COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/83

PRELIMINARY GEOLOGICAL INVESTIGATION OF ADELAIDE RIVER DAM SITE, NORTHERN TERRITORY. FINAL REPORT

by

John Hays

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PRELIMINARY GEOLOGICAL INVESTIGATION OF ADELAIDE RIVER DAM SITE : FINAL REPORT.

SUMMARY:

The north-west trending section of the Adelaide River Gorge appears to be suitable for a dam site, subject to confirmation by diamond drilling. No further investigation should be done, and no specific recommendations can be made, until a topographic or photogrammetric survey of the catchment area has been completed and an estimate of the optimum height of the dam wall has been made.

Alternative dam sites are available if the height of the wall is between 150 feet and 80 feet, or less than 80 feet. These sites have been mapped but no detailed survey has been made of the spillway to be used in conjunction with them.

The main problem appears to be the ratio of catchment area to storage area. If a dam is practicable, a provisional site should be selected and cleared and exploratory diamond drilling should be done. A final decision on the dam site can then be made.

There is abundant rock suitable for aggregate and rock-fill, but a search for local sources of sand and clay will be necessary.

INTRODUCTION.

The Adelaide River Gorge has been suggested as a suitable site for a dam for domestic water for Darwin (Woolnough 1936) and for hydro-electric power (Rosenthal 1948). The maintenance of a steady dry season flow, to prevent the inflow of tidal salt water at the rice farms downstream at Humpty Doo, is as important as the other functions. The supply of irrigation water to non-rice growing areas is of secondary importance.

Locality and Access

The downstream end of the gorge is one mile west of Adelaide River township, which is on the Stuart Highway 72 miles south of Darwin. The gorge extends upstream for one mile in a south-westerly direction, bends to the south-east for about half a mile, and then bends back to the south-south-west for one and a half miles. Access is by rough dry-weather track, suitable for four-wheel-drive vehicles, as far as the south-east trending part of the gorge, and by foot thereafter.

Previous Work

A preliminary report, based on reconnaissance, was submitted by Dr. W.G. Woolnough in 1936. The report was brief and drew attention to the need for detailed work. The south-east part of the gorge was suggested as a possible dam site.

A summary of the hydro-electric potential of the gorge was submitted by C.C. Rosenthal in 1948. This report referred to a height of 170 feet for the final stage of the dam wall, and 100 feet for an initial stage.

Present Investigations

The present investigation was started in March,1960, and continued intermittently until January,1961. The total field work involved was 28 geologist-days. This was spread over ten months because of the need for accurate survey data at several stages in the investigation. These data were supplied by the Surveys and Lands Branch, Northern Territory Administration, and involved the topographic survey of the main dam site, two low saddles, and a detailed traverse of the watershed. The site has not yet been cleared and fresh bed-rock has not been exposed. Further mapping will be necessary when this is done.

Progress reports (Appendices 1-4) were submitted as memoranda to the Director of Water Resources, Northern Territory Administration, as each preliminary stage of the investigations was completed. No separate search for construction materials was made but some observations are listed below:

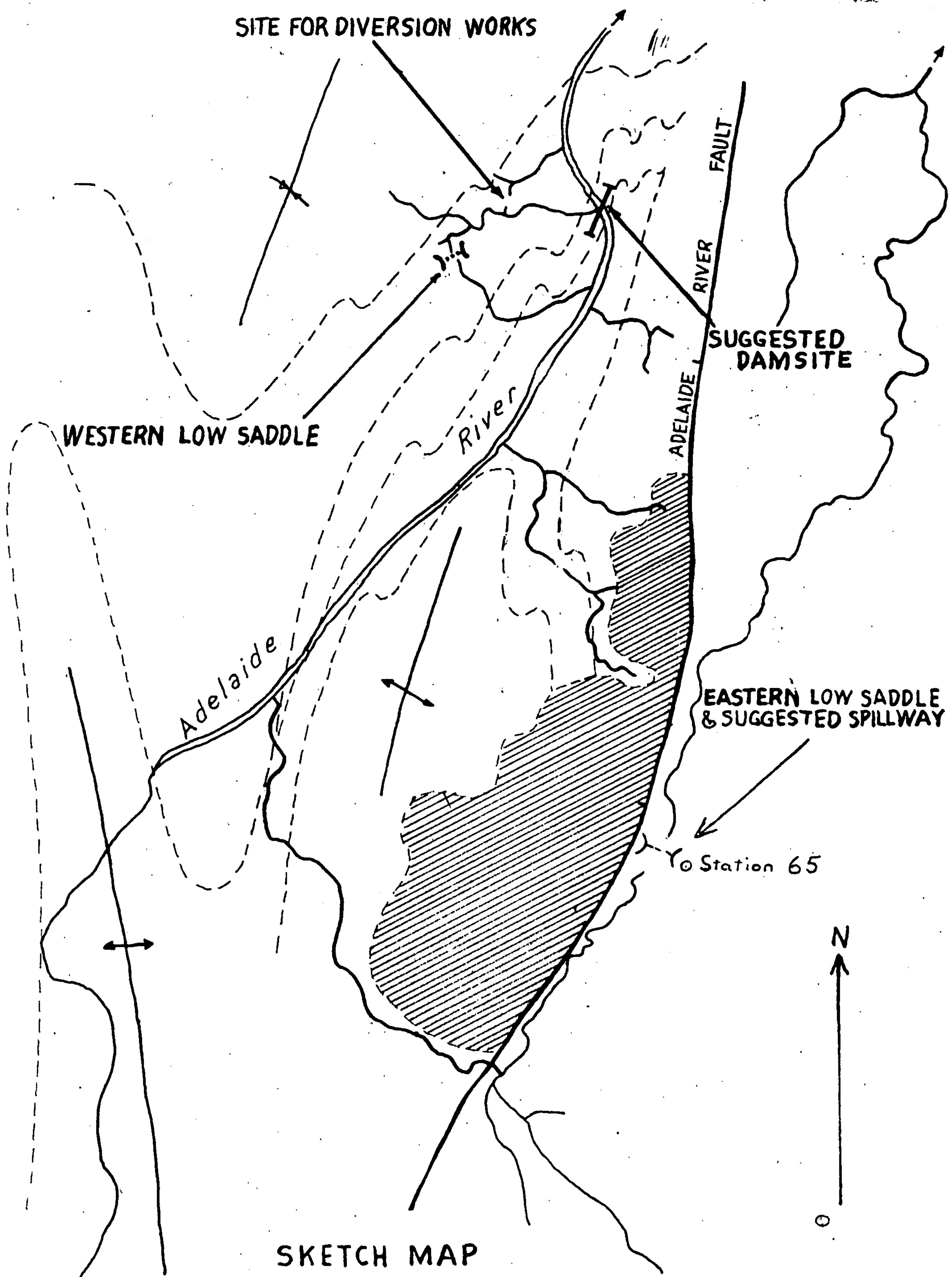
MAIN DAM SITE

The Adelaide River Gorge is in an area of folded coarse quartz-greywacke and slate of the Noltenius and Burrell Creek Formations. The downstream part of the gorge may be along a branch of the Adelaide River fault; the central part cuts across the strike of a bed of greywacke 500 feet thick; and the upstream portion is along the axis of an anticline in incompetent slate.

The greywacke ranges from a dark medium-fine grained rock to one in which there are abundant small angular fragments of quartz. It is highly sheared and chloritic in places and the shearing appears to be associated with axial planes of small congruous subsidiary folds formed by drag on the sides of a minor fold. Within the greywacke are lenses and bands of conglomerate and silty slate. The conglomerate bands contain rounded quartz pebbles ranging from half to one inch in diameter. These pebbly bands may represent one horizon in the greywacke although it was impossible to follow any band for more than 600 feet. The only bedding planes to be recognised were on conglomerate lenses and bands and on slate partings. There is no clearly defined joint pattern, presumably because most of the joints are shear joints associated with the complicated subsidiary folding. In the north-east striking part of the greywacke, joints are north-west and north-east. The exact boundaries of the greywacke have not been located: outcrops are abundant only on the hills; the hillsides are covered by scree consisting almost entirely of boulders of greywacke; and the banks of the stream are of ferricrete at least twenty feet thick. The ferricrete is a superficial deposit consisting of ill-sorted angular to rounded fragments of greywacke and slate in a matrix of ferruginous sandy clay.

