DEPARTMENT OF MINES AND ENERGY

SOUTH AUSTRALIA

GEOLOGICAL SURVEY

FOUNDATION DRILLING AT ROBE SLIPWAY - LAKE BUTLER

by

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ENGINEERING DIVISION

Rept.Bk.No. 79/21
G.S. No. 6140
D.M. No. 86/63
Eng. No. 1979/NA10

DEPARTMENT OF MINES - SOUTH AUSTRALIA

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1 2 2 1 — TITLE: FOUNDATION DRILLING AT ROBE SLIPWAY - LAKE BUTLER (3 FIGS)

1 3 — ORGAN, OR COMPANY: A.F. WILLIAMS, AUTHORS: A.F.

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1 3 5 1 — HUNDRED — SECTIONS — LICENCE AREA

1 6 — MAJOR KEYWORD: ENGINEERING GEOLOGY | FOUNDATION | DIAMOND ~~DRILL~~ DRILLING | BRIDGEWATER FORMATION

DRILLING | GEOL. LOG | GAMBIER LS | CA. NO. 201.C

LAKE

1 3 6 1

KEYWORDS

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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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FOUNDATION DRILLING AT ROBE SLIPWAY - LAKE BUTLER

ABSTRACT

Foundation testing for strengthening the existing slipway at Lake Butler, Robe has shown the presence of medium strong rock (Bridgewater Formation limestones) at a depth of less than 2 m which should provide an adequate bearing horizon for the structure. However a significant number of solution cavities, probably in the form of narrow vertical pipes, were intersected which could cause localised weakening of the rock mass. It is suggested that steel foundation piles be used and each pile be driven to refusal.

INTRODUCTION

A request was received from the South Australian Department of Marine and Harbours in October, 1978 to provide geologic detail below the existing slip-way at Lake Butler, Robe (see Fig. 1). A new slipway is to be constructed on piles to bedrock. Three diamond drill holes were completed during the 9th to the 13th January. The rig was mounted on a boat cradle run down the slipway. Unfortunately silt and sand up to 1.5 m deep prevented drilling right at the end of the slipway. A diver was able to jet sediment away at about 8 m from the end.

Three holes were drilled to depths of 10.0, 12.2 and 13.4 m respectively 54, 30 and 70 m from the zero chainage point on the slipway (see Fig. 2).

GEOLOGY

All holes intersected Bridgewater Formation limestones at or near surface to about 9 m. MC59 and 60 struck Gambier Limestone at 11.4 and 9.0 m while MC59 was not drilled deep

enough to intersect Gambier Limestone, but the contact is expected only 1-2 m below the hole bottom. A geologic section down the slipway is shown on Fig. 3. Logs of all holes appear in Appendix I and a summary of rock properties is given in Table I.

TABLE I

ROCK PROPERTIES

Formation and lithology	Strength	Condition	Structure (including solution features)
Bridgewater Formation, granular limestone (one thin clay band (0.25 m) in MC59)	Medium strong, weaker near top	Slightly weathered at top 1 metre metre (calcreted)	No fractures, core parts generally along bedding planes in pieces 1 to 30 cm when drilled. Solution features common, ranging in size from 1 to 5 cm. Some show lining by secondary carbonate. Major cavities in all three holes - see below.
Gambier Limestone, fossiliferous limestone	Weak to medium strong	Some recrystallization near top gives better cemented rock	No fractures, no obvious bedding. Core parts irregularly in 5 to 25 cm pieces when drilled. Core broken into chips where soft.

CAVITIES

No water returns were obtained in all three holes within the Bridgewater Formation and the driller reported silt in these sections. It is suspected that there are moderate size vertical solution pipes, varying from 0.3 to 1 m in diameter as often seen in road cuttings, occurring through this formation. From the logs they appear restricted to the Bridgewater Formation but it is felt that insufficient thickness of Gambier Limestone has been penetrated to preclude their presence in that formation. They do not appear within the drill holes 9.5 m below the slipway surface.

DISCUSSION

Drilling has shown that bedrock of sufficient strength to form a bearing horizon occurs at shallow depth (maximum 2 m) beneath the existing slipway.

Lack of core recovery and drilling water returns on all holes drilled indicate the presence of narrow fissures formed by solution effects within the limestone. These fissures may extend to considerable depth and form the main geological hazard on the site. In view of this it is recommended that steel piles be used, designed to effect maximum penetration into the limestone, and that each pile be driven to refusal.

