70°
12·0	70° (2x)
	25°
	70°
	70° (3x)
	70° chl.
13·0	70° chl. (2x)
	60° chl.
	75° chl, clay
	65° chl, clay
	65° chl, clay, 15° st.
14·0	15° clay, 80° st.
	10° clay.
	70° st.
15·0	30°, 70°, 6°
	intersecting
	30°
	65° clay.
	45° (2x)
16·0	65° clay, 60°, 30°, 80° chl.
	45°
	40°
	70° (3x)
17·0	16·80m.
18·0	
19·0	

2nd Packer Test L=0

3rd Packer Test. L=0

ROCK SUBSTANCE

Strength Term
- SO Soil Properties
- VW Very Weak
- W Weak
- MS Medium Strong
- S Strong
- VS Very Strong

Condition Term
- Fresh
- Slightly Weathered
- Moderately Weathered
- Highly Weathered
- Completely Weathered

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis
- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION	
Drill No. MINDRILL	LOGGED B.W.
Type	Date 2/7/79
Driller S. BERGER	Traced B.T.
Start 28/6/79	Checked
Finish 30/6/79	Sheet 2 of 2

A P P E N D I X _ 7

LOG OF DDH 4 DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION: CHANNEL

HOLE No. DDH 4

TEMPORARY No. 2

GRID CO-ORDS 1:250,000: ALICE SPRINGS 164052

PROJECT: TODD RIVER DAM SITE

ANGLE FROM HORIZON: 45°

DIRECTION: 185

TYPE: FOUNDATION, PERMEABILITY

E.L. COLLAR: 1·62 m

DATUM: m. A.H.D.

Description of Core	Core Depth (m)	Description of Structure	Remarks
Channel Alluvium gravelly sand / sandy gravel. *Brown clay / silt reported at depth.*	0 – ~6.8	*HQ bit, mud circulation.*	*difficult drilling: collapse of hole, outwash*
Quartz, loose boulder (?)	~6.8 – 7.2		*cemented.*
Gneiss granite, coarse-grained with augen up to 20mm, indistinctly foliated, grey, hard, dense. 50% felspar, 40% quartz, 10% mica.	7.2 – ~9.8	*60° chlorite (chl)* *15° stained (st), 25 st.* *45° st, chl.* *70° chl.* *80° st, 60° (2×) st.* *85° st.* *70° st, chl.* *30° st.*	*NQ-bit split-tube.* *1st Packer Test. L > 50 (washout) casing dislodged. (to 11m.)*

Casing: NX (from surface); BX (from ~7.2 m)

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0–25% Very poor; 25–50 Poor; 50–75 Fair; 75–100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- Horizontal 0–5°
- Inclined 6–30°
- Inclined 31–60°
- Steep 61–90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No. MINDRILL	LOGGED B.W.
Type	Date 28/6/79
Driller S. BERGER	Traced B.T.
Start 25/6/79	Checked
Finish 27/6/79	Sheet 1 of 2

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION	CHANNEL
HOLE No.	DDH 4
GRID CO-ORDS 1:250,000	
TEMPORARY No.	
PROJECT	TODD RIVER DAM SITE
ANGLE FROM HORIZON	45°
DIRECTION	185
TYPE	FOUNDATION, PERMEABILITY
E L COLLAR	
DATUM	

Columns: DESCRIPTION OF CORE | GROUP SYMBOL | Strength Term (SO VW W MS S VS) | CORE DEPTH | GRAPH LOG | RQD % (25 50 75) | DESCRIPTION OF STRUCTURE | FREQUENCY (1 4 16 64) | ATTITUDE | CORE LOSS | CASING | Water level

Core depth: m, 11·0, 12·0, 13·0, 14·0, 15·0, 16·0

DESCRIPTION OF CORE

see sheet 1.

Sheared, but recemented.

sl. weathered, discoloured

sl. weathered reddish discoloured.

DESCRIPTION OF STRUCTURE

45° chl.
70° st.
80° st.
35° st.
70° st. (2×)
30°
45°, 50°
60° chl.
60° chl.
45° chl.
30° chl.
70° chl. 80° chl.
60° st.
40° chl. 0°, 70°, 60°.
10° chl.
20° chl. st. 15° st.
0° st.
finely broken to pieces
st. surfaces.
finely broken to pieces.
70°
70° (2×)
60°, 80°
10° 45°
20° 50mm finely broken.
70°/70°
15°, 30° (2×)
55°
15°, 20° (2×)
90°, 70° clay.
70° chl.
35° st, 70° (2×)

16·45 m.

2nd Packer Test. L > 100

3rd Packer Test. abandoned due to leakage.

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis
- Horizontal 0-5° | Steep 61-90°
- Inclined 6-30° x Intersecting
- Inclined 31-60°

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	29/6/79
Driller	S. BERGER	Traced	B.T.
Start	23/6/79	Checked	
Finish	27/6/79	Sheet	2 of 2

A P P E N D I X _ 8

LOG OF DDH 5   DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT TODD RIVER DAM SITE

TYPE FOUNDATION - PERMEABILITY

LOCATION E - BANK OF CHANNEL

GRID CO-ORDS 1:250,000 ALICE SPRINGS 164 052

ANGLE FROM HORIZON 45° DIRECTION 265

E L COLLAR 1·50 m DATUM m A. H. D.

HOLE No. 5

TEMPORARY No. 5

DESCRIPTION OF CORE	GROUP SYMBOL	Strength Term (SO VW W MS S VS)	CORE DEPTH	GRAPH LOG	RQD (25 50 75)	DESCRIPTION OF STRUCTURE	FREQUENCY (1 4 16 64)	ATTITUDE	CORE LOSS	CASING	Water level
Channel Alluvium sand / gravel	SW/GW		0 – 4.3 m							NX	
Sand: silty - clayey, fine			4.3 – 4.6 m								
N. C.			4.6 – 5.7 m								
Gneiss granite: reddish-grey, very coarse-grained with felspar augen, indistinctly foliated *50% felspar* *40% quartz* *10% mica* *hard, dense.*			5.7 – 9.9 m								

Description of structure (gneiss granite interval):

- *30°, 75° st. + clay*
- *80°*
- *20° chlorite (chl)*
- *finely broken*
- *90° clay (2×)*
- *70°, 70°, (2×) clay*
- *finely broken*
- *30° traces of clay, 45°*
- *75°, 60° (2×) traces of clay*
- *5° st, traces of chl.*
- *45° (2×) st, smooth.*
- *75° (2×) st.*
- *5° st, 70° st.*
- *60° st.*
- *30°*

Packer Test 1. L > 200

ROCK SUBSTANCE Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor	50-75 Fair
25-50 Poor	75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

– Horizontal 0-5°	I Steep 61-90°
⁻ Inclined 6-30°	x Intersecting
⁄ Inclined 31-60°	

ENGINEERING GEOLOGY SECTION	
Drill No. MINDRILL	LOGGED B.W.
Type	Date 6 / 7 / 79
Driller S. BERGER	Traced B.T.
Start 2 / 7 / 79	Checked
Finish 3 / 7 / 79	Sheet 1 of 2

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION

HOLE No. 5

GRID CO-ORDS 1:250,000

TEMPORARY No. 5

PROJECT · SEE SHEET 1.

ANGLE FROM HORIZON

DIRECTION

TYPE

E L COLLAR

DATUM

DESCRIPTION OF CORE	GROUP SYMBOL	Strength Term (SO VW W MS S VS)	CORE DEPTH	GRAPH LOG	RQD 25 50 75	DESCRIPTION OF STRUCTURE	FREQUENCY 1 4 16 64	ATTITUDE	CORE LOSS	CASING	Water level
See sheet 1.			m								
						40°					
			11·0			65°					
						80°					
						40° 2mm clay 45°					Packer Test 2 L > 2
						40° chl, 50°, 65°					
			12·0			70° 20° chl.					
						40°, 60°					
						40° (2x)					
			13·0			45°, 35°					
						25°					
						45°/ 70°/ 80°					Packer Test 3 L = 0
			14·0			45° chl.					
						15° chl. 40°					
						25° chl.					
			15·0			45°					
						15° chl					
						45° (2x)					
						very rough.					
						50°					
			16·0			75°					
						30°/40° very rough.					
						70°					
						45° chl.					Packer Test 4 L = 0
						70°					
			17·0			10°/ 15°/ 75°, 30°					
						70°, 45°, 60° chl					
						45° chl					
						65°					
			18·0								
						18 · 20 m.					

ROCK SUBSTANCE

Strength Term
- SO Soil Properties
- VW Very Weak
- W Weak
- MS Medium Strong
- S Strong
- VS Very Strong

Condition Term
- Fresh
- Slightly Weathered
- Moderately Weathered
- Highly Weathered
- Completely Weathered

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor · 50-75 Fair
25-50 Poor · 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis
- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- x Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	6 / 7 / 79
Driller	S. BERGER	Traced	B.T.
Start	2 / 7 / 79	Checked	
Finish	3 / 7 / 79	Sheet 2 of 2	

A P P E N D I X 9

LOG OF DDH 6 DAM SITE

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

LOCATION	E- BANK OF CHANNEL
GRID CO-ORDS 1:250,000	ALICE SPRINGS 164 052
HOLE No.	6
TEMPORARY No.	6
PROJECT	TODD RIVER DAM SITE
ANGLE FROM HORIZON	45°
DIRECTION	095°
TYPE	FOUNDATION, PERMEABILITY
E L COLLAR	1·44
DATUM	m. A.H.D.

DESCRIPTION OF CORE	GROUP SYMBOL	CORE DEPTH (m)	DESCRIPTION OF STRUCTURE	Notes
N.C. Sandy gravel / gravelly sand (channel alluvium)	SP, GP, GW	0 – 2·4		Roller-bit; casing NX
boulders and framents of gneiss granite.		2·4 – 2·8		HQ
Channel Alluvium — reported: clay. →		2·8 – 5·5		
Gneiss granite: coarse-grained, very coarse with felspar-"augen" up to 20 mm ø. sl. foliated, dense, hard. 50% felspar, 40% quartz, 10% mica.		5·5 – 7·5	45° stained (st); 70° st. 45° chlorite (chl); 45° st. sl. st.; 45°, 30° chl, traces of clay.; 45°; 70° (2×) traces of clay; 70° traces of clay; 80° traces of clay, st.; 70° traces of clay.; core very broken < 5 mm st. surfaces.	NQ
N.C.		7·5 – 7·9	90° (?)	
		7·9 – 9·5	finely broken to pieces st. surfaces < 5 mm.; 80° st, 35° st.; 70° (2×) chl.; 70°; finely broken to pieces	1st Packer Test L<3.
N.C.		9·5 –		

Column headings: DESCRIPTION OF CORE; GROUP SYMBOL; Strength Term (SO VW W MS S VS); CORE DEPTH; GRAPH LOG; R.Q.D. (25 50 75); DESCRIPTION OF STRUCTURE; FREQUENCY (1 4 16 64); ATTITUDE; % CORE LOSS; CASING; Water level

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis
– Horizontal 0-5° | Steep 61-90°
– Inclined 6-30°   x Intersecting
⁄ Inclined 31-60°

ENGINEERING GEOLOGY SECTION

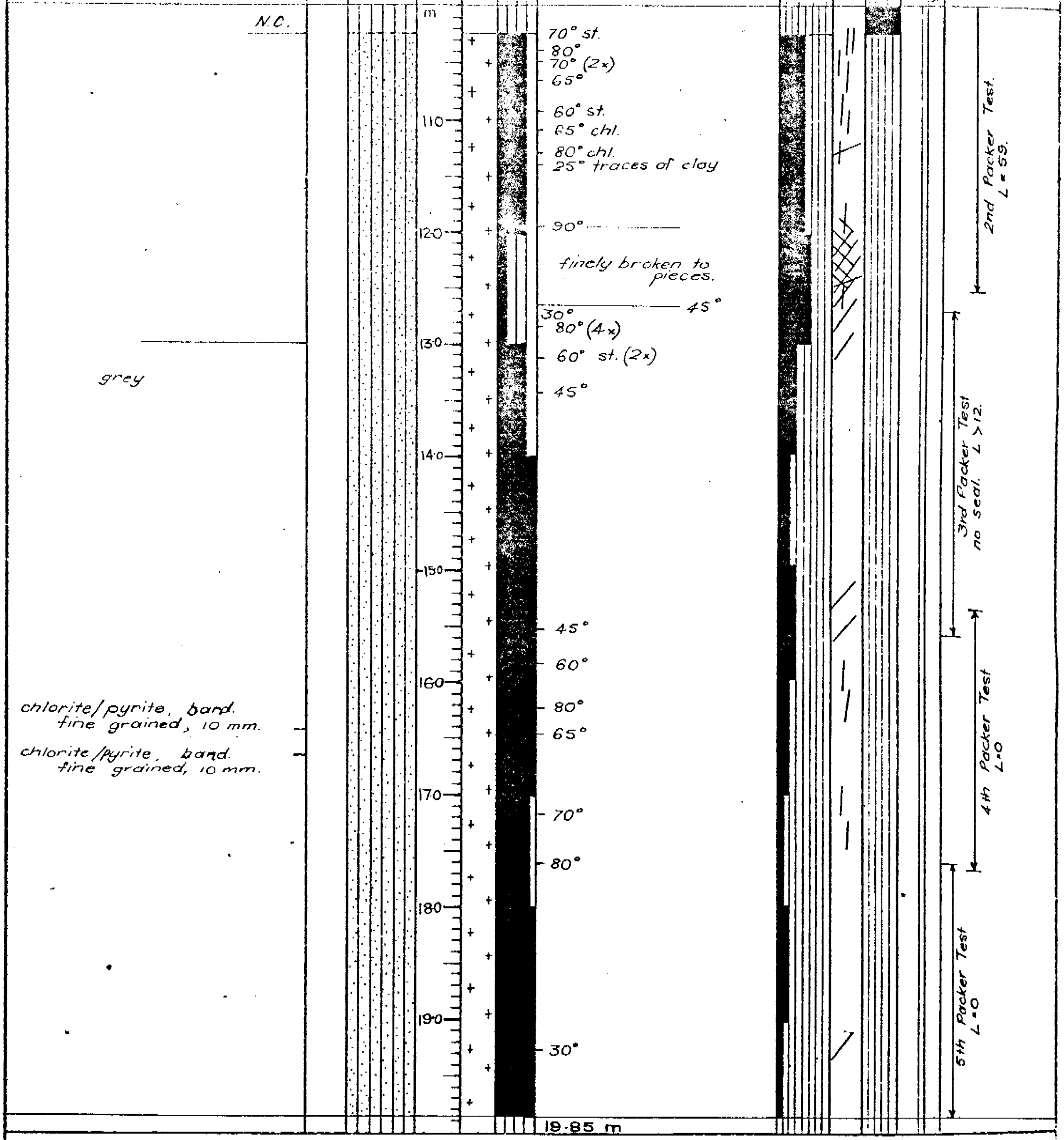
Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	13/8/79
Driller	S BERGER	Traced	B.T.
Start	5/7/79	Checked	
Finish	10/7/79	Sheet	1 of 2

N.T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT SEE SHEET 1	LOCATION	HOLE No. 6
TYPE	GRID CO-ORDS 1:250,000	TEMPORARY No. 6
	ANGLE FROM HORIZON	DIRECTION
	E L COLLAR	DATUM

DESCRIPTION OF CORE | GROUP SYMBOL | Strength Term | CORE DEPTH | GRAPH LOG | RQD 25 50 75 | DESCRIPTION OF STRUCTURE | FREQUENCY | ATTITUDE | CORE LOSS | CASING | WATER LEVEL



ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis

- Horizontal 0-5° | Steep 61-90°
- Inclined 6-30° × Intersecting
- Inclined 31-60°

ENGINEERING GEOLOGY SECTION	
Drill No. MINDRILL	LOGGED
Type	Date / /
Driller S. BERGER	Traced
Start / /	Checked
Finish / /	Sheet 2 of 2

APPENDIX 10

LOG OF DDH 7 DAM SITE

N.T. GEOLOGICAL SURVEY
LOG OF DIAMOND DRILL HOLE

PROJECT: TODD RIVER DAM SITE

TYPE: FOUNDATION, PERMEABILITY

LOCATION: LEFT ABUTMENT.