The subsidiary folding was recognised only by plotting the pebbly bands and slate partings, because air photos of a suitable scale were not available. An examination from a helicopter at heights ranging up to 5,000 feet confirmed that the structure was correctly interpreted. During this examination, special

FIG. 1.



SKETCH MAP
ADELAIDE RIVER DAMSITE

SCALE 0 ½ 1 MILE

- Ur. Proterozoic Depot Creek Sandstone
- Lr. Proterozoic Noltenius & Burrell Creek Formations
- Photo trend lines in Lr. Proterozoic
- Anticlinal Axis
- Synclinal Axis
- Saddle

Resident Geologist's Office, Bureau of Mineral Resources, Darwin, N.T. March 1961

attention was paid to the north-west boundary of the greywacke in the gorge. The occurrence of shearing and quartz veins along this boundary indicated that a branch of the Adelaide River fault could be near. No faulting could be detected from the air but it was noted that shearing was most intense in folded areas.

The south-west trending part of the gorge is the most suitable place for a dam site unless the changes in direction are due to either concealed faulting or abnormal jointing, of which there is no evidence. The suggested explanation of the changes indicates that they are independent of faulting and jointing.

A study of air photographs shows no dominant drainage directions. In some of the area the discordance between drainage and structure suggests that many of the streams are superimposed. In other parts, a well developed trellised pattern shows a high degree of structural control of drainage. The Adelaide River is well adjusted to structure where it flows over Lower Proterozoic rocks, and follows a course along slate beds and other structural features. The downstream portion of the gorge was produced by headward erosion along a branch of the Adelaide River Fault, where it interrupts a minor syncline. The syncline has a core of slate and plunges north-east. Headward erosion was checked when folded greywacke was reached. A subsequent stream on the east side of the river cut through unfolded greywacke, following north-west joint planes, to a slate bed in an anticline plunging north-east, and then followed the slate bed. The middle and upstream parts of the gorge were thus initiated.

The upstream entrance to the middle part of the gorge is underlain by a cuspate anticline in greywacke with slate partings. A wall at this place may thus be on heterogeneous foundations. Moreover, the rock in the core of the anticline may be either crumpled or strongly cleaved. To take full advantage of the greywacke sequence for dam foundations it may be necessary to build a wall at an angle of 60° to the river. The attached map (Plate 2) shows the area in which the foundations of the dam are probably homogeneous, and the area in which the foundations are on folded heterogeneous rocks.

It is assumed that the eastern saddle will be adopted as the main spillway (see Fig. 1). The necessary difference in elevation between the spillway and the top of the dam wall has not been calculated; a main wall 150 feet high would be 25 feet above the crest of the spillway.

If an arch wall is built, the abutment areas must be as indicated in Plate 2. This means that the chord of the arc at the 300 foot contour will be about 1,000 feet and that the foundations may be on folded heterogeneous rocks. This would have to be confirmed by drilling, and a final decision on the site would depend upon the drilling results.

Any straight wall type of dam would have a length on the 300 foot contour ranging from 900 feet with foundations on dragfolded rock to 1,200 feet with foundations in homogeneous rock. The nature of the foundations would have to be confirmed by diamond drilling.

Whatever type of wall is constructed, some excavation down to unweathered rock may be necessary. This involves a trench through at least twenty feet of ferricrete, and an unknown thickness of weathered rock. Diamond drilling will be necessary to ascertain the depth of the trench.

LOW SADDLES ON WATERSHED

Eastern Low Saddle

The lowest saddle is on the east side of the catchment about two miles south of the dam site. Access is by good dry-weather bush track. This saddle was studied in considerable detail because (I) any increase in the head of water above 125 feet depends on the construction of a wall in the saddle; and (II) the saddle is a potential spillway. Geophysical and geological examinations were made and an unsuccessful attempt was made to explore the floor of the saddle with hand augers (Appendix 3).

The saddle is wide and flat bottomed with a floor of ferricrete, (Plate 3). Gradients are so low that the crest had to be determined by surveying. Streams drain to the north-east and south-west and have gradients ranging from 1 in 30 to 1 in 70. The north-western edge of the saddle is a fault line scarp in which Upper Proterozoic or Lower Cambrian quartzitic sandstones crop out. The south-eastern edge is irregular and the only rock that crops out is slate of the Burrell Creek Formation.

The fault, named the Adelaide River Fault by B.M.R. field parties, is not thought to be a potential leakage channel. It is sealed in places by silicified fault breccia, and springs along the fault line are caused by water draining into the fault area from the sandstone hills to the west. The fact that the stream draining to the south-west, parallel to the regional strike of the Burrell Creek Formation, has cut a gorge in Lower Proterozoic rocks, parallel to and near the fault, indicates that the fault seal is less permeable than the country rocks.

Western Low Saddle

A low saddle on the west interfluve, ¾ mile west of the main site, has been selected as a possible alternative spillway, but it has not been mapped in detail. There is no access road nearer than the main dam site. The saddle, whose lowest point is 135 feet above the river bed at the dam site, is a depression on a steep-sided ridge that curves from north to north-west at the lowest point. This curvature would produce engineering problems if a wall had to be built across the saddle. The slopes draining out of the saddle have gradients ranging from 1 in 2 to 1 in 6. The country rock appears to consist entirely of silty slate of the Noltenius and Burrell

Creek Formations. It is well-cleaved and very fissile and joints appear to be open to a depth of between 50 feet and 100 feet. Outcrops are generally heaps of slate rubble. Because of the steep slopes in easily eroded material the saddle is not a good site for a spillway. A cement cap and grout blanket are necessary to prevent leakage, even if the saddle is not used as a spillway.

A further disadvantage is that the drainage north from the saddle area is into a small creek that runs easterly and enters the Adelaide River at the approximate position of the toe of any dam built at the proposed site. Diversion of the stream or strengthening of the toe would be necessary to avoid scour at the toe. A wind-gap ¼ mile west of the dam site, along a branch of the Adelaide River fault, is a suitable place for a diversion. The normal wet season flow of the creek may not require diversion.

The features of the two suggested spillways are tabulated below:

FEATURE	EASTERN SADDLE	WESTERN SADDLE.
Height above river bed	125 feet.	135 feet
Width	160 at 125 ft. 480 at 135 ft. 800 at 145 ft.	70 at 135 ft. 260 at 145 ft.
Water flow gradients	± 1: 50	± 1: 3
Simplicity of erection	Straightforward	Complicated
Incidental expenditure if selected	1. Grouting and capping in western saddle	1. Excavation to 125 ft. or costly construction in eastern saddle to raise height to 135 ft.
	2. Low level bridge on access road to main dam - probably necessary in any case	2. Diversion works to prevent scour at toe of dam.
Accessibility	Easy for vehicles	Inaccessible to vehicles at present.

CATCHMENT AREA

The catchment (Plate 4) covers an area of about 240 square miles on the southern border of the coastal plain of the Northern Territory. The headwaters of the Daly, Finniss, Reynolds and Adelaide Rivers interdigitate in the area. When the investigations started it was feared that low connecting saddles between the various catchments might make the scheme impracticable (Appendix 1). In fact, two such saddles were located, the lower being 125 feet above the bed of the stream at the dam site. This means that the final stage visualised by Rosenthal can only be reached if extensive retaining walls are built, but that the initial stage can be surpassed.

The catchment area is a valley floor panplain,* covered by ferricrete and alluvium, and underlain by slate and greywacke of the Lower Proterozoic Burrell Creek and Noltenius Formations. The watershed consists of sediments of the same formations, capped in places by younger formations including Upper Proterozoic, Cambrian, and Cretaceous rocks.

Within the catchment, slopes on the panplain are very gentle and an adequate deep storage area may not be available. If the ratio of catchment area to storage area is very low, evaporation losses will be very high and it may be impossible to fill the dam.

Although the probable water level contour behind the completed dam has not been surveyed, no leakage from the catchment is anticipated. Not only do the Lower Proterozoic rocks dip steeply, but they include low grade metamorphic rocks that are poor aquifers. It was thought that the ferricrete represented a potential outlet for water through low saddles (Appendix 1), but this may not be so. The ferricrete examined near the dam site and low saddles consisted originally of ill-sorted angular fragments of fresh and weathered country rocks in a ferruginous matrix. Subsequently, the ferricrete has been

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* Panplain: A plain of lateral erosion by rivers (Crickmay, 1933).