AFW:ZV

A.F. WILLIAMS

APPENDIX 1

DRILL HOLE LOGS

PROJECT: ROBE SLIPWAY

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

LOG OF DIAMOND DRILL HOLE

HOLE NO. MC 48

UNIT/STATE NO

SERIAL NO

FOLDER NO.

LOCATION OR CO-ORDS: SLIPWAY. LAKE BUTLER, ROBE

SEC. HD. EL Surface EL ref. point Datum

GEOLOGICAL DESCRIPTION OF CORE	② GROUP SYMBOL	① STRENGTH TERM VS S MS W VW SO	HOLE Dia.	DEPTH m	GRAPHIC LOG	③ R.Q.D.% 75 50 25	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT CORE LOSS% 10 5 50	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0 100	④ WATER PRESSURE TESTS LUGEONS 0.5 1 5 10 50
No rec. - driller reports silt CALCRETE, - weathered limestone shelly, cemented sandsize grains LIMESTONE cemented carbonate grains and shell fragments 0.1 to 1mm. calcareous cement, some pockets (20-30mm) of calcrete as above. Traces of horizontal bedding. BRIDGEWATER FORMATN.				1		Core in 2-30cm pieces breaks irregularly on drilling.	Breaks irregularly on drilling No fractures apparent. Minor solution features to 10mm					
No recovery - driller reports silt and sand				2			Cavity - probably infilled to some extent					
				3								
				4								
LIMESTONE as above 0.2 to 1.8 Both horizontal and cross bedding noticeable. Speckled grey, cream & yellow brown as above				5		Core in 4-20cm pieces breaks along bedding planes on drilling	No fractures apparent - solution features abundant - unit 5-10 cm 6-6.2m with secondary carbonate lining cavities. There on has effected appearance with most cavities ±2 cm. occasional to 3, 4cm.					
				6								
				7		Core in 3cm pieces few up to 8cm	Solution features enlarged to many cm and much more abundant than above					
No recovery, driller reports silt and sand.				8			Cavity - probably infilled to some extent					
				9								
LIMESTONE, as above BRIDGEWATER FORMATION				10			As for 6.75 - 8m T.D. 10.0m					

Below lake bed

Nil

Not tested

① ROCK SUBSTANCE

STRENGTH TERM
VS–Very Strong
S–Strong
MS–Medium Strong
W–Weak
VW–Very Weak
SO–Soil properties

CONDITION TERM
Fresh
Weathered
Altered
Soil properties

Numbers give diametral point load strength (Is) in MPa.

② Substances with soil properties remoulded and classified by Unified System

③ ROCK QUALITY DESIGNATION
0–25% Very poor
25–50% Poor
50–75% Fair
75–100% Good to excellent

④ (350) Maximum effective pressure (kiloposcals) reached during test.

DRILL TYPE	Mindrill	LOGGED BY:	MW
CIRCULATION:	Water	DATE:	17/1/79
HOLE ANGLE:	Vertical	BEARING:	- -
START:	10/1/79	TRACED BY:	
FINISH:	10/1/79	DATE:	

SHEET 1 OF 1

PROJECT: ROBE SLIPWAY

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

LOG OF DIAMOND DRILL HOLE

HOLE NO. MC 59

UNIT/STATE NO.

SERIAL NO.

FOLDER NO.

LOCATION OR CO-ORDS: SLIPWAY, LAKE BUTLER, ROBE

SEC. HD. EL Surface EL ref. point Datum

GEOLOGICAL DESCRIPTION OF CORE	② GROUP SYMBOL	① STRENGTH TERM VS S MS W VW SO	HOLE Dia.	DEPTH m	GRAPHIC LOG	③ R.Q.D.% 75 50 25	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT CORE LOSS% 10 5 50	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0 100	WATER PRESSURE TESTS ④ LUGEONS 0.5 1 5 10 50
No recovery - driller reports silt												
LIMESTONE, cemented carbonate grains and fragments 0.1 to 2mm Calcareous cement - partly weathered (calcreted) 0.75 to 1.30m Traces of horiz. bedding Speckled grey, yellow brown. Minor calcrete				1		Core in pieces 2-25cm Breaks irregular by during drilling	No fractures apparent, odd solution feature about 0.95 m - several cm in size and lined with secondary carbonate					
No recovery - driller reports silt				2			Cavity, probably infilled to some extent					
				3								
				4								
LIMESTONE as above, few chips of concrete calcrete at 4.50-4.60 m - also shells at 5.0m - probably from above. Horizontal and cross bedding obvious.				5		Core in pieces mainly 10-30cm Breaks along bedding plane during drilling	No fractures apparent - solution features more prevalent and abundant from 8.40 m 1-5cm in size					
BRIDGEWATER FORMATION				6								
AS ABOVE.				7								
				8								
				9								
				10		Core in pieces 1-7cm						

Below lake bed

Nil

Not tested

① ROCK SUBSTANCE

STRENGTH TERM
VS–Very Strong
S–Strong
MS–Medium Strong
W–Weak
VW–Very Weak
SO–Soil properties

CONDITION TERM
Fresh
Weathered
Altered
Soil properties

Numbers give diametral point load strength (Is) in MPa.