GRID CO-ORDS 1:250,000: ALICE SPRINGS 164 052

ANGLE FROM HORIZON: 45° DIRECTION: 005

E L COLLAR: 3·57m DATUM: m. A.H.D.

HOLE No. 7

TEMPORARY No. 7

DESCRIPTION OF CORE	CORE DEPTH (m)	DESCRIPTION OF STRUCTURE
Gneiss granite, sl. foliated, coarse grained with felspar 'augen' up to 20mm. discoloured where weathered, detached boulders to 3m. 45% felspar 45% quartz. 10% mica. grey mottled red.	0 – 3·0	microfractured to 4m.
	3·0	85° chlorite (chl) stained (st)
		75° chl, st, 60° chl. st. slickensided (sl sd) 70° clay 45° st.
		60° (2×) st, 45° st, 90° st,
	4·0	45° st (2×)
		60° st.
		45° clay.
		70° st.
		70° st.
	5·0	80° st, 65° st,
		50°
		60° + 70° st.
	6·0	65° (2×) intersecting.
		60° st (2×) 80°
		80° st.
		60° (2×) st.
	7·0	90° st.
		45° st.
		75° + 25° st.
		45° st
		45° st, 90° st, 85°, 50°
	8·0	intersecting 70°, 90°, 70°
		80° (2×)
		70° (2×), 60° st (2×)
		30° + 70° st.
	9·0	35°
Dolerite, chloritised pyrite.		70°
		90° (2×)
		65° st.
		80° st.
		70° st.

Column headings: DESCRIPTION OF CORE; GROUP SYMBOL; Strength Term (VW W MS S VS); CORE DEPTH; GRAPHIC LOG; R.Q.D. % (0 50 % 100); DESCRIPTION OF STRUCTURE; FREQUENCY (1 4 16 64); ATTITUDE; CORE LOSS; CASING; Water level

HQ - bit.

NX

BX

HQ / NQ

1st Packer Test L = 1.

2nd Packer Test L = 11

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor 50-75 Fair
25-50 Poor 75-100 Good to excellent

ATTITUDE OF JOINTS
Angle between feature and core axis
— Horizontal 0-5° | Steep 61-90°
— Inclined 6-30° x Intersecting
/ Inclined 31-60°

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	31 / 7 / 79
Driller	S. BERGER	Traced	B.T.
Start	18 / 7 / 79	Checked	
Finish	20 / 7 / 79	Sheet	1 of 2

N. T. GEOLOGICAL SURVEY

LOG OF DIAMOND DRILL HOLE

PROJECT: TODD RIVER DAM SITE

TYPE: FOUNDATION, PERMEABILITY

LOCATION: LEFT ABUTMENT

GRID CO-ORDS 1:250,000

ANGLE FROM HORIZON: 45°

DIRECTION

E. L. COLLAR

DATUM

HOLE No. 7

TEMPORARY No. 7

Description of core	Core depth (m)	Description of structure
see sheet 1.		45° st.
		70°, 85°, 80° (2×) 45° st.
		55 st.
		55 st.
		90° st.
		60° (2×) st, 70°, 80°
	11·0	80°
		70° st.
N. C.		N. C.
		finely broken to pieces
		70° chl.
		70° chl.
	12·0	70° st.
		finely broken to pieces
		85°, 70°, 65°
		35° st.
		80° clay, st.
		70°
	13·0	finely broken to pieces.
pegmatite, felspar		
		90°
		70°
	14·0	20° clay, st.
		75°
		60°
		90°
		15° chl, st.
	15·0	90°
		70°
		70° (2×)
		70° (3×)
		70°
	16·0	
pegmatite.		finely broken to pieces
		70°
		75°
	17·0	10° carbonate
		15°
		70°, 60°
		30° chl.
		80° (2×) chl, 40°
	18·0	45°
		45°
	19·0	45°
		45°
		19·40 m.

Water test annotations: 3rd Packer Test L < 1; 4th Packer Test L = 0

Casing: NQ / BQ

ROCK SUBSTANCE

Strength Term		Condition Term
SO	Soil Properties	Fresh
VW	Very Weak	Slightly Weathered
W	Weak	Moderately Weathered
MS	Medium Strong	Highly Weathered
S	Strong	Completely Weathered
VS	Very Strong	

ROCK QUALITY DESIGNATION (R.Q.D.)

0-25% Very poor; 25-50 Poor; 50-75 Fair; 75-100 Good to excellent

ATTITUDE OF JOINTS

Angle between feature and core axis

- Horizontal 0-5°
- Inclined 6-30°
- Inclined 31-60°
- Steep 61-90°
- × Intersecting

ENGINEERING GEOLOGY SECTION

Drill No.	MINDRILL	LOGGED	B.W.
Type		Date	31 / 7 / 79
Driller	S. BERGER	Traced	B.T.
Start	19 / 7 / 79	Checked	
Finish	20 / 7 / 79	Sheet 2 of 2	

APPENDIX 11

ADOPTED

CLASSIFICATION OF THE VARIOUS STAGES OF THE WEATHERING PROCESS

Degree of Decomposition	Field Recognition	Engineering Properties
Soil	No recognisable rock texture; surface layer contains humus and plant roots.	Unsuitable for important foundations. Unstable on slopes when cover is destroyed.
Completely Weathered	Rock is completely decomposed by weathering in place but texture still recognisable. In types of granitic origin, original felspars completely decomposed to clay minerals. Cannot be recovered as cores by ordinary rotary drilling methods.	Can be excavated by hand or ripping without use of explosives. Unsuitable for foundations of concrete dams or large structures. May be suitable for foundations of earth dams and for fill. Unstable in high cuttings at steep angles. Requires erosion protection.
Highly Weathered	Rock so weakened by weathering that fairly large pieces can be broken and crumbled in the hands. Sometimes recovered as core by careful rotary drilling. Stained by limonite. Less than 50% rock.	Similar to above. Unlikely to be suitable for foundations of concrete dams. Erratic presence of boulders make it an unreliable foundation stratum for large structures.
Moderately Weathered	Considerably weathered throughout. Possessing some strength - large pieces (e.g. NX drill core) cannot be broken by hand. Often limonite-stained. 50% to 90% rock.	Excavated with difficulty without use of explosives. Mostly crushes under bulldozer tracks. Suitable for foundations of small concrete structures and rockfill dams. May be suitable for semi-pervious fill. Stability in cuttings depends on structural features, especially joint attitudes.
Slightly Weathered	Distinctly weathered through much of the rock fabric with slight limonite staining. Some decomposed felspar in granites. Strength approaching that of fresh rock. More than 90% rock.	Requires explosives for excavation. Suitable for concrete dam foundations. Highly permeable through open joints. Often more permeable than the zones above or below. Questionable as concrete aggregate.
Fresh Rock	Fresh rock may have some limonite-stained joints immediately beneath weathered rock.	Staining indicates water percolation along joints; individual pieces may be loosened by blasting or stress relief and support may be required in tunnels and shafts.

Reference: Dearman, W.R. in Bull. IAEG No 13, 1976 - p123

Plate 3

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site. **BORE HOLE:** DDH1.

WATER LOSS in Lugeons (L): 1, 2, 5, 10, 20, 50, 100

1st TEST

Water loss (L)	Pressure (kPa)
0·5	30
0·95	50
1·0	80
0	50
0	30

Test Section: 4·45 to 7·60 m. Packer: mechanical. Lugeon value: 1·0

2nd TEST

Water loss (L)	Pressure (kPa)
0·3	50
0·5	90
0·5	130
0	90
0	50

Test Section: 7·90 to 11·05 m. Packer: mechanical. Lugeon value: 0·5

3rd TEST

Water loss (L)	Pressure (kPa)
0	70
0·5	130
0·6	180
0·1	130
0	70

Test Section: 10·90 to 14·05 m. Packer: mechanical. Lugeon value: 0·6(?)

Remarks: Seal not properly set.

4th TEST

Water loss (L)	Pressure (kPa)
0	90
0	160
0·1	220
0	160
0	90

Test Section: 13·85 to 17·0 m. Packer: mechanical. Lugeon value: 0

5th TEST

Water loss (L)	Pressure (kPa)
0	100
0·3	180
0·1	250
0	180
0	100

Test Section: 16·55 to 19·70 m. Packer: mechanical. Lugeon value: 0

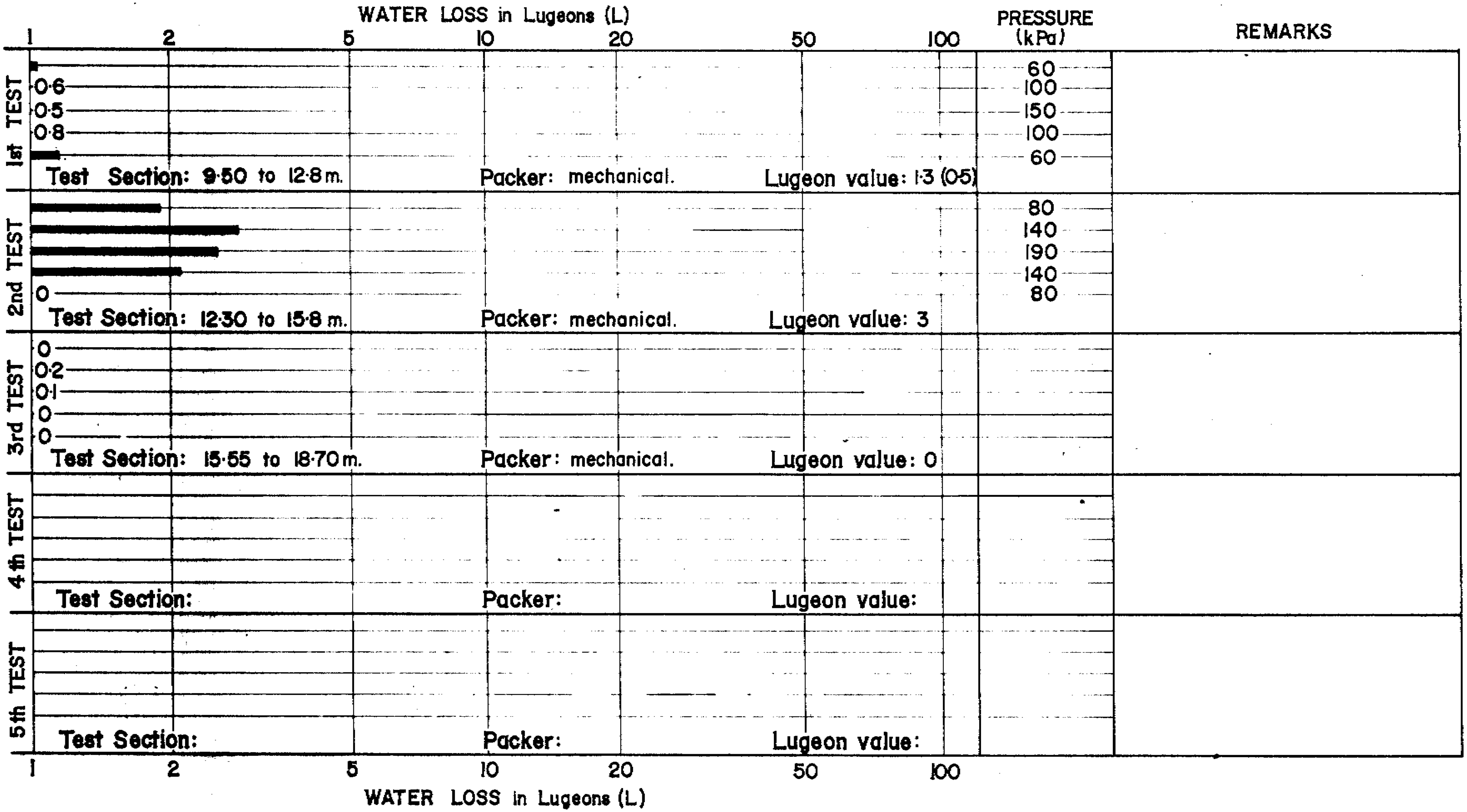
WATER LOSS in Lugeons (L): 1, 2, 5, 10, 20, 50, 100