~~has been~~ kaolinised and is now a thick clayey blanket sealing off the underlying rock.

Leakage may occur in the watershed area if highly cleaved and jointed slate crops out below the waterlevel in low saddles. The joints are thought to be tight at moderate depths and it is probable that grouting will be adequate to cope with such leaks.

A list of potential leaks can be compiled when the water-level contour is being surveyed.

On the upstream part of the catchment the ferricrete is at a higher level and better drained than that near the main dam site. Kaolinisation may be less advanced and the permeability may be high. This could mean a slight increase in effective storage capacity. Such increase would not be significant if there is abundant deep storage but may be important if the deep storage is only just adequate. In the latter case it might be desirable to test the ferricrete by diamond drilling before a final decision is made. No recommendation for drilling can be made until the topographic (or photogrammetric) survey of the catchment is done.

ALTERNATIVE SITES

The investigation was based on the assumption that the construction of a wall 150 feet high would be justified. If this is not so, a shorter wall could be built downstream from the selected site, as indicated on plate 2. The spillway for this would be the site of the diversion works for the creek from the western low saddle. The maximum possible height of such a wall would be 80 feet, the length would be 500 feet, and the maximum depth of water would be 62 feet. The foundations would be entirely upon greywacke. The spillway saddle has not been surveyed and a built-up spillway may be necessary. Some construction would also be necessary in the saddle 200 feet west of the western abutment, and the strength of the western abutment would have to be investigated.

If this wall is too low, or the abutment too weak, a second alternative site, 500 feet downstream from the first, should be investigated. A wall at this site would be built across the strike of interbedded greywacke and slate but would have abutments in greywacke.

The wall would be between 600 feet and 900 feet long, and from 80 feet to 125 feet of water could be impounded.

The same spillway would be used as for the first alternative. This spillway is on a branch of the Adelaide River fault and a detailed investigation would be necessary to confirm its suitability.

If this spillway is suitable, and a wall of less than 150 feet height is decided on, cost would be the major factor in deciding whether to build at the downstream site or to build at the main site and incorporate the spillway in the wall.

DIAMOND DRILLING

Diamond drilling is necessary at the main dam site and the eastern saddle, and is desirable at the western saddle. Drill sites will not be selected until a decision is made on the suitability of the storage area and the main dam site has been cleared. A more detailed map of the foundation and abutment areas can then be made and drill sites can be selected. Only general recommendations can be made at this stage.

Main Dam Site

Exploratory drilling is necessary to determine the nature of the foundations, important joint directions, and the exact geological structure. One hole about 150 feet deep is necessary in the slate and one in the greywacke to indicate the thickness of ferricrete and weathered rock, and the inclination and extent of jointing. These two holes could be vertical. A minimum of four inclined holes, each about 100 feet long, drilled downwards to fresh rock at an inclination of 50°, is necessary. Two of these should be sited to intersect the cuspate anticline on the north-east boundary of the greywacke. All holes should be NX size and should be water pressure tested to obtain information for grouting and about possible leakage, and core samples should be taken for load tests. This requires the use of a split core barrel and NM bits, particularly in the ferricrete and weathered rock. Between 750 feet and 1500 feet of exploratory drilling may be necessary.

If results are favourable, further drilling will be necessary to decide whether an arch or straight wall should be built. This drilling programme should include at least four holes along the centre line of any proposed foundation trench. Drilling in the abutment areas is necessary and several holes outside the limits of the foundation trenches are desirable. The amount of drilling would be indicated by the results of the exploratory programme.

Eastern Saddle.

Two diamond drill holes, each penetrating at least 20 feet of fresh rock are necessary to supplement the geophysical data obtained in the Eastern Saddle.

Western Saddle.

It may be desirable to study jointing at depth in the saddle before grouting. All necessary information could be obtained from two holes in the saddle crest.

CONSTRUCTION MATERIALS.

No search was made for suitable construction materials but the Noltenius Formation greywacke and the Depot Creek Sandstone were noted as probably suitable as aggregate for concrete or as rockfill. Sand deposits are expected in the Adelaide River, downstream from the dam site, and small quantities may be found upstream. If adequate sand reserves are not found near the dam site, crushed Depot Creek Sandstone could be investigated as an alternative.

No natural clay deposits have been observed but there are extensive deposits of ferricrete, some of which may be an adequate substitute for clay. If the ferricrete is unsuitable, alluvial clays should be sought downstream from the gorge. Alternatively, areas of lateritized slate could be investigated.

CONCLUSIONS

The north-west trending section of the gorge may be suitable for the construction of a dam wall 150 feet high retaining 125 feet of water. The type of wall to be built, and its position, [illegible] not be decided until the area has been diamond drilled and accurate geological sections have been drawn. It is thought that deep excavations will be necessary for the foundations of any wall in the gorge area.

There is an excellent natural spillway at a saddle on the eastern interfluve. This spillway will limit the depth of water to 125 feet at the dam, unless a retaining wall is constructed across the saddle. This can only be raised 10 feet before spillage occurs over a low saddle on the western interfluve. The western saddle is not suitable for use as a spillway and is not a suitable place for building a retaining wall. Moreover, if it is used as a spillway, diversion works will be needed to reduce the risk of scour at the toe of the dam.

A final decision on the dam site cannot be made until the survey of the catchment area is done. No further work should be done until it is proved that adequate storage is available.

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HELICOPTER RECONNAISSANCE OF THE ADELAIDE RIVER GORGE DAM SITES AND CATCHMENT AREA.

Two flights up the Adelaide River gorge were made by the writer on 30th March, 1960. The first flight was a reconnaissance to locate potential dam sites and possible drawbacks to each site. The second flight was made to investigate each site more closely.

Three sites were noted; at the downstream entrance to the gorge, within the gorge, and at the upstream entrance. The estimated width at the lower site was 1200 feet, and at the other sites was about 800 feet. The country rock at all three sites appeared to be well jointed massive quartzite or quartz greywacke of the Noltenius Formation. No clearly-defined joint pattern could be detected. Folding is thought to occur but the examination was not sufficiently detailed to confirm this. A brief visit on foot to the gorge showed that the quartzite is interbedded with slate or phyllitic slate. The regional strike is approximately north-north-east and dips range from vertical to steeply west.

The gorge follows the strike of the bedding for most of its course but swings across the strike at the middle site. Walls at the upper and lower sites would thus have to be built across the bedding and might have very heterogeneous foundations. There is a better chance of obtaining homogeneous foundations at the middle site where a wall could be built parallel to the bedding, although the final selection of the site would depend upon the height and design of the wall. Examination of saddles and creeks on either side of the gorge indicated that a wall about 200 feet high could be built at the middle and upper sites without danger of spillage across the sides of the gorge. Unfortunately, there is no certainty that such a depth of water could be stored without leakage out of the catchment area, the nature of which is discussed.

The coastal plain of the Northern Territory is advancing southwards by a process of scarp formation and pedimentation involving the bevelling of numerous valley floor plains or panplains. As the coastal plain extends, these panplains coalesce and are separated only by residuals of the original divides. Because of this, there is an escarpment zone but no clearly defined scarp between the coastal plain and the main tableland. Upwarping of the tableland along north-west and north-north-east axes, and eustatic changes of sea level have caused irregular and intermittent rejuvenation of streams. This has resulted in repeated river capture and recapture and the formation of windgaps.

During one of the rises in sea level, the whole topography of the area was modified by the deposition of a layer of ferricrete (a coarse, poorly sorted, intensely porous gravel with a ferruginous cement) on the coastal plain. The surface of the ferricrete has a mean northerly gradient of about 10 feet per mile in the escarpment zone, but this figure may be exceeded, and the direction probably varies near hills. Modern rejuvenation has caused streams to be incised into the ferricrete.

The catchment area of the Adelaide River dam site is wholly within the escarpment zone. The watershed is a line of high relief in which the lowest points could be windgaps at much the same level as the proposed dam wall. Moreover, the ferricrete floor of the catchment may be as much as 50 feet thick and could extend through any windgap into the Finniss, Daly, or Ferguson, drainage systems. If this occurs, the effective floor of the windgap may be the base of the ferricrete because of the high porosity and permeability of this rock in many places. The danger of seepage losses through the ferricrete is slight in the extreme south of the catchment, where the base of the ferricrete is expected to be about 200 feet higher than the foot of the proposed dam, and where windgaps are commonly higher than the ferricrete. The major danger is from windgaps in the north. These are likely to be wider, lower, and more extensively covered in ferricrete than the southern ones. In general, it may be stated that any area on the watershed must be regarded as a potential source of seepage losses if the minimum height is less than 50 feet above the intended final water level in the dam. Any such area should be investigated and, if necessary, drilled to ascertain the thickness of the ferricrete floor.