Plate 4

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site **BORE HOLE:** DDH 2



N.T. GEOLOGICAL SURVEY

Plate 5

PERMEABILITY TESTS

SITE: Todd River Dam Site BORE HOLE: DDH 3

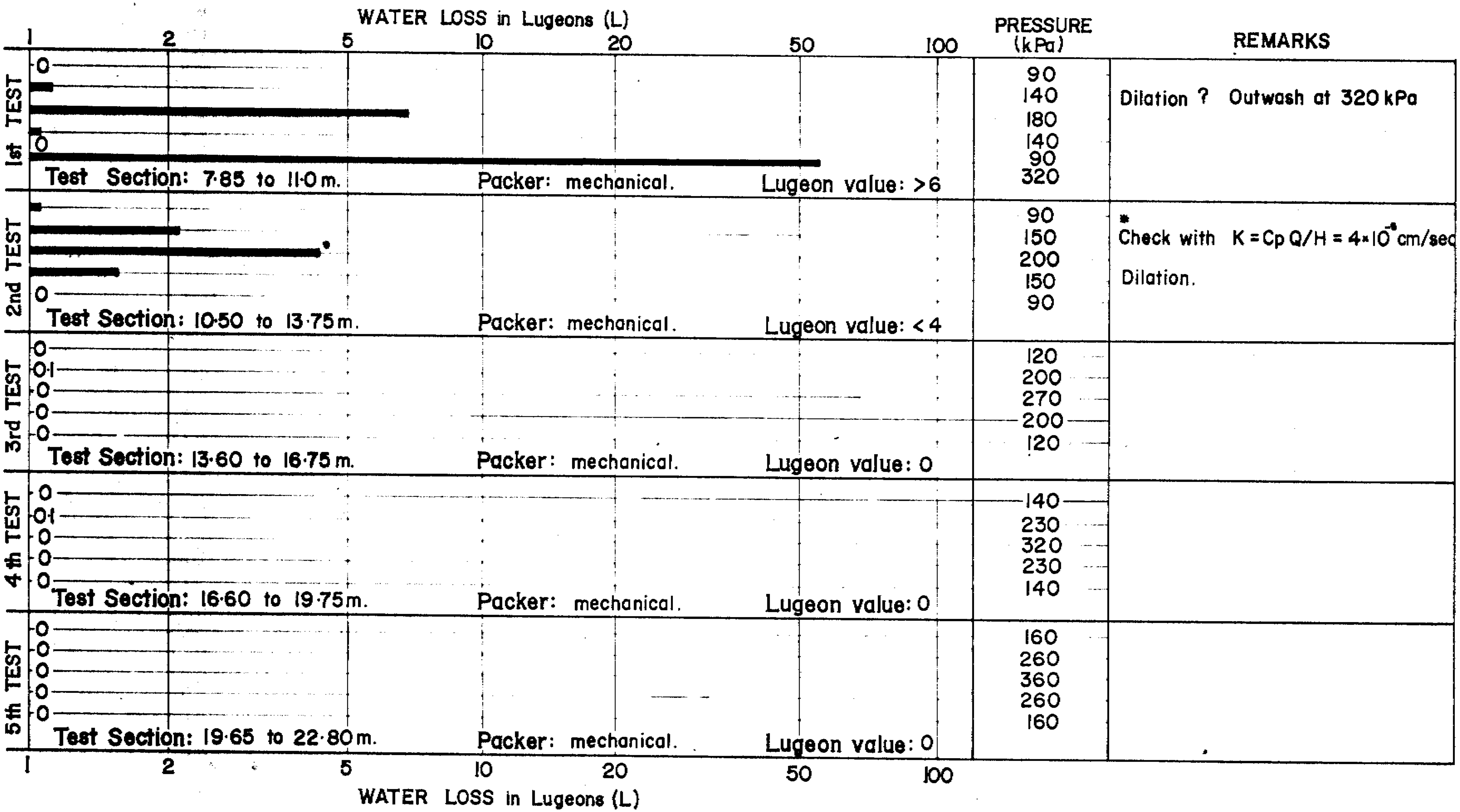


Plate 6

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site **BORE HOLE:** DDH3A

WATER LOSS in Lugeons (L) — scale: 1, 2, 5, 10, 20, 50, 100

Test	Water loss (L)	Pressure (kPa)	Test Section	Packer	Lugeon value	Remarks
1st TEST	—, 106, —	80, 150, 80	6·30 to 9·45 m.	mechanical.	>100	Non-standard test due to high water loss.
2nd TEST	0, 0, 0·1, 0, 0	100, 200, 290, 200, 100	10·65 to 13·80 m.	mechanical.	0	
3rd TEST	0, 0, 0·2, 0, 0	110, 220, 330, 220, 110	13·65 to 16·80 m.	mechanical.	0	
4th TEST						
5th TEST						

WATER LOSS in Lugeons (L)

Plate 7

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site   BORE HOLE: DDH4

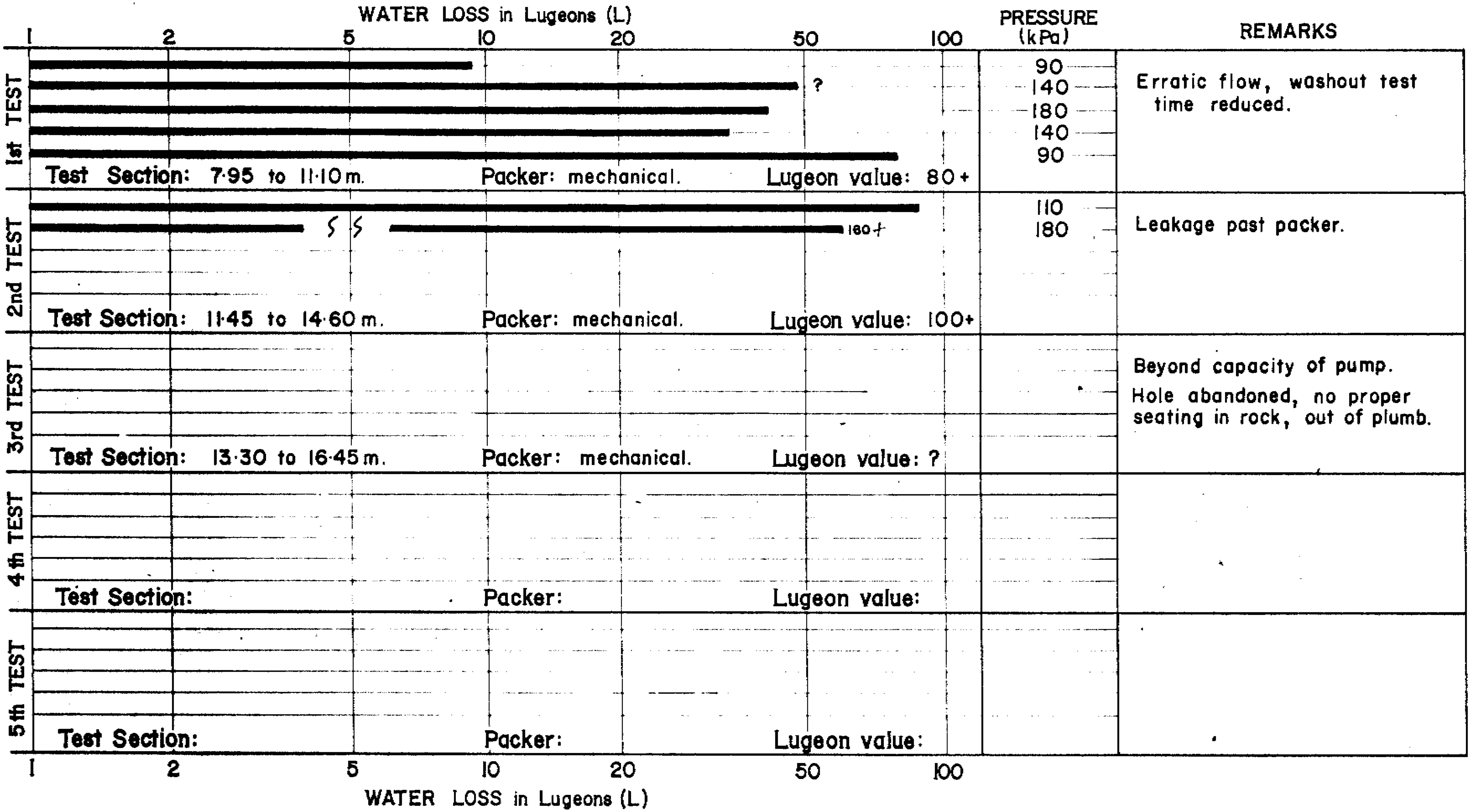


Plate 8

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site **BORE HOLE:** DDH5

WATER LOSS in Lugeons (L): 1, 2, 5, 10, 20, 50, 100

Test	Water loss (L)	Pressure (kPa)	Remarks
1st TEST		60	Washout.
		100	
		150	
	149	100	
	196	60	
	Test Section: 7·05 to 10·20 m. Packer: mechanical. Lugeon value: 200.		
2nd TEST			No seal obtained.
	Test Section: 10·05 to 13·20 m. Packer: mechanical. Lugeon value: large		
3rd TEST	0	90	
	0·05	160	
	0	220	
	0	160	
	not conducted	90	
	Test Section: 12·05 to 15·20 m. Packer: mechanical. Lugeon value: nil		
4th TEST	0	110	
	0·7	180	
	0·2	270	
	0	180	
	0	110	
	Test Section: 15·05 to 18·20 m. Packer: mechanical. Lugeon value: nil		
5th TEST			
	Test Section: Packer: Lugeon value:		

WATER LOSS in Lugeons (L): 1, 2, 5, 10, 20, 50, 100

Plate 9

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site BORE HOLE: DDH6

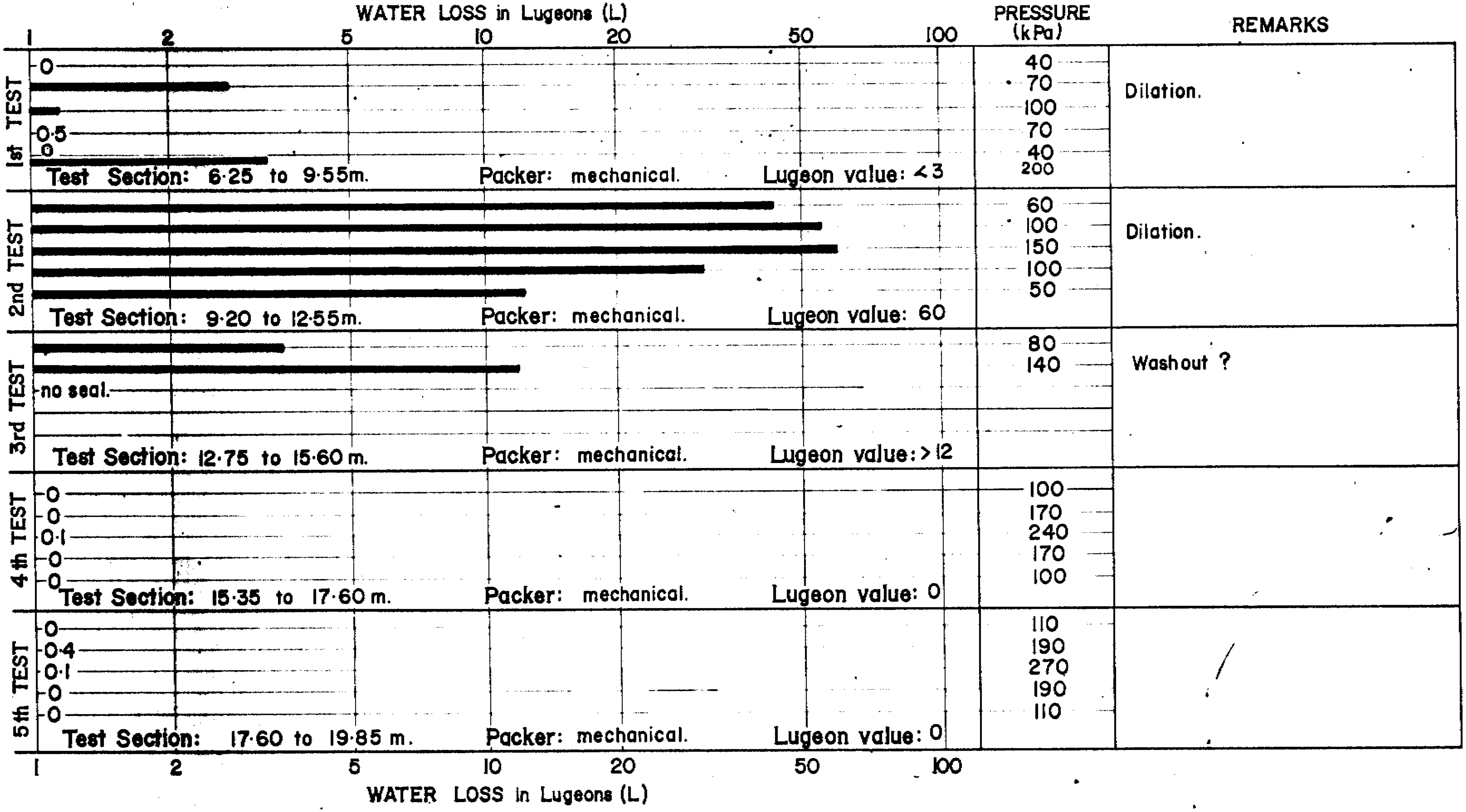


Plate 10

N.T. GEOLOGICAL SURVEY

PERMEABILITY TESTS

SITE: Todd River Dam Site   BORE HOLE: DDH7

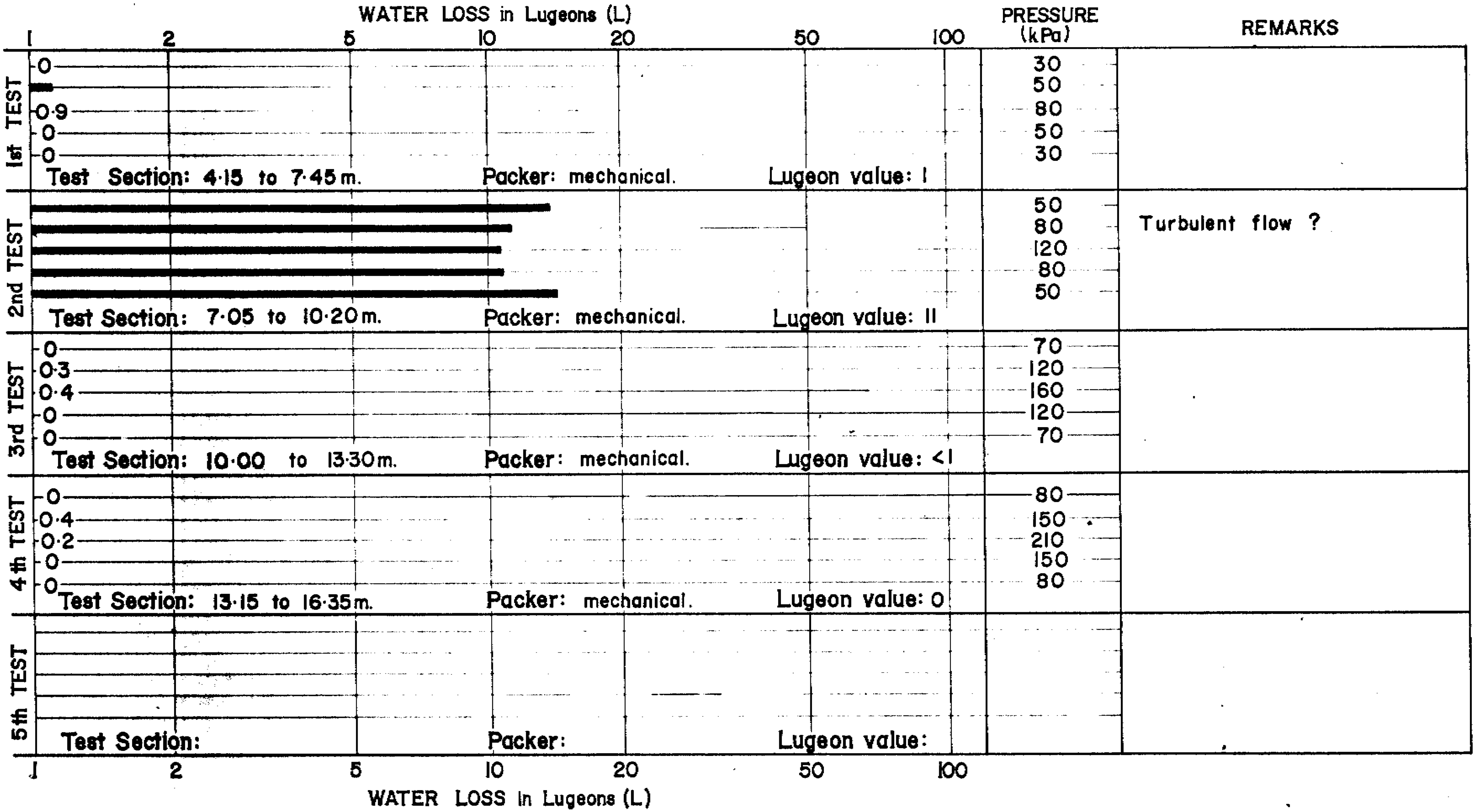
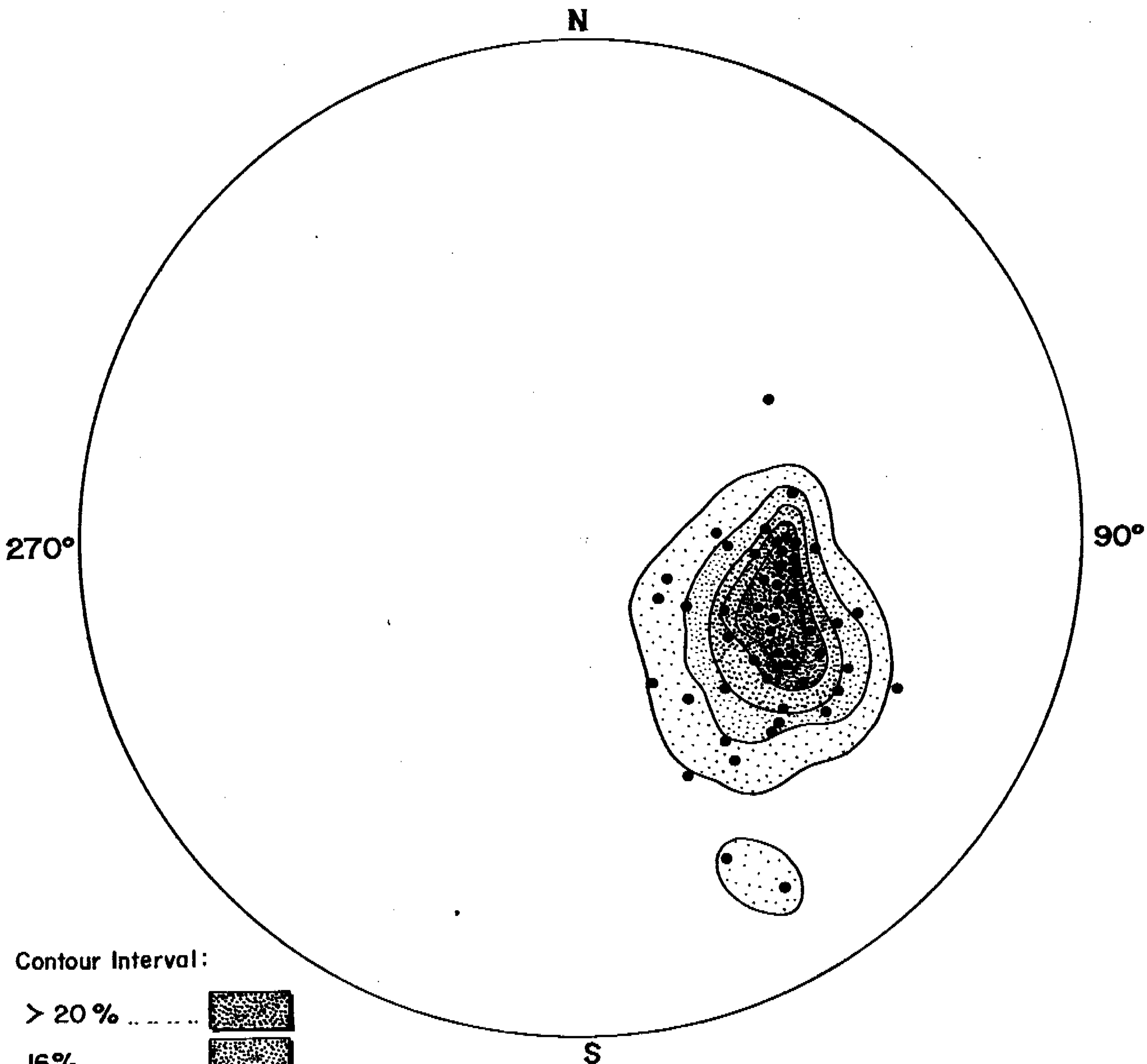


Plate II

Todd River Dam Site

CONTOURED POLES TO FOLIATION
DAM SITE, SPILLWAY & RESERVOIR
(Equatorial Equal Area Net)



Contour Interval:

> 20 % ....
16% ....
12 % ....
8 % ....
4 % ....

Pole of Joint .... •

Todd River Dam Site

JOINT DISTRIBUTION (Equatorial Equal Area Net)
LEFT ABUTMENT

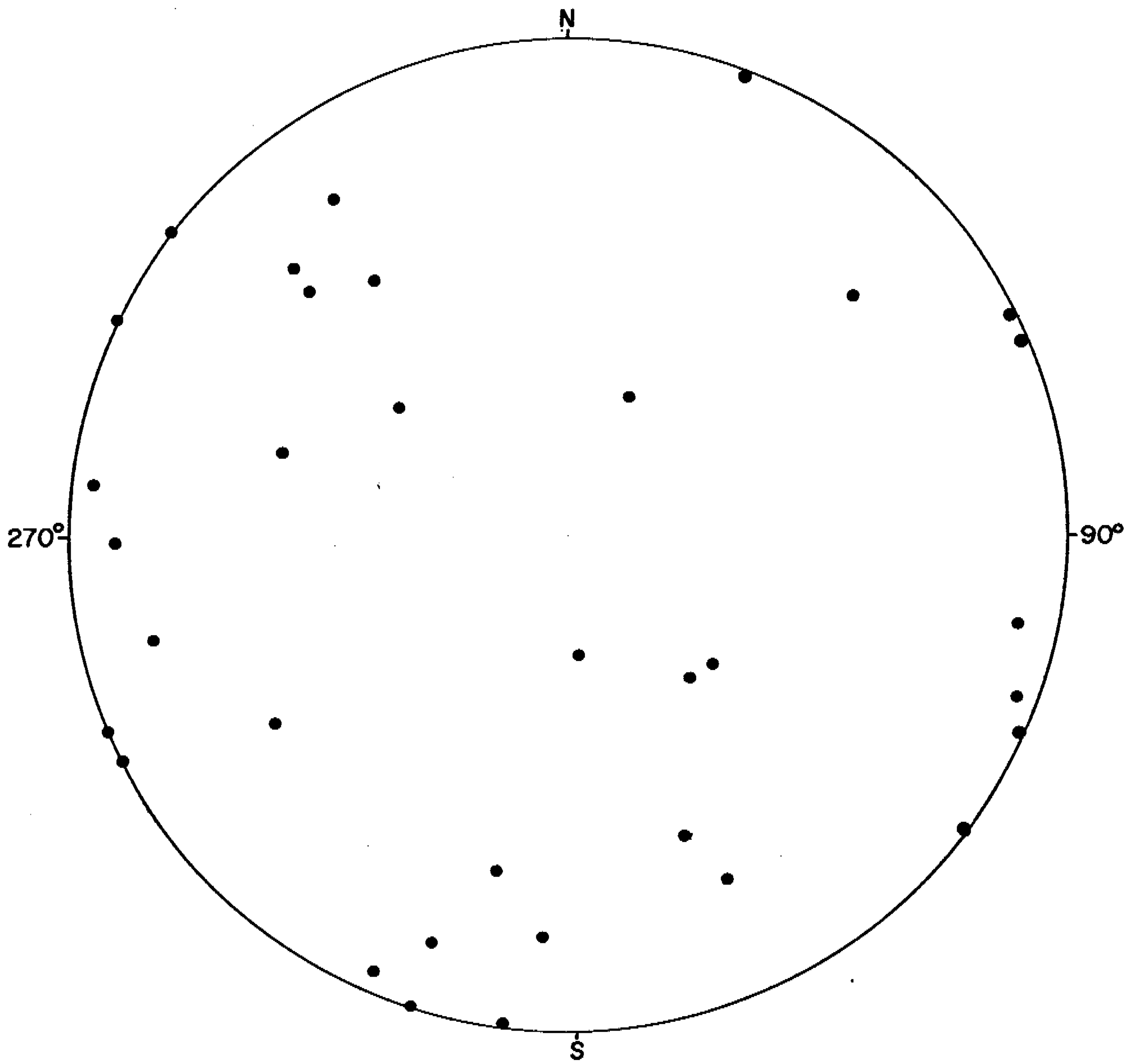
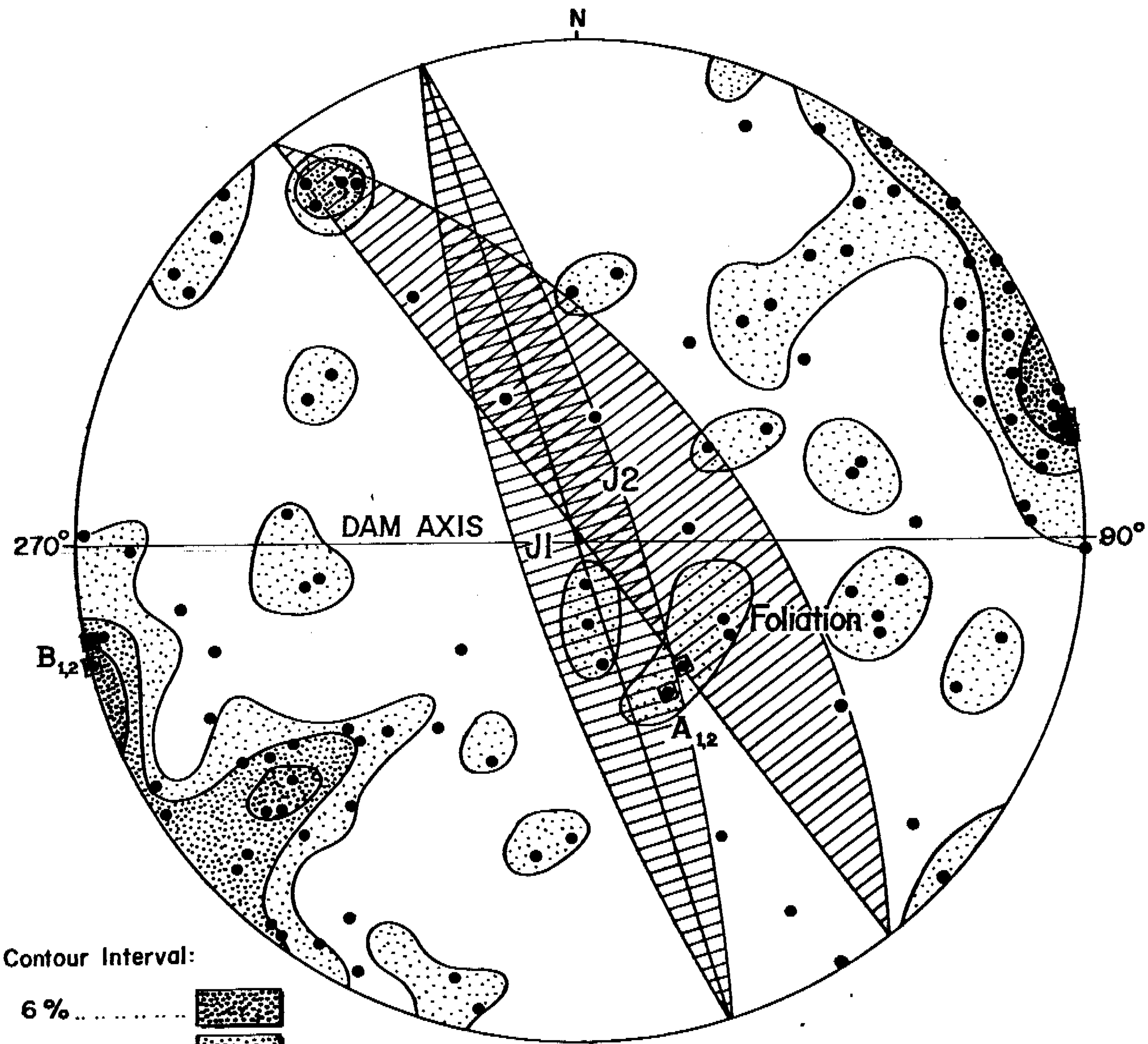


Plate 15

Todd River Dam Site

JOINT DISTRIBUTION (Equatorial Equal Area Net)

RIGHT ABUTMENT



Contour Interval:

6 % ....

4 % ....

2 % ....

Pole of Joint .... ●

Pole of Fault .... ▣

Lower Hemisphere Net.