Finally, because the storage area consists of coalescing panplains of very low gradient, the effective head (for hydro-electric purposes) would be at a minimum and the evaporation area would be at a maximum for a given volume of water. Moreover, the storage capacity of a high wall may prove to be far in excess of the available water. In the early stages, losses by percolation underground could be high until the ferricrete became saturated. Such losses might be more apparent than real, as much of the water stored in the ferricrete would be available at a later date and would not be subject to evaporation losses.

CONCLUSIONS

Detailed geological survey of the dam sites is necessary before a decision on the final site can be made. This should be followed by investigation of sites of potential seepage loss around the watershed. Finally, when the maximum water level contour has been plotted, all saddles below or not more than 50 feet above this contour should be investigated.

APPENDIX 2.

GENERAL RECONNAISSANCE OF THE ADELAIDE RIVER GORGE DAM SITES

Three days, 24th, 25th, and 26th May, 1960, were spent in and near the Adelaide River Gorge, investigating the middle and upper dam sites (see Appendix 1) and two saddles on the eastern watershed.

The first saddle investigated is at the head of a small creek, which flows into the gorge from the east, about half a mile above the middle dam site. The lowest point of the saddle is about 130 feet above the level of the bank at the dam site and about 150 feet above the stream bed. The contact between Upper Proterozoic quartzitic sandstone and greywacke of the Noltenius Formation is on the west side of the saddle. The contact, which is not exposed, is thought to be a fault because of intense shearing in the greywacke, parallel to the inferred contact. If this is the case, and if the water level in the dam approaches the level of the saddle, there is a danger of leakage both at the fault and through the Upper Proterozoic sandstone. The sandstone is well jointed, strikes at 040°, and dips south-east out of the catchment area, at between 10° and 15°. Grouting should suffice to prevent leakage.

The second saddle, at station 62 on the eastern watershed, is about 90 feet above bank level at the dam site. Bedrock in the saddle is vertically cleaved silty slate of the Noltenius Formation; the strike of the cleavage is 040°, across the saddle. The slate is partly concealed by a skin of ferricrete and the creeks on both sides of the saddle occupy wide flat valleys floored with ferricrete. The maximum thickness of ferricrete in the saddle is about 10 feet, so that the effective height of the saddle is reduced to about 80 feet above bank level. If the depth of water in the dam is to be greater than 80 feet, the ferricrete will have to be sealed. Grouting may not be adequate for this, because of the very high porosity and permeability.

The sub-ferricrete profile of the saddle could be plotted very easily by resistivity traverses and a check bore-hole or shaft. If a retaining wall is to be built, its foundations would have to extend into bedrock below the ferricrete. Until the degree of decomposition of this bedrock is seen, no forecast of foundation depth can be made. An estimate might be obtained from a resistivity survey.

The upper dam site was examined briefly. The gorge is flat-bottomed and steep-sided and the river is incised about 20 feet into the ferricrete floor. No outcrops were seen in the floor, where bedrock is thought to be silty slate of the Noltenius Formation. The banks are strike-ridges of greywacke dipping steeply west. The site might be suitable for a thin arch wall as the greywacke ridges would not present buttress problems, but much excavation would be needed in the stream bed in order to reach solid rock.

The middle dam site is at a point where the river bends from north-east to north-west and cuts through a strike ridge of greywacke. The estimated thickness of the greywacke is about 600 feet, the strike is 040° and the dip is 70° north-west. The greywacke is a chloritic medium-grained to coarse rock containing pebbly lenses. There are many anastomosing quartz-specularite veins ranging in thickness from ¼ inch to 6 inches. Two silty intercalations are suspected, each with a maximum thickness of less than 100 feet. The flat bottom of the gorge is covered by ferricrete, scree, and recent alluvium, and the maximum depth to bedrock is not known but may exceed 30 feet. No outcrops were seen in the shallow parts of the stream. No evidence could be found to show that faulting was the cause of the change in direction of the gorge. A slight apparent off-setting of the main greywacke outcrop on the west bank may be due to a small fault. This will have to be investigated in greater detail as a possible source of leakage but is not thought to be dangerous to the stability of the dam wall. Folding could not be detected on either bank, but there are many vertical joints striking at 180° to 090°.

Grouting will probably be necessary over the full length and width of wall below water level and deep excavation to bedrock is necessary.

CONCLUSIONS

The natural advantages of the middle site justify further investigation. Before such work is done, however, it will be necessary to complete the investigations on the nature of the watershed. The north-western side of the watershed is regarded as potentially less satisfactory than the eastern side and no work should be done on the gorge until the minimum height of the western watershed is known. As soon as this information is available, a decision on the height of the dam wall will have to be made. Topographic surveys will then have to be made of every low saddle, followed by detailed geological surveys. If the saddles prove to be suitable for closure by grouting or the construction of inexpensive retaining walls, the middle site can be cleared and surveyed in detail.

ADELAIDE RIVER INVESTIGATIONS

GEOPHYSICAL INVESTIGATION OF EASTERN LOW SADDLE

The eastern low saddle between survey stations 62 and 65 was visited on 22nd, 23rd and 24th June, 1960; and 12th and 13th July, 1960. The purpose of the investigation was to investigate the depth of ferricrete and decomposed rock in the floor of the saddle. Resistivity surveys were undertaken and the findings were to be confirmed by hand auger. In the event, it proved impossible to drill hand auger holes in the ferricrete beyond a depth of 5 feet. A hand auger with a screw type bit was used in the first attempt. The bit sheared off at a depth of 5 feet. A chisel bit was then tried. This could not be with drawn at a depth of 3 feet and had to be dug out. A percussion type auger was then tried. Several holes were drilled, the deepest being 5 feet. Each hole was stopped after reaching a stage at which no advance was made in two hours drilling. The bit had to be jacked out of every hole.

RESISTIVITY OBSERVATIONS:

The instrument used was a Japanese-constructed meter of the Megger type, loaned by the Director, Water Resources Branch, N.T.A.. A hand-operated alternating current generator is incorporated in the meter and direct values of resistance are measured. It was used with four steel electrodes in the Wenner arrangement. Traverses at depths of 5 feet, 10 feet, 15 feet and 20 feet, and depth probes at intervals of 20 feet were done along the crest of the saddle. During the attempts to drill auger holes, it was noted that there was a layer of alluvial sand of constant thickness (2' 9") overlying the ferricrete. Some patches of the sand, on the west side of the saddle, had been blown into small dunes. This sand layer had an unduly large influence on the 5-foot constant depth traverse, particularly on the west side and the traverse was rejected as unreliable. The 10-foot traverse was not reliable but indicated a broad shallow valley with its deepest point about 250 feet from survey station 65. The 15-foot and 20-foot traverses were almost identical and indicated that the underlying rocks were fairly homogeneous at these depths. It seems possible, therefore, that the change from ferricrete to bedrock occurs between 10 feet and 15 feet below the floor of the saddle. The difference between the 10-foot and 15-foot traverses was so marked that the change may occur near the 10-foot depth. An alternative explanation of the curves is that the ferricrete was deposited in a deeper valley, is more than 20 feet thick, and that the 10-foot depth coincides with the water table in the ferricrete.

A depth probe at 240 feet from station 65 was taken to a depth of 100 feet and indicated that the base of the ferricrete could be at either 10 feet or 25 feet and that this rests upon rock weathered to a depth of 40 feet. This was thought to be the maximum depth likely to be reached along the crest and all other depth probes were stopped at either 50 feet or 60 feet. The results were then collated on a topographic section. The base of the weathered rock was deepest below the centre of the saddle but the base of the ferricrete could not be identified with certainty. Two horizons were identified. The top one is at a constant depth of approximately 10 feet. The lower one has the shape of a broad V, 150 feet wide and 25 feet deep, and is parallel to what is believed to be the base of the weathered zone in bedrock, about 15 feet below. The constant depth horizon is probably the water table in the ferricrete, and it is thought that the broad V-shaped valley is the original valley in which the ferricrete was deposited.

An important fact noted during the attempts to extract the auger bits was that the ferricrete contains a high proportion of clay and that many of the fragments of country rock are kaolinised. If this is generally true of the catchment area, leakage losses through the ferricrete are not expected to be high.

A single bore-hole to a depth of 60 feet at 240 feet from station 65 would be adequate to confirm the geophysical interpretation.

A narrow gorge exists 3000 feet downstream on the Adelaide River side of the saddle and a single depth probe was done near the gorge to ascertain the nature of the foundations of a wall built across the gorge. One depth probe was not enough to establish the profile of the subferricrete floor or even estimate the depth of ferricrete. The ferricrete may be more than 20 feet thick and weathered rock may extend to 60 feet. Topographical survey has since shown that the fall to the gorge is 30 feet and that a wall to the 300 foot contour in the gorge would be 420 feet long and 70 feet high (maximum) as opposed to 800 feet long and 25 feet high in the saddle. The maximum possible altitude of the crest of a dam built in the saddle is 300 feet. A wall 1300 feet long and 52 feet high with the crest at 315 feet, could be built 600 feet downstream. A similar wall in the gorge would be about 500 feet long and 85 feet high.

RECOMMENDATIONS:

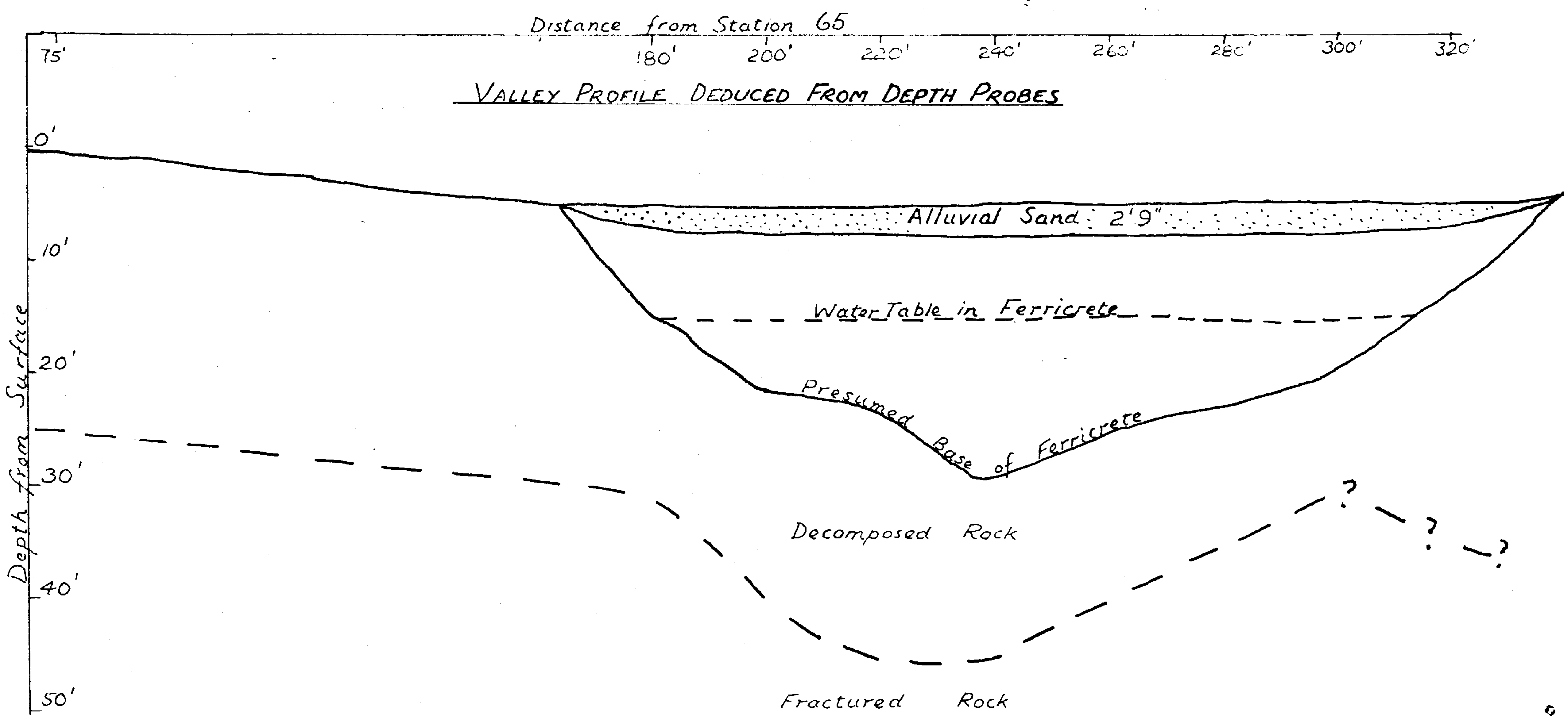
The minimum thickness of ferricrete over most of the saddle is 10 feet. If no attempt is made to increase the effective height of the saddle, the only extra work necessary to prevent leakage is grouting round the edges of the ferricrete. Water should not be allowed to overflow across the saddle because of the probable ease of erosion of the ferricrete. If construction work is to be done in the saddle, exhaustive tests will be necessary to establish the load-carrying capacity of the ferricrete.

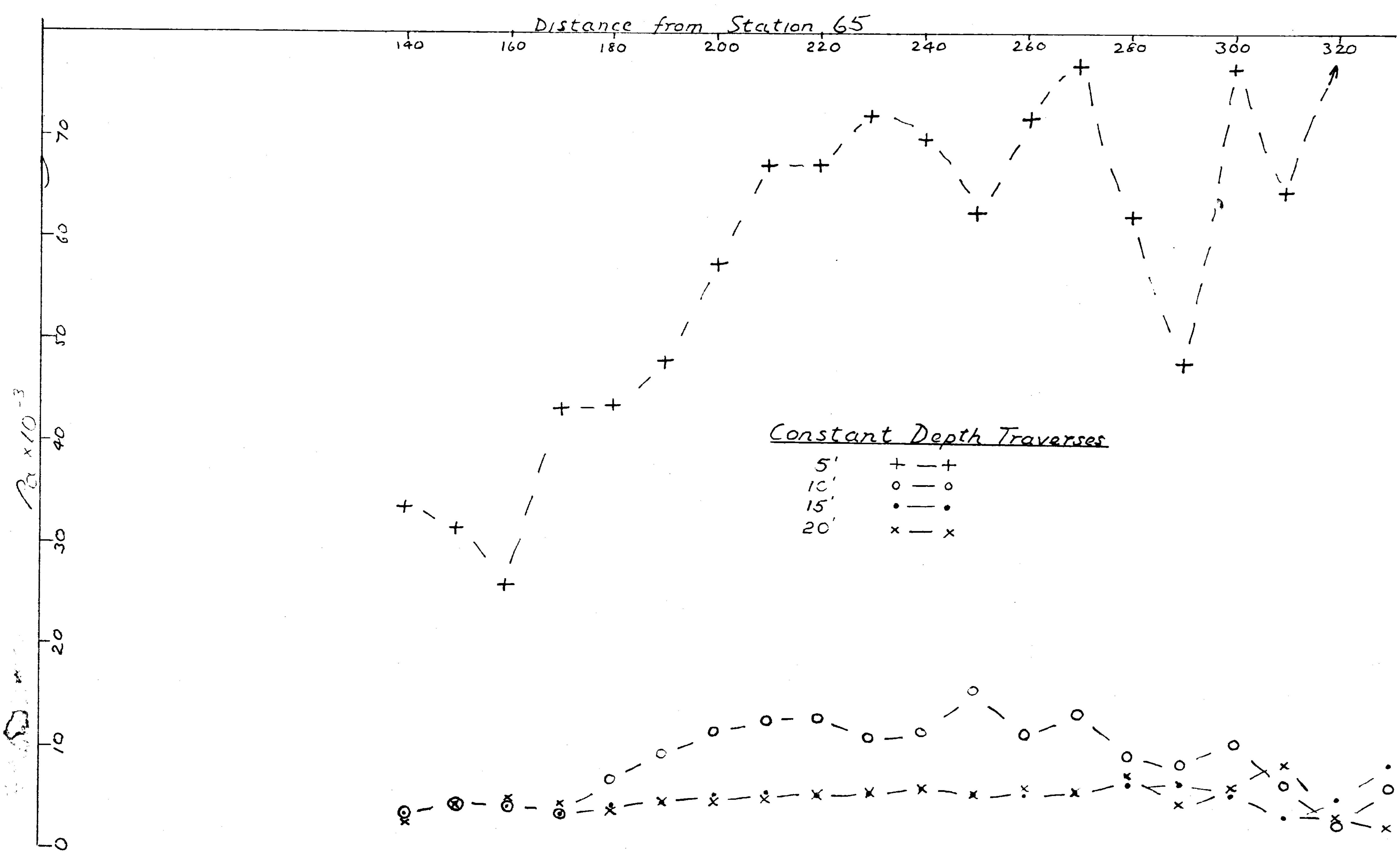
If construction is decided upon, the choice of site will be based upon the final water level and consequent building costs. If the final contour is 300 fe[illegible], the saddle may be the most suitable site for a wall. For a higher final contour, the gorge may be more suitable.