N.T. DEPT OF MINES & ENERGY

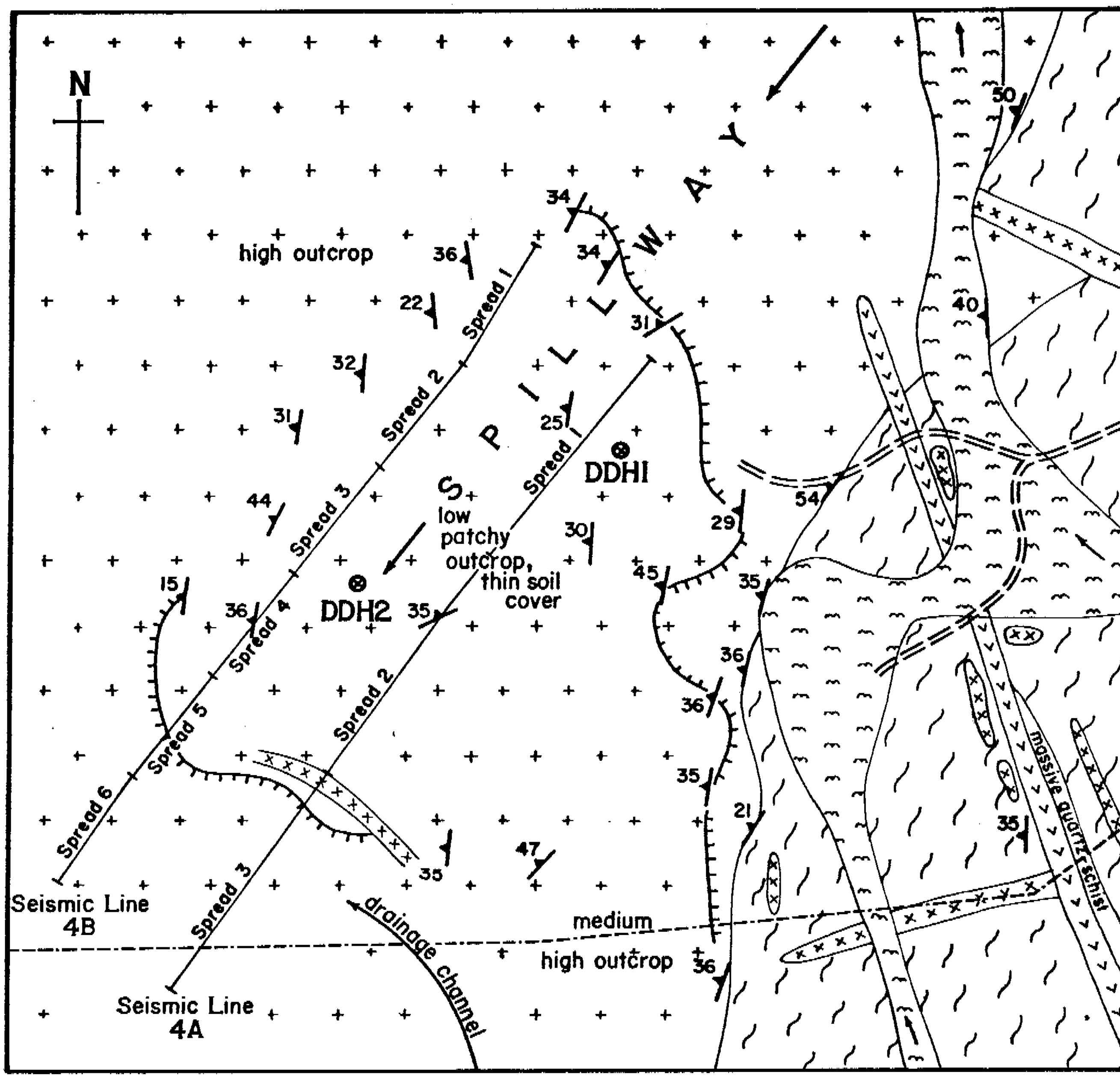
AS197952

Plate 16

Todd River Dam Site

GEOLOGY OF SADDLE 4 (Quarry & Spillway)

Scale 1:1000



Alluvium

Dolerite

Pegmatite

Granite gneiss

Schist (gneiss)

Strike and dip of foliation

Geological boundary

Access track

Refraction seismic spread

Diamond Drillhole DDH1

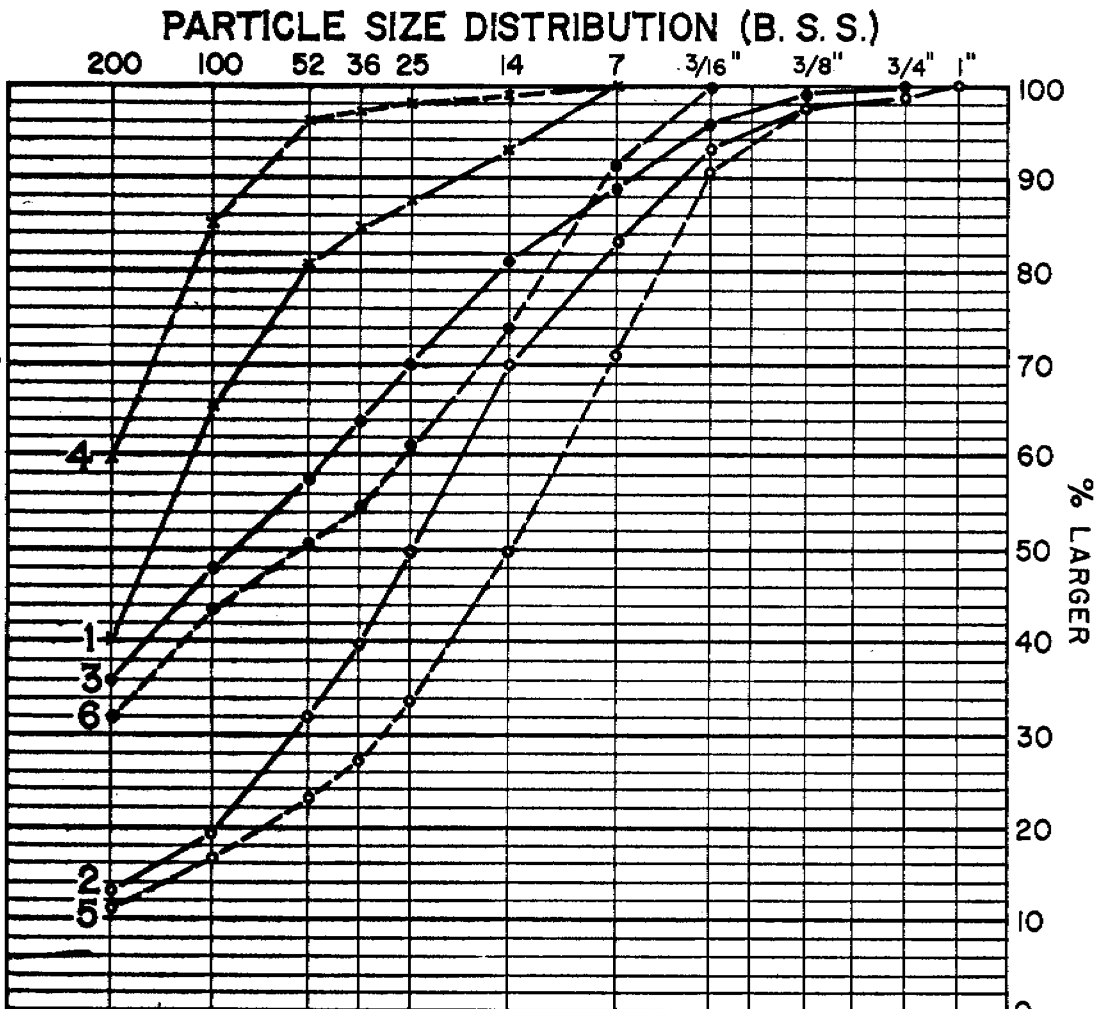
Electric power line

Scarp

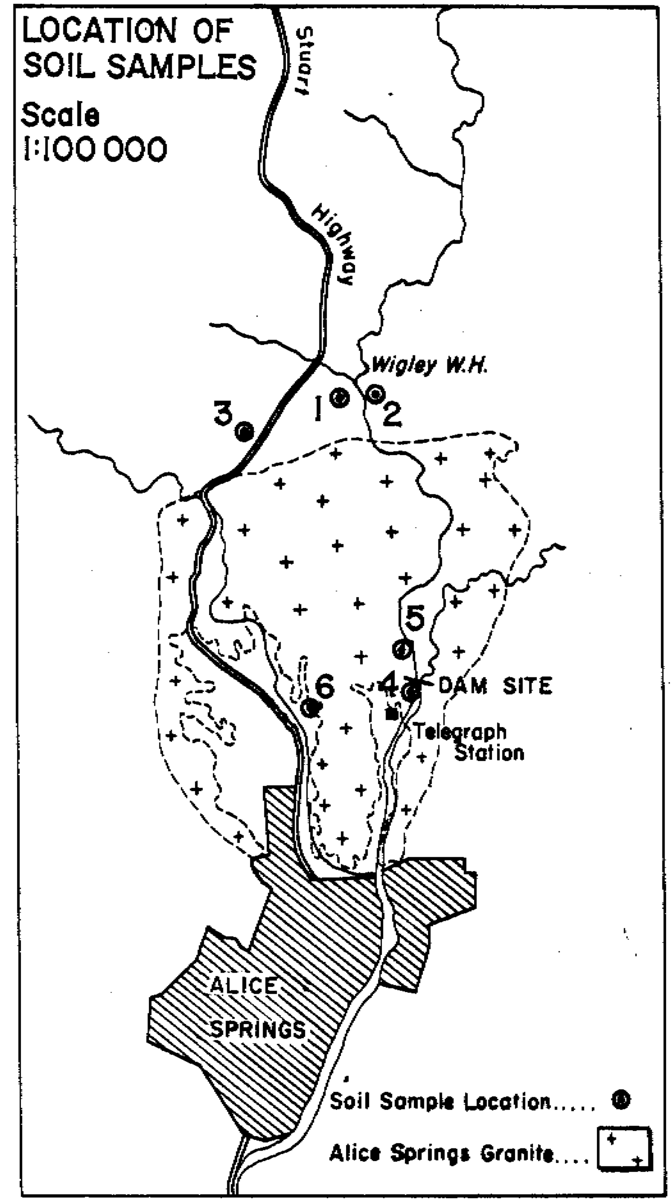
Plate 17

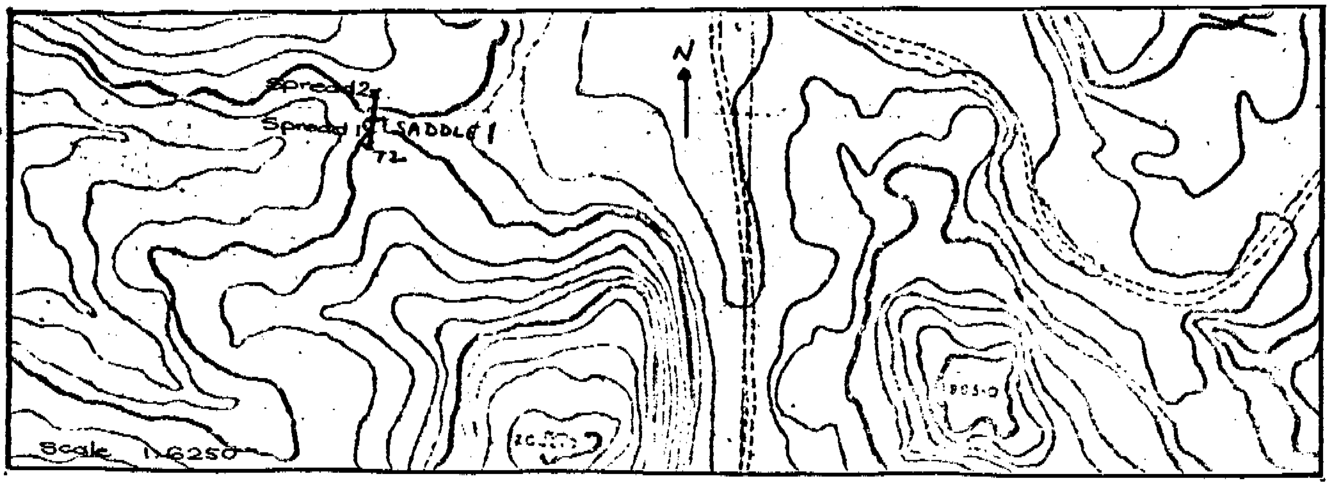
Todd River Dam Site

GRADINGS OF SOILS NEAR DAM SITE

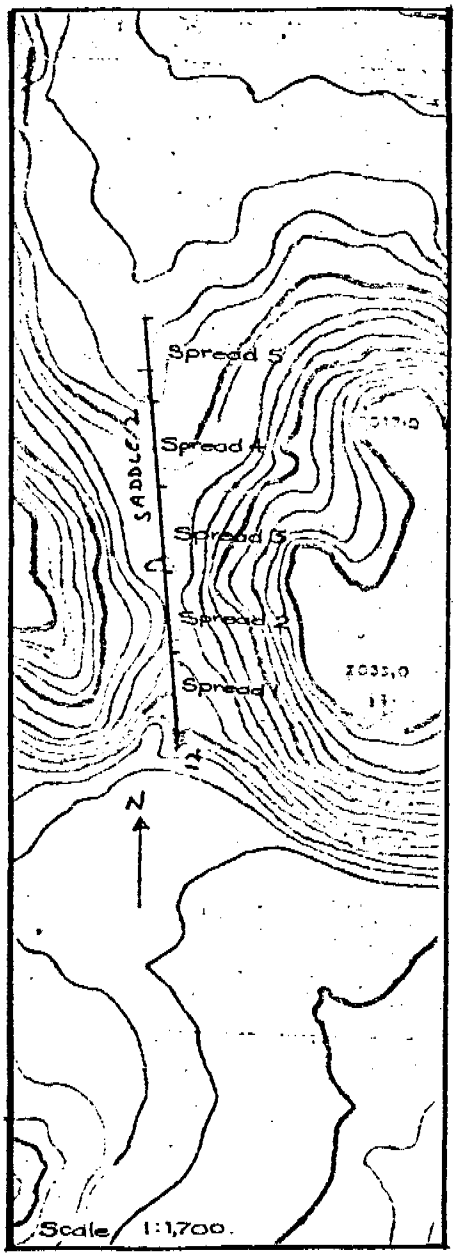


Sample 1 (SM) Non-plastic. Alluvial soil (Floodplain)
Sample 2 (SC) LL = 29, PI = 7. Residual soil (Schist)
Sample 3 (SC) LL = 26, PI = 12. Alluvial soil.
Sample 4 (ML) Non-plastic. Alluvial soil (Floodplain)
Sample 5 (SW-SM) Non plastic. Residual soil (Granite)
Sample 6 (SM) Non plastic. Alluvial soil (Floodplain)

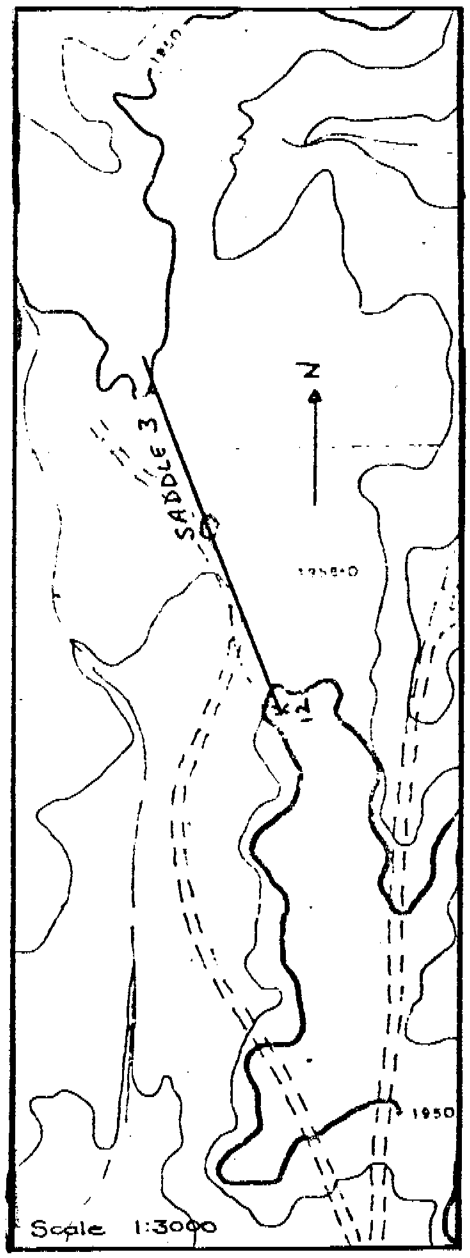




SADDLE 1



SADDLE 2



SADDLE 3

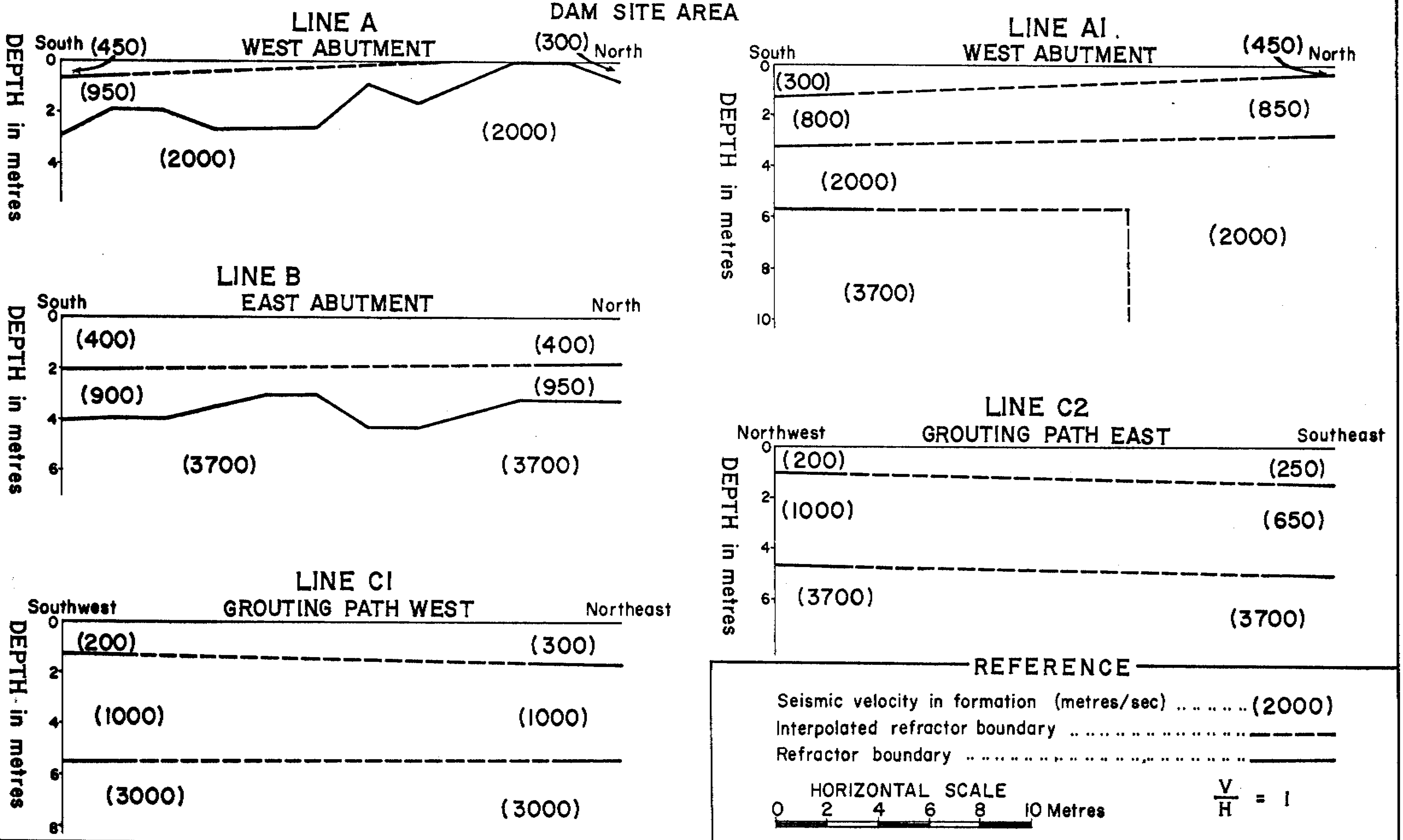
Approximate Spread Locations. Saddles 1,2,3

Plate 18

Todd River Dam Site

SEISMIC REFRACTION SECTIONS

Plate 19

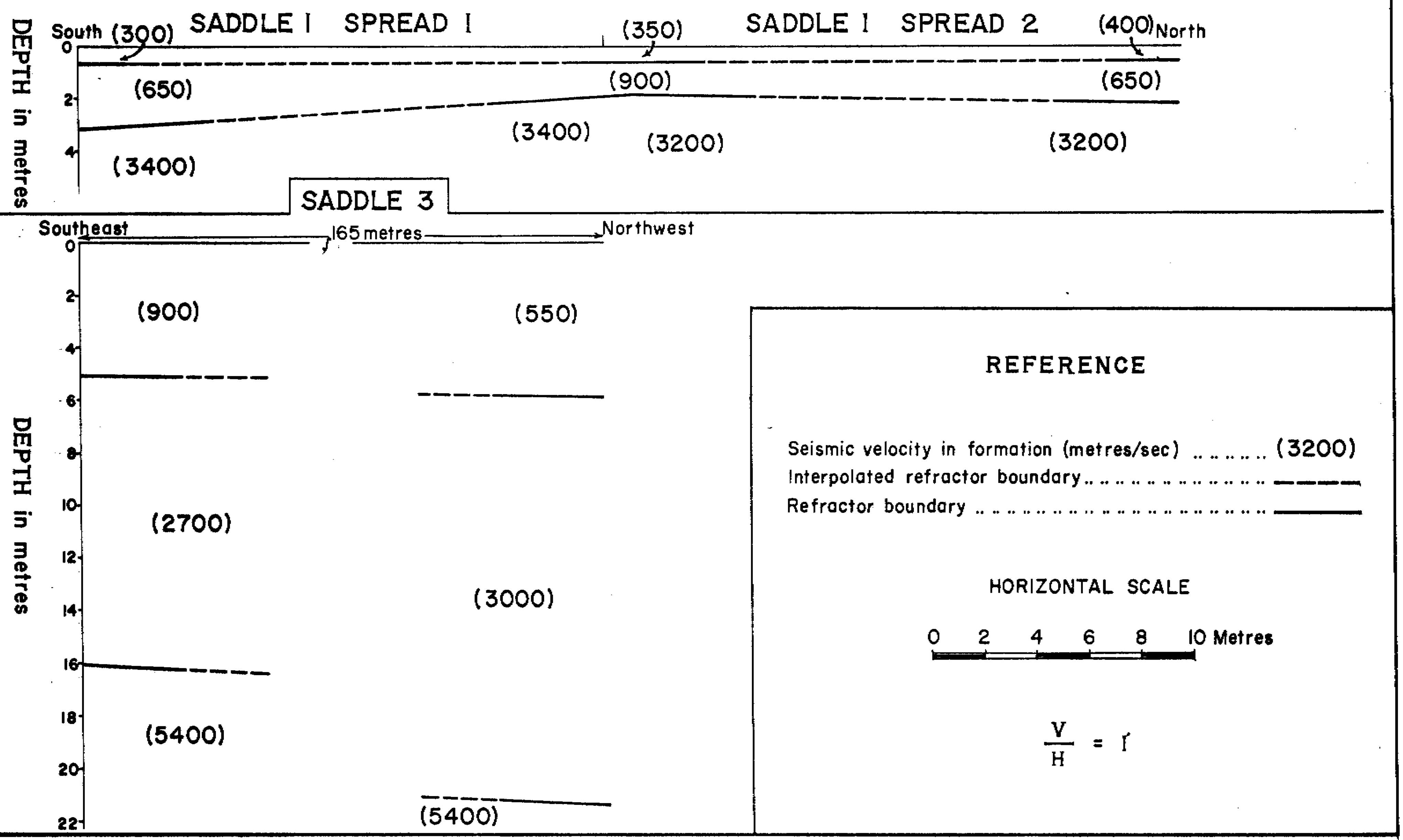


N.T.DEPT OF MINES & ENERGY.

AS19796O

Todd River Dam Site
SEISMIC REFRACTION SECTIONS
SADDLES 1+3

Plate 20



N.T. DEPT OF MINES & ENERGY

AS197961

Fig. 1. TOTAL VIEW OF LEFT ABUTMENT

Note Major photolineament enhanced

Fig. 2. TOTAL VIEW OF RIGHT ABUTMENT

Fig. 3. RIVER SECTION, TODD RIVER DAM SITE

Fig. 4. VIEW OF SADDLE 4 (SPILLWAY)