A complete geological survey, should be superimposed on the recently completed 80 foot to one inch plan of the saddle and gorge.

RESISTIVITY DATA : APPENDIX 3

Depth Probe	1		2		3		4		5		6		7		8		9	
Distance from Station 65	320		300		280		260		240		220		200		180		73 ft. from Station 65	
Vertical Depth	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}	V/I	Pax10^{-3}
feet																		
4	115	88	110	84.2	180	158	135	102	170	130	150	115	140	107.5	120	94		
5	55	52.7	80	76.4	80	76.3	65	62.2	105	101	87.5	87.0	75	71.8	50	47.8	90	86
6	50	57.45	35	40.2	30	34.5	35	40.3	55	57.8	50	57.4	45	51.6	27.5	31.6		
7	8.5	11.38	16.5	22.1	4.5	12.75	23.5	31.5	30	40.3	30	40.3	29	38.9	14.5	14.5		
8	8.0	12.22	11.0	16.82	11.0	16.82	14.0	21.4	18.75	28.7	23	35.2	18.5	28.2	8.0	12.25		
9	13.0	22.4	5.5	9.5	6.5	11.25	7.5	12.95	9.75	16.82	15.5	26.8	11.0	18.95	4.5	7.26		
10	9.0	17.25	4.25	8.13	5.0	9.57	3.25	6.23	3.5	6.7	12.5	23.9	7.5	14.37	3.5	6.7	5.5	10.3
12	4.0	9.2	4.25	9.73	2.2	5.05	2.25	5.16	2.6	5.98	5.0	11.23	3.0	6.88	1.9	4.37		
14	2.15	5.75	1.1	2.95	1.8	4.83	0.95	2.54	1.7	4.56	3.2	8.56	1.9	5.10	1.45	3.88		
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.15	6.2
16	5.0	15.32	.95	2.92	1.25	3.83	0.95	2.92	1.2	3.67	2.0	6.13	1.45	4.43	1.3	3.97		
18	8.0	27.5	1.2	4.13	.65	2.24	0.775	2.68	1.15	3.96	1.35	4.65	1.3	4.48	1.1	3.8		
20	20.0	76.6	.9	3.45	1.3	5.0	0.425	1.63	1.25	4.80	1.17	4.46	1.25	9.80	1.0	3.83	1.35	5.2
25	17.5	83.5	.6	2.93	1.5	7.18	1.2	5.74	0.75	3.58	0.95	4.55	1.1	5.28	0.85	4.07	.75	3.6
30	0.8	4.6	1.55	8.90	1.3	7.48	1.25	7.2	1.15	6.62	1.0	5.795	1.15	6.62	0.9	5.17	.7	4.0
35	1.0	6.7	1.2	8.05	0.9	6.03	1.15	7.75	1.1	7.4	1.0	6.70	0.85	5.7	0.9	6.06	.75	5.05
40	2.6	2.0	1.0	7.66	1.2	9.4	0.9	6.9	1.33	10.12	0.9	6.91	1.05	8.08	0.9	6.88	.55	4.23
45	5.0	4.30	.24	2.07	0.7	6.03	0.8	6.9	1.20	10.18	0.9	7.75	0.95	8.2	0.9	7.78	.5	4.3
50	1.5	1.4	0.5	4.79	0.75	7.17	0.8	7.65	1.15	11.0	0.875	8.37	0.75	7.18	0.9	8.6	.7	6.7
55			0.18	1.9	0.6	6.3	0.8	8.4										
60					0.65	7.48	0.8	9.45	1.10	12.65								
70									1.075	14.45								
80									1.0	15.3								
90									0.95	16.5								
100									0.8	15.3								


Distance from Station 65
75'
180'
200'
220'
240'
260'
280'
300'
320'
VALLEY PROFILE DEDUCED FROM DEPTH PROBES
0'
10'
20'
30'
40'
50'
Depth from Surface
Alluvial Sand 2'9"
Water Table in Ferricrete
Presumed Base of Ferricrete
Decomposed Rock
Fractured Rock


Distance from Station 65
140
160
180
200
220
240
260
280
300
320
0
10
20
30
40
50
60
70
Constant Depth Traverses
5' + — +
10' o — o
15' • — •
20' × — ×

ADELAIDE RIVER DAMSITE
INVESTIGATION OF SADDLES ON WEST SIDE OF GORGE

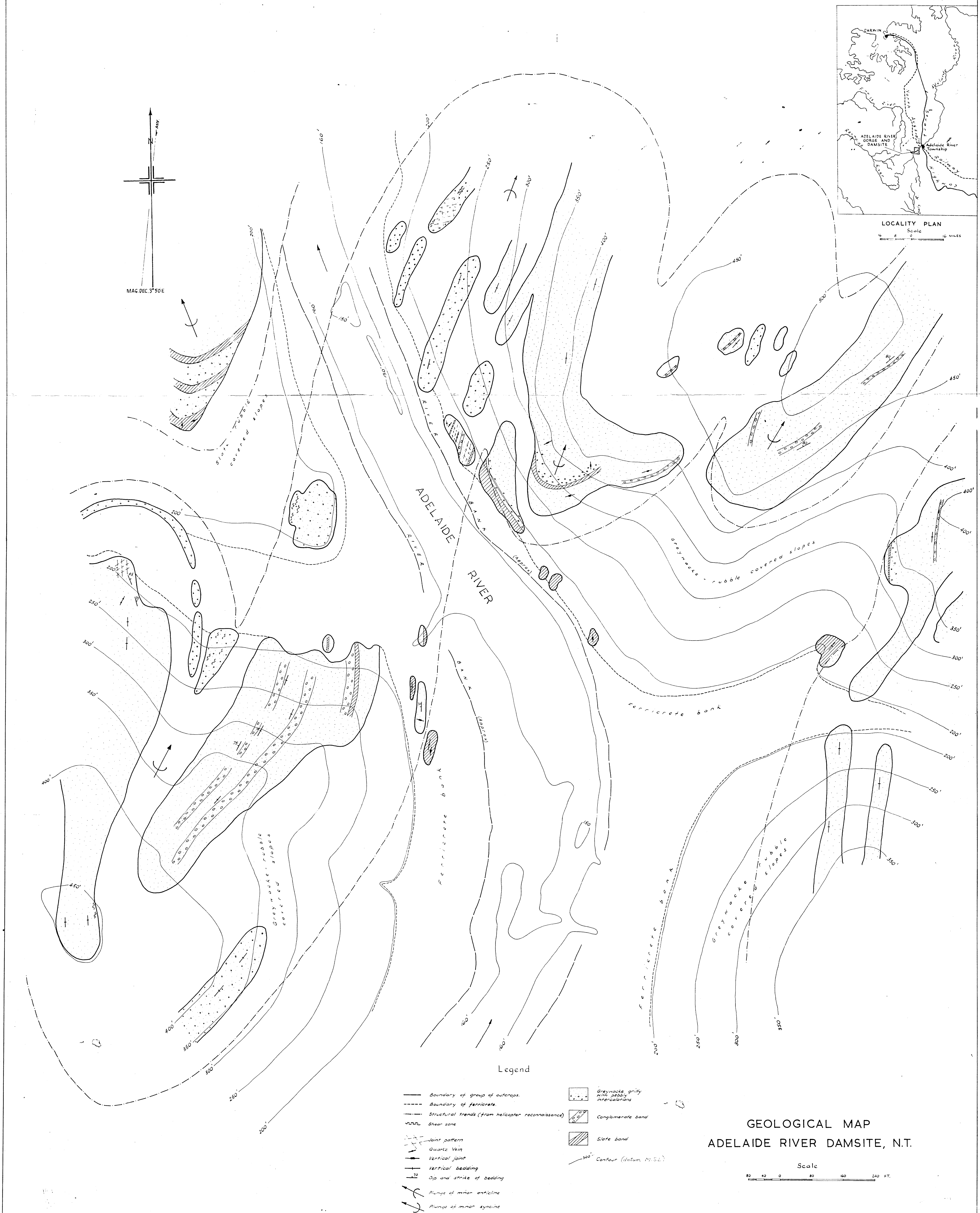
Two low saddles occur at the head of a small creek that flows into the gorge from the west, north of the middle damsite. As it is understood that the lower of the two saddles may be selected as a spillway and a detailed topographic survey may be undertaken, no detailed geological map was prepared and investigations were extended to the surrounding area.