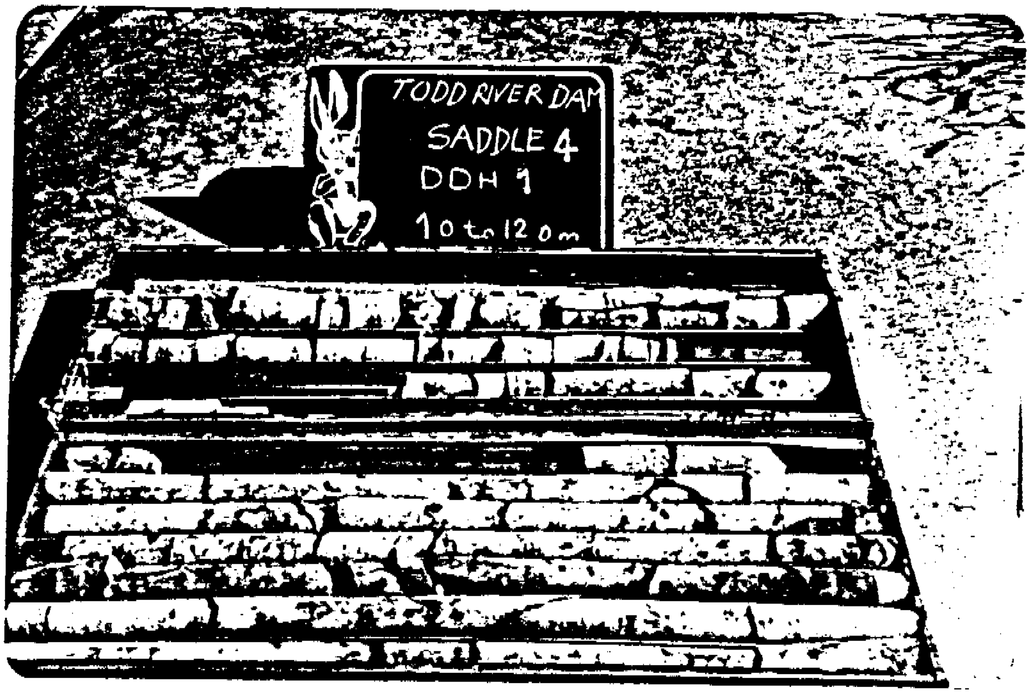


Fig. 5. CORE OF DDH1, SADDLE 4

Fig. 6. CORE OF DDH2, SADDLE 4

NOTE: DARK COLOURED SECTION CAUSED BY GREASE FILM

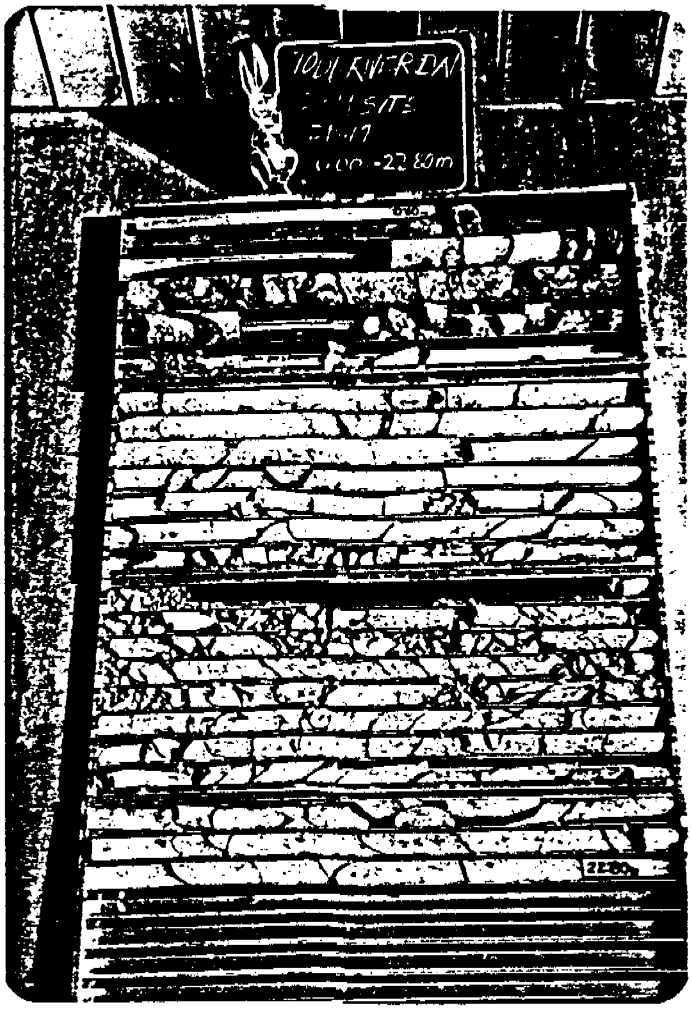


Fig. 7. CORE OF DDH1, DAM SITE 1,
RIGHT ABUTMENT

Fig. 8. CORE OF DDH2, DAM SITE
RIGHT BANK OF CHANNEL

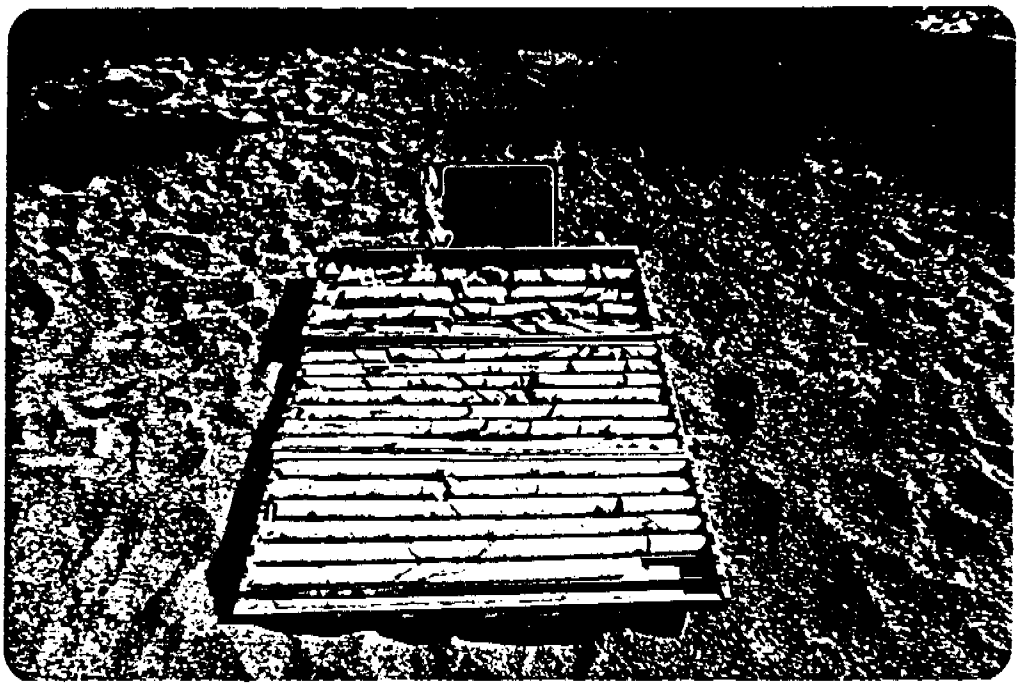


Fig. 9. CORE OF DDH3, DAM SITE, CENTRE OF CHANNEL

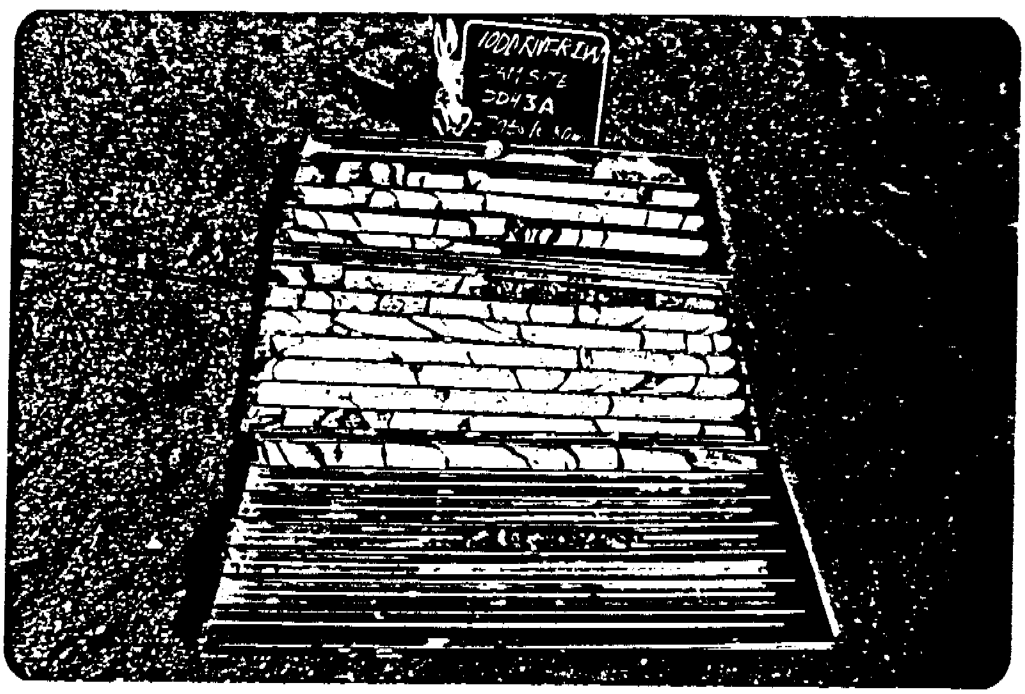


Fig. 10. CORE OF DDH3A, DAMSITE, CENTRE OF CHANNEL

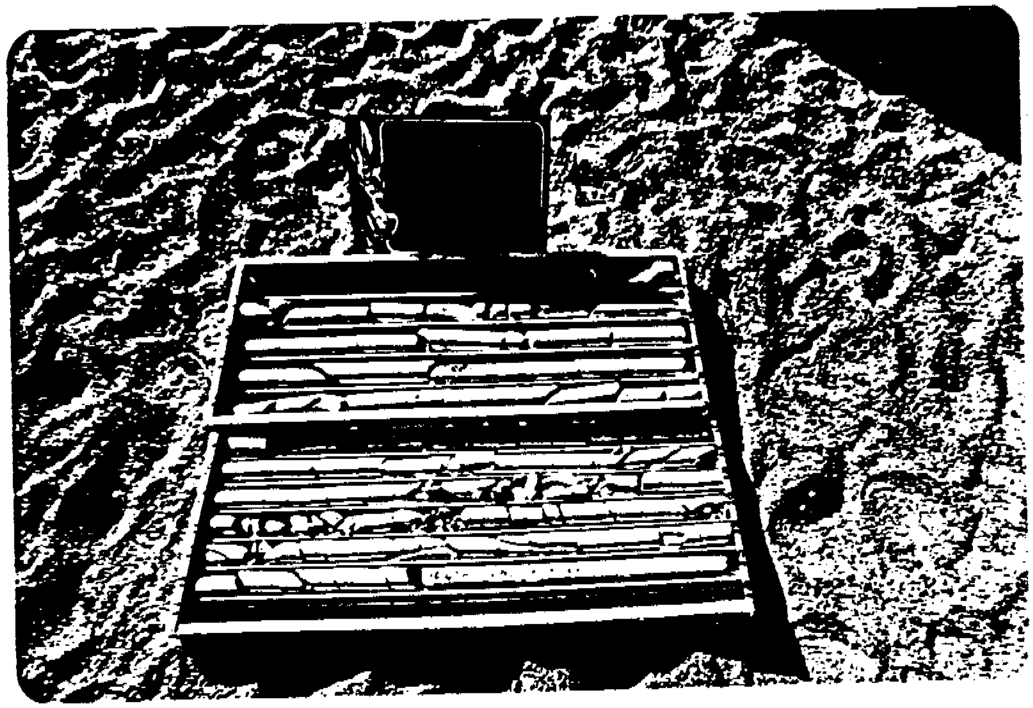


Fig. 11. CORE OF DDH4, DAM SITE, CENTRE OF CHANNEL

Fig. 12. CORE OF DDH5, DAM SITE CHANNEL

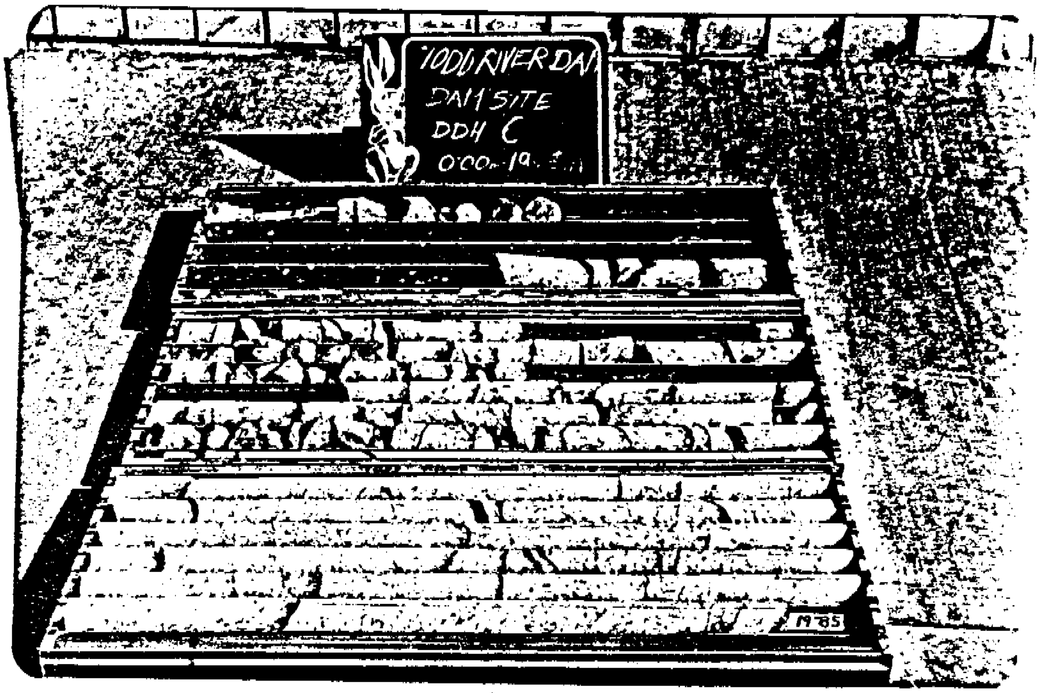


Fig. 13. CORE OF DDH6, DAM SITE
LEFT BANK OF CHANNEL

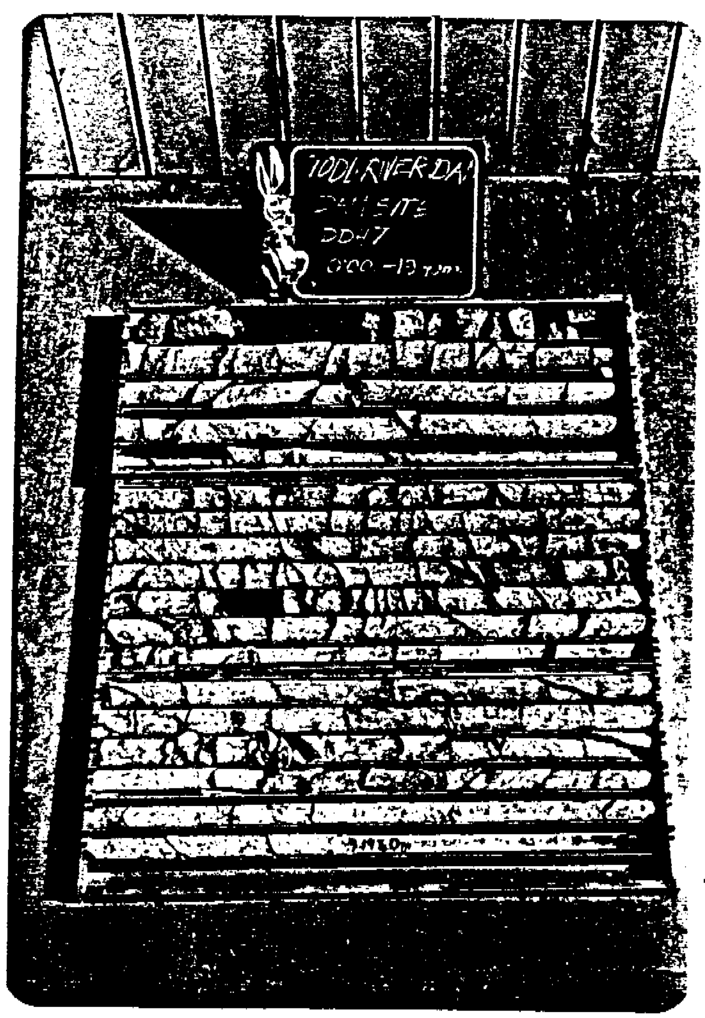
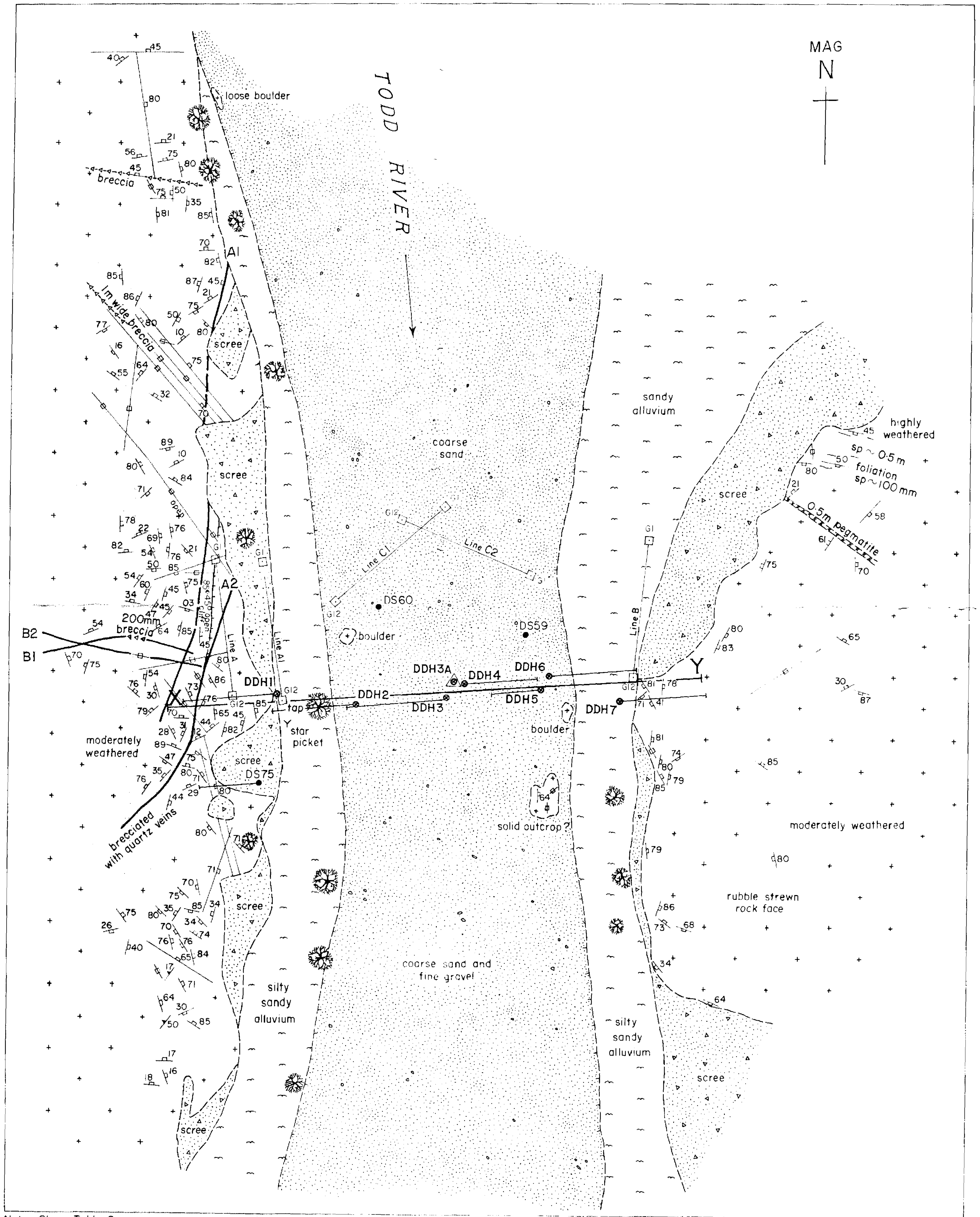


Fig. 14. CORE OF DDH7, DAM SITE
LEFT ABUTMENT



Note: Plane Table Survey.