Both saddles are floored by slate or slaty siltstone in which both bedding and cleavage strike north-easterly along the centre line of the saddle. The cleavage is nearly vertical and the bedding dips at about 50° north-west. The dominant rock type near the saddles is slate but sheared grit and greywacke are dominant nearer the gorge. Several quartz-specularite veins were observed east of the lower saddle. Observations in stream sections indicate that all jointing is closed at a depth of between 50 feet and 100 feet below the crest of the saddle but there is grave danger of leakage in the more intensely weathered rocks near the surface. The top few feet are effectively slate rubble and it may be necessary to replace them by a concrete cap. Grouting will be necessary at both the saddles.

An extra problem is that of scour at the foot of the main wall if the saddle is used as a spillway. The spillway creek joins the main gorge at a point very near the probable position of the toe of the wall. To prevent scour it may be necessary either to strengthen the toe or divert the creek. The latter may be the easier solution. A small hill stands at the confluence of the spillway creek and the Adelaide River. The creek now runs on the south side of the hill but in former times it flowed north of the hill. It would be possible to excavate a new channel north of the small hill.

A decision on the spillway should not be made until the detailed surveys of the east and both/west low saddles have been made and the final water level contour has been selected. If the west saddle is selected, the east saddle will have to be built up so that its final height is greater than that of the west saddle. If the east saddle is selected, either no such extra construction or less construction will be necessary, according to final water level. The east saddle has a far larger capacity than the west one so that the cost of construction in the east saddle will be much greater per vertical foot than that in the west saddle.

PLATE I



GEOLOGICAL MAP
ADELAIDE RIVER DAMSITE, N.T.

Resident Geologist's Office, Bureau of Mineral Resources, Darwin, N.T. March, 194

PLATE 2

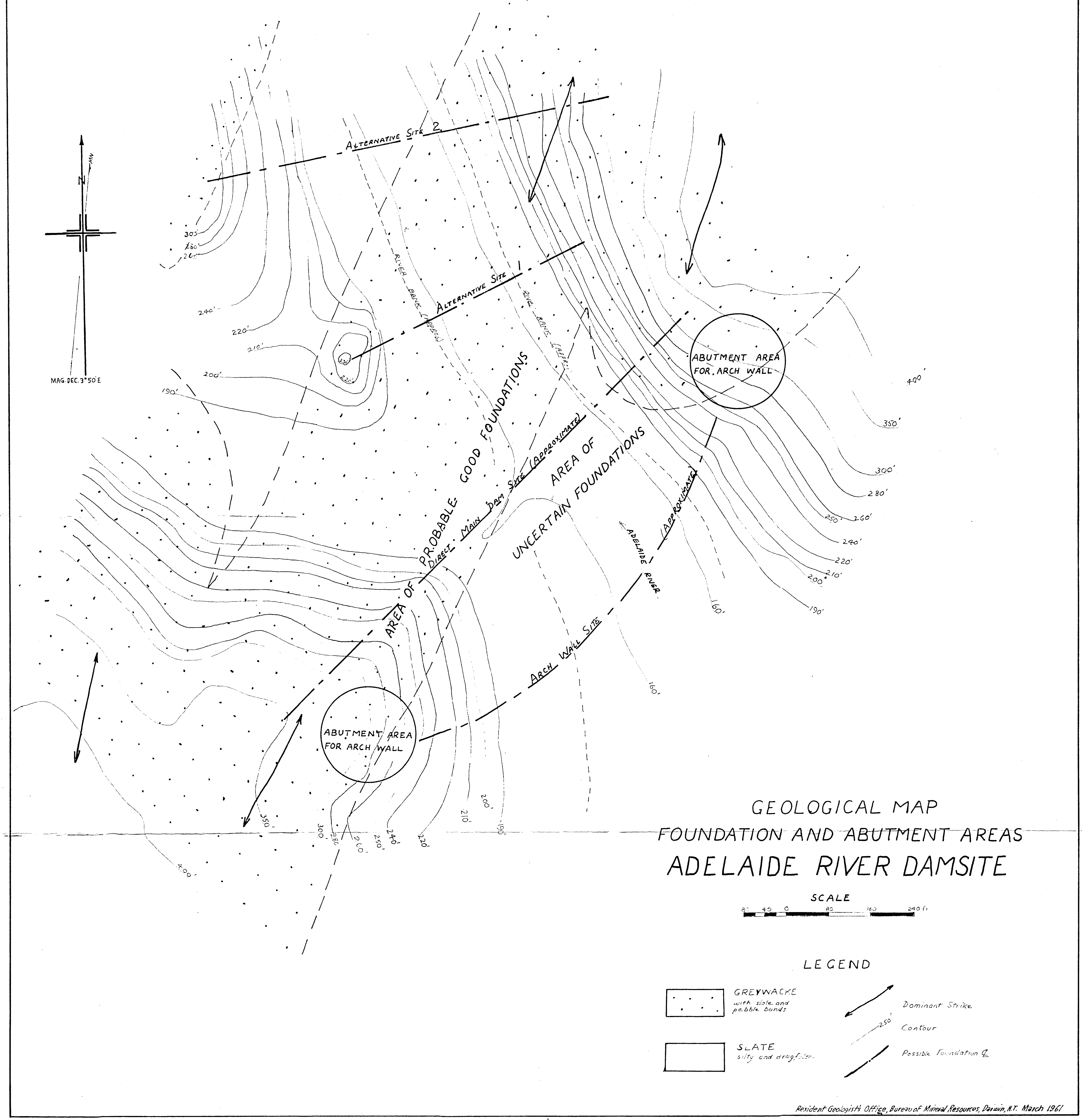
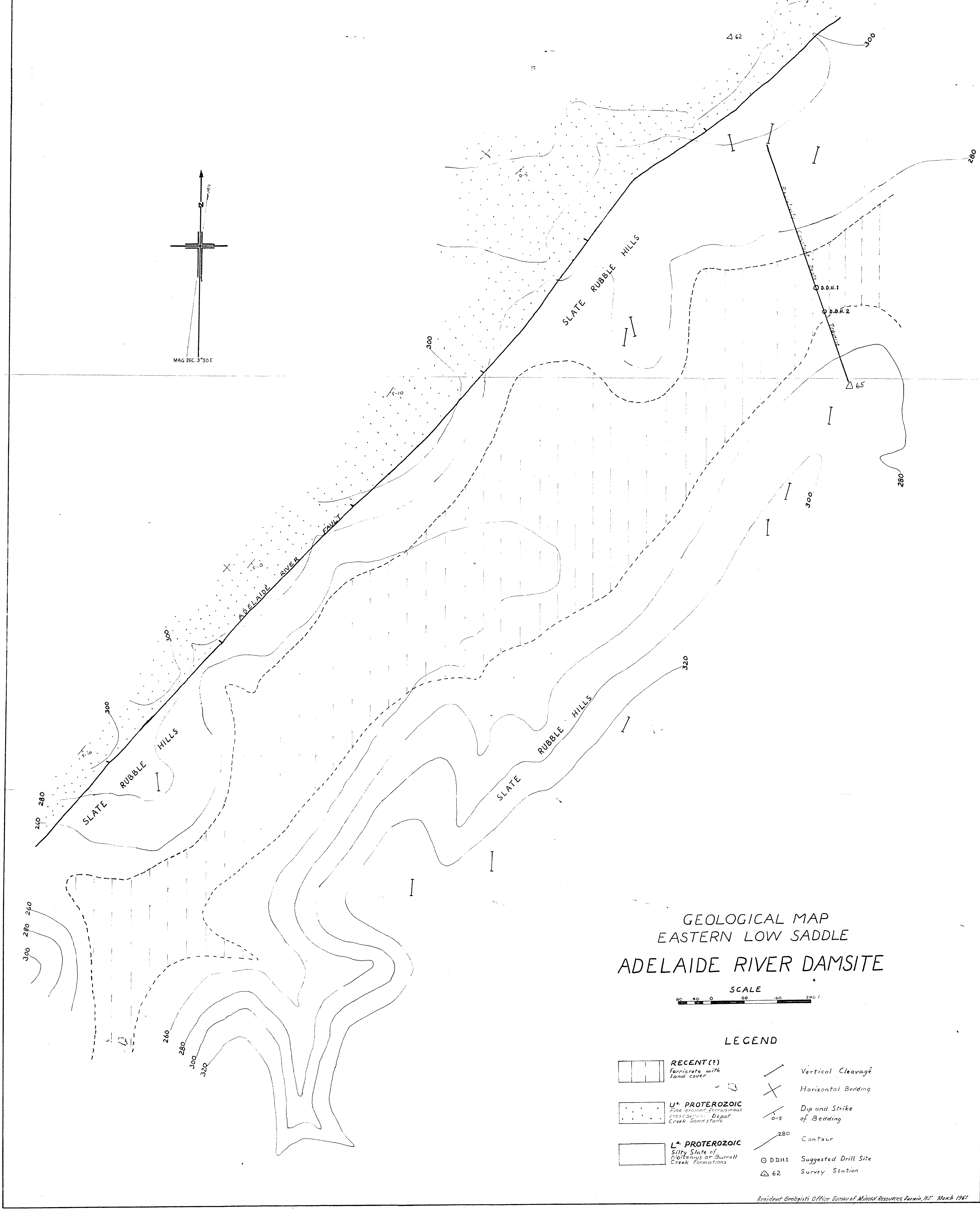
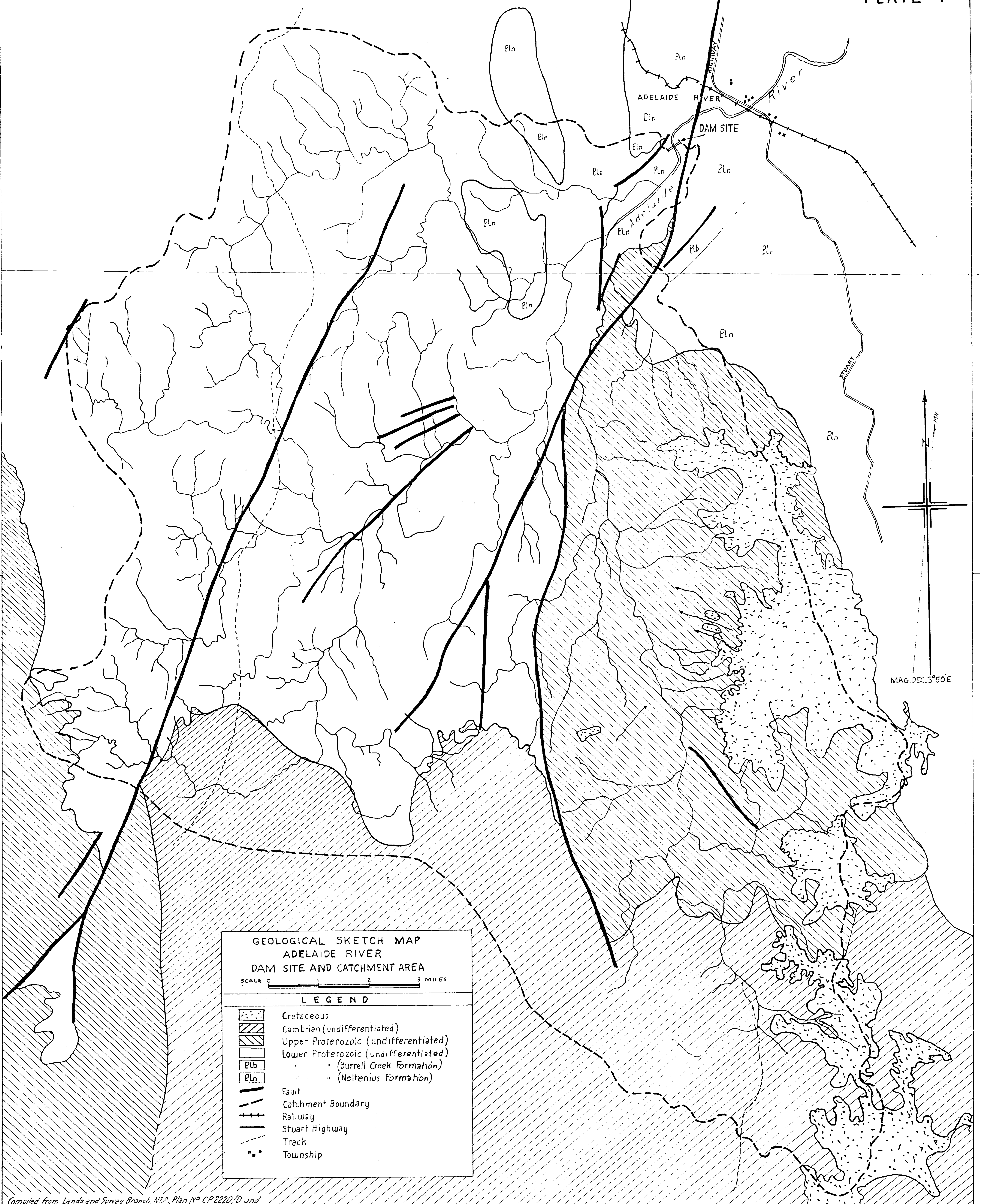

GEOLOGICAL MAP
FOUNDATION AND ABUTMENT AREAS
ADELAIDE RIVER DAMSITE
SCALE
80 40 0 80 160 240 ft
LEGEND
GREYWACKE
with slate and pebble bands
SLATE
silty and dragfolded
Dominant Strike
Contour
Possible Foundation ℄
MAG. DEC. 3°50'E
N
MN
ALTERNATIVE SITE 2
ALTERNATIVE SITE 1
RIVER BANK (APPROX.)
RIVER BANK (APPROX.)
AREA OF PROBABLE GOOD FOUNDATIONS
DIRECT MAIN DAM SITE (APPROXIMATE)
AREA OF UNCERTAIN FOUNDATIONS
ADELAIDE RIVER (APPROXIMATE)
ARCH WALL SITE
ABUTMENT AREA FOR ARCH WALL
ABUTMENT AREA FOR ARCH WALL
400'
350'
300'
280'
260'
250'
240'
220'
210'
200'
190'
160'
160'
Resident Geologist's Office, Bureau of Mineral Resources, Darwin, N.T. March 1961

PLATE 3



N
MN
MAG. DEC. 3°30'E
SLATE RUBBLE HILLS
ADELAIDE RIVER FAULT
SLATE RUBBLE HILLS
SLATE RUBBLE HILLS
D.D.H.1
D.D.H.2
65
62
320
300
280
260
240
0-5
5-10
GEOLOGICAL MAP
EASTERN LOW SADDLE
ADELAIDE RIVER DAMSITE
SCALE
80 40 0 80 160 240 ft.
LEGEND
RECENT (?)
Ferricrete with sand cover
U. PROTEROZOIC
Fine grained, ferruginous cross bedded Depot Creek Sandstone
L. PROTEROZOIC
Silty Slate of Noltenius or Burrell Creek Formations
Vertical Cleavage
Horizontal Bedding
Dip and Strike of Bedding
Contour
D.D.H.1 Suggested Drill Site
62 Survey Station
Resident Geologist's Office, Bureau of Mineral Resources, Darwin, N.T. March 1961

PLATE 4



Compiled from Lands and Survey Branch, N.T.A., Plan Nº CP2220/D and Bureau of Mineral Resources 1 Inch to 1 Mile geological maps.

Resident Geologist's Office, Bureau of Mineral Resources, Darwin, N.T. March 1961