Mapped: B.W. & R.P. July 1979

Todd River Dam Site

DETAILED GEOLOGY

Scale 1:500

Metres 25 20 15 10 5 0 25 50 Metres

REFERENCE

Channel deposits, sand / gravel

Floodplain deposits: silt / sand

Talus; boulder gravel

Breccia

Pegmatite

Gneiss granite, (Alice Springs Granite)

Diamond drillhole with direction indicator and extent (1979) — DDH1

Diamond drillhole (1965) — DS59

Reversed Seismic Refraction Spread (with geophone location G1, G12) — G1, G12

Joint — inclined, dip in degrees — 50

Joint — vertical

Master joint — 80

Foliation — inclined, dip in degrees — 50

Fault — A1

Geological boundary

Embankment

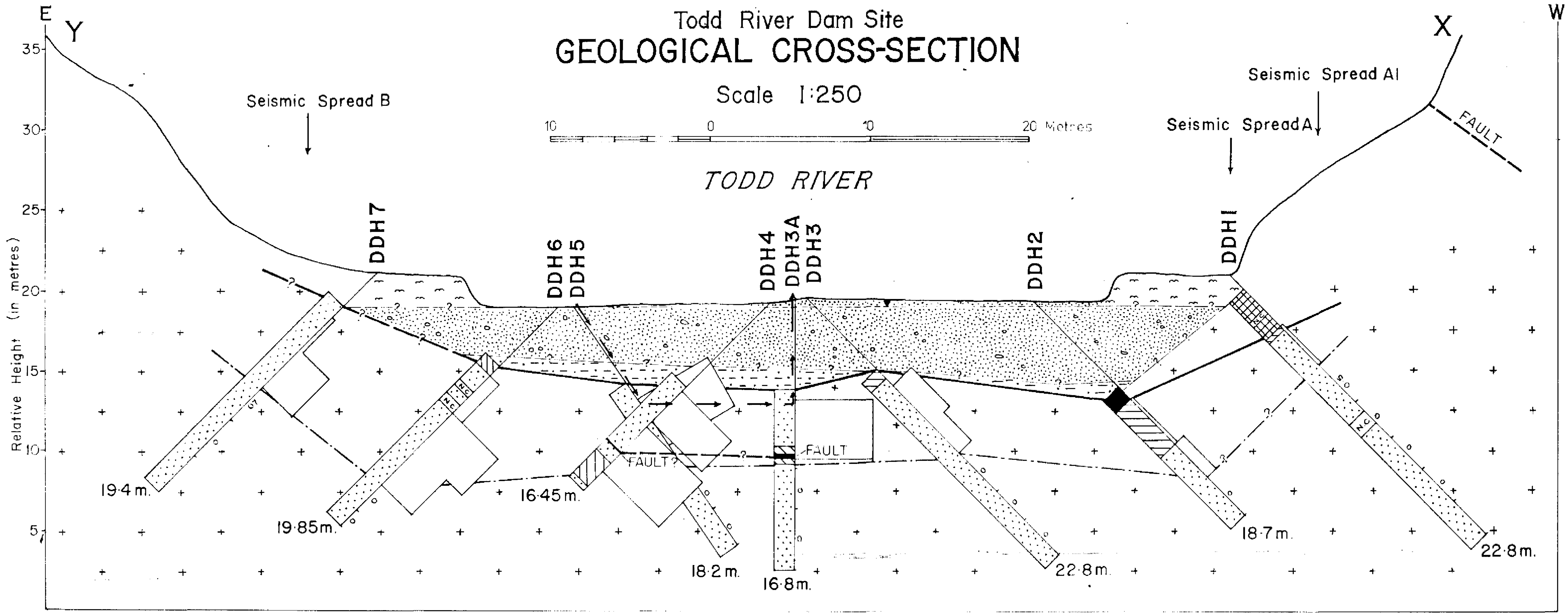
Survey starpicket — Y

Plane Table point (DDH3A)

Contour (not yet available)

Prominent gum tree

GEOLOGICAL CROSS-SECTION (See Plate 13) — X Y



REFERENCE

Diamond Drillhole DDH1

Permeability:

Taken as less than 1 Lugeon

0 5 10 50 100+

Water loss in Lugeons ......

Degree of Weathering:

- Fresh ....
- Slightly weathered ....
- Moderately weathered ....
- Highly weathered ....
- Completely weathered ....

Lithology:

- Floodplain deposit, sandy silt........
- Channel deposit, sand, gravel .....
- Channel deposit, clay, silt, sand.....
- Alice Springs Granite gneiss-granite..

Fault ....

Lithological boundary, Ground watertable July 1979...

Excavation for Plinth, (prop.) ....

Depth of Grouting or Cut-off trench, (prop) ....

Tracer test ....

No Core .... N.C.

Plate 13

N.T. DEPT OF MINES & ENERGY

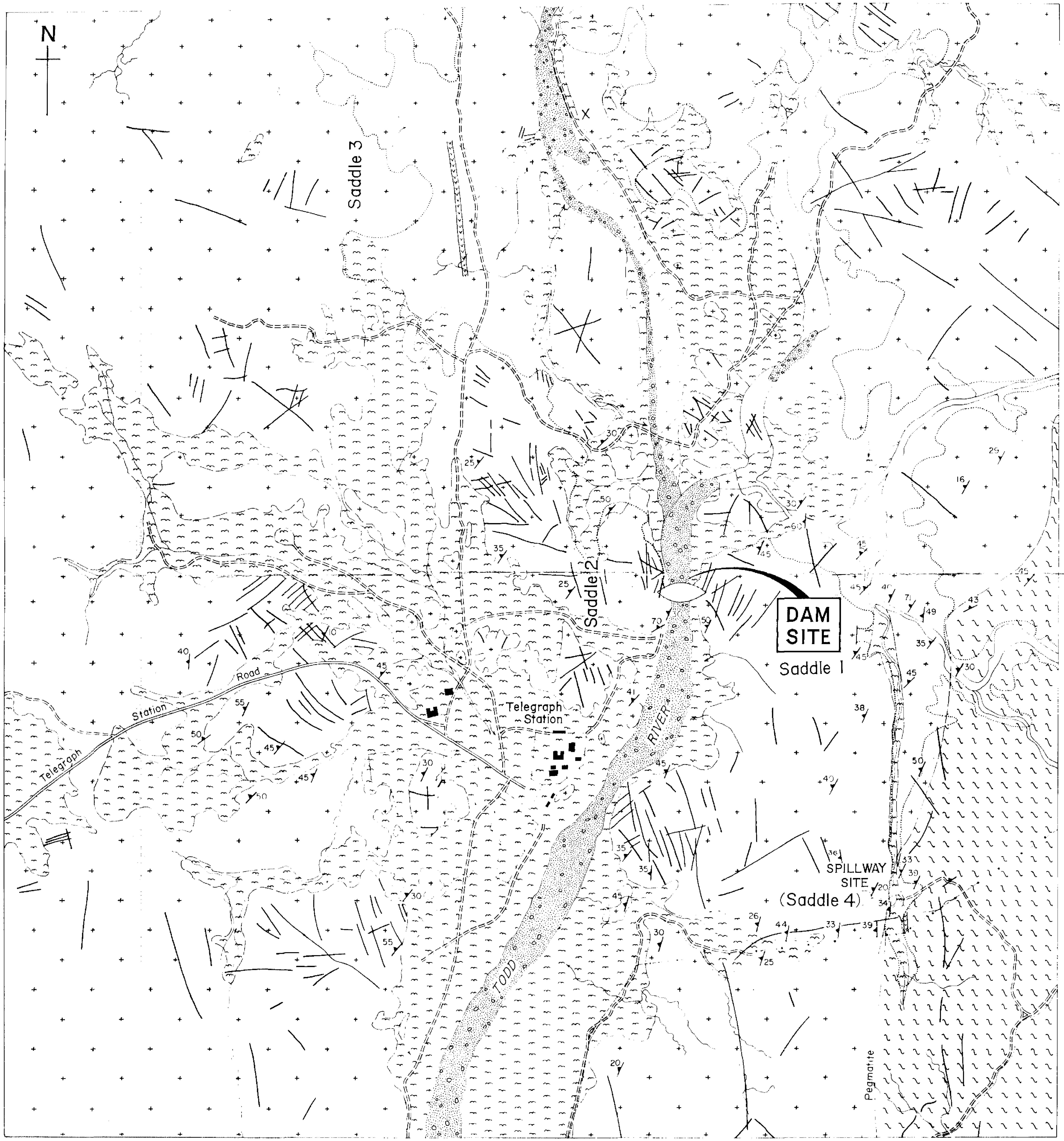
AS197958

Plate I

Todd River Dam Site
REGIONAL GEOLOGY

Scale 1:5 500

Metres 250 150 50 0 0·5 Kilometres



Drawn from uncontrolled airphoto mosaic — Alice Springs 1978 (Film No NT 497) Runs 4,5,6,7

REFERENCE

Channel deposits: sand / gravel

Alluvium undifferentiated : silt, sand, gravel

Dolerite

Gneiss-granite & granite-gneiss

Schist

Sealed road, Access track

Power transmission line

Fence

Building

Watercourse

Floodplain (on bedrock)

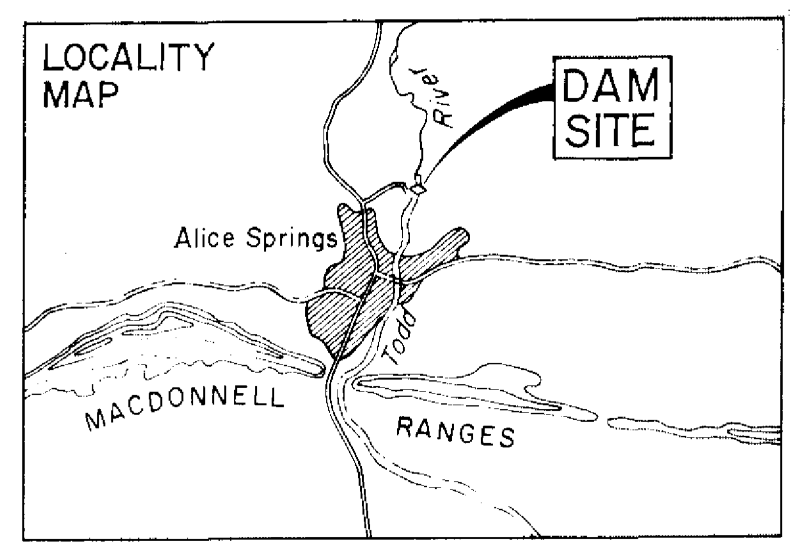
Photolineament

Foliation with dip

Geological boundary

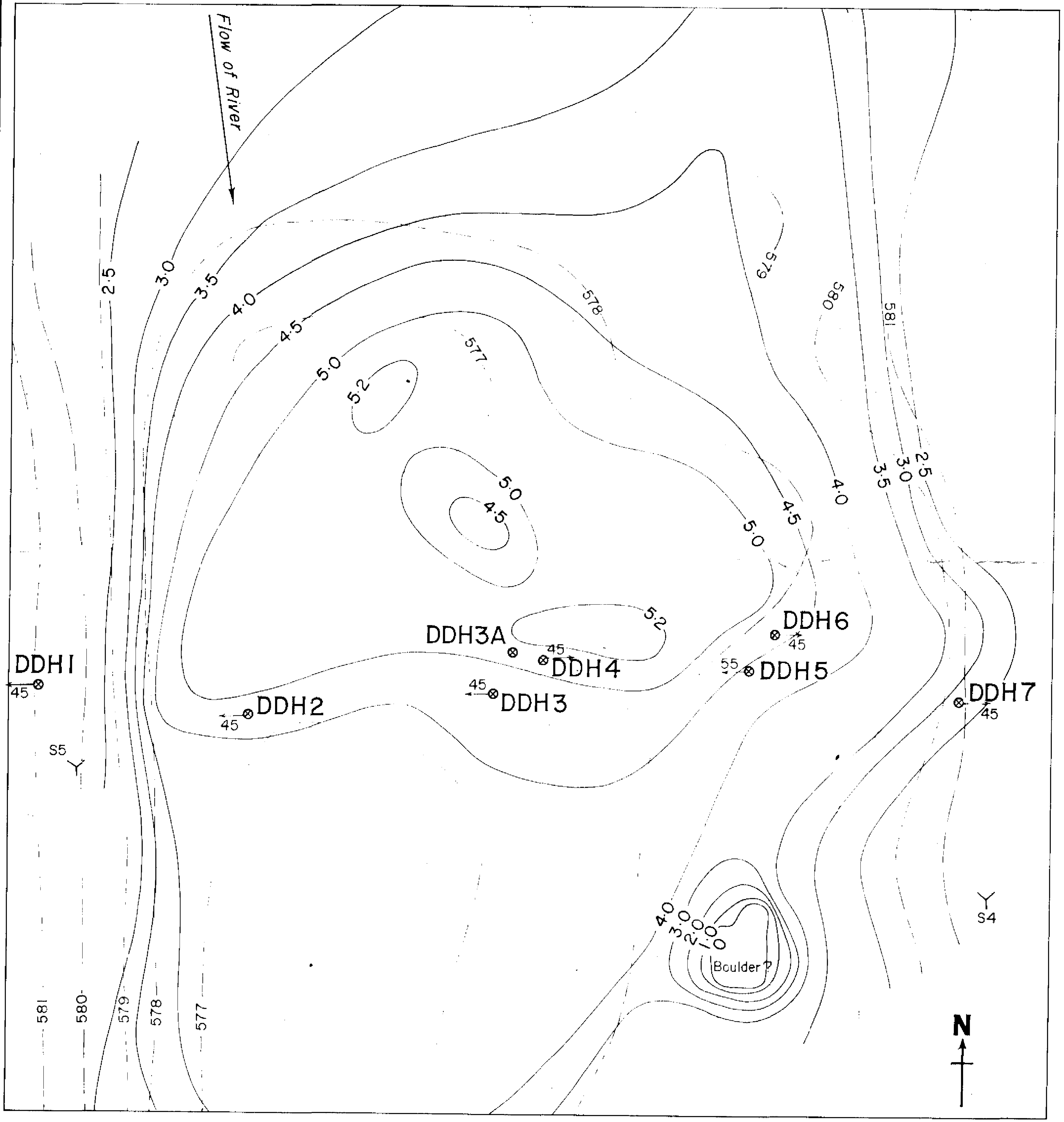
Proposed dam wall

Proposed reservoir rim (approximate location)



N.T. DEPT OF MINES & ENERGY

Plate 2



Todd River Dam Site

CHANNEL ALLUVIUM
ISOPACH MAP

REFERENCE

Isopach Contour (metres) — 3.5
Contour Interval 0.5 m.

Bedrock Contour (metres) — 579
Contour Interval 1.0 m.

Diamond Drillhole (with inclination) — 45 DDH3

Survey Starpicket — S4

Based on Water Resources Branch Map No. R181.
Compiled by B. Thornley.

SCALE 1: 240

Metres 5 0 10 20 Metres

Plate 21

Todd River Dam Site
SEISMIC REFRACTION SECTIONS
SADDLES 2+4