② Substances with soil properties remoulded and classified by Unified System

③ ROCK QUALITY DESIGNATION
0–25% Very poor
25–50% Poor
50–75% Fair
75–100% Good to excellent

④ (350) Maximum effective pressure (kiloposcals) reached during test.

DRILL TYPE Mindrill	LOGGED BY: AFW
CIRCULATION: Water	DATE: 17/1/79
HOLE ANGLE: Vertical	BEARING: —
START: 11/1/79	TRACED BY:
FINISH: 11/1/79	DATE:

SHEET 1 OF 2

PROJECT: ROBE SLIPWAY

LOCATION OR CO-ORDS:

SEC. HD. EL Surface EL ref. point Datum

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

LOG OF DIAMOND DRILL HOLE

HOLE NO. MC 59
UNIT/STATE NO
SERIAL NO
FOLDER NO.

GEOLOGICAL DESCRIPTION OF CORE	② GROUP SYMBOL	① STRENGTH TERM VS S MS W VW SO	HOLE Dia.	DEPTH m	GRAPHIC LOG	③ R.Q.D.% 75 50 25	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT CORE LOSS% 10 5 50	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0 100	WATER PRESSURE TESTS ④ LUGEONS 0.5 1 5 10 50
LIMESTONE as above, becomes yellow to cream after 10.20m NOTE 0 – 11.1 BRIDGEWATER FORMATION CLAY, sandy fine to coarse grains to 2mm, brown grey to khaki, stiff LIMESTONE as above till 11.40m then comprised of shell and bryozoal fragments 3 – 15mm +. Calcareous cement. No obvious bedding. Coarser grained than above. SEQUENCE 0 – 11.1 BRIDGEWATER FORMATION 11.1 – 11.35 ? CLAY INFILLED CAVITY 11.35 – 11.40 BRIDGEWATER FORMATION 11.40 – 12.20 GAMBIER LIMESTONE				11 12	Core in pieces 2-10cm Core in pieces 5-15cm Very poor Core in pieces mainly 15-20cm Breaks irregular from drilling	Solution features as for 8.40m to 10.0m till 10.40m when less prevalent. No fractures. No fractures. Solution features to several cm T.D. 12.2m		Below lake bed Nil			Not tested	

① ROCK SUBSTANCE

STRENGTH TERM
VS–Very Strong
S–Strong
MS–Medium Strong
W–Weak
VW–Very Weak
SO–Soil properties

CONDITION TERM
Fresh
Weathered
Altered
Soil properties

Numbers give diametral point load strength (Is) in MPa.

② Substances with soil properties remoulded and classified by Unified System

③ ROCK QUALITY DESIGNATION
0–25% Very poor
25–50% Poor
50–75% Fair
75–100% Good to excellent

④ (350) Maximum effective pressure (kilopascals) reached during test.

DRILL TYPE	LOGGED BY: AFW
CIRCULATION:	DATE: 17/1/79
HOLE ANGLE:	BEARING:
START:	TRACED BY:
FINISH:	DATE:

SHEET 2 OF 2

PROJECT: RUSE SLIPWAY

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

LOG OF DIAMOND DRILL HOLE

HOLE NO. MC 6.
UNIT/STATE NO.
SERIAL NO.
FOLDER NO.

LOCATION OR CO-ORDS: SLIPWAY LAKE BUTLER ROBE
SEC. HD. EL Surface EL ref. point Datum

GEOLOGICAL DESCRIPTION OF CORE	② GROUP SYMBOL	① STRENGTH TERM (VS MS W VW SO)	HOLE Dia.	DEPTH m	GRAPHIC LOG	③ R.Q.D.% (75 50 25)	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT CORE LOSS% (10 5 50)	WATER LEVEL DATE	CASING	DRILL WATER LOSS % (0 100)	WATER PRESSURE TESTS LUGEONS (0.5 1 5 10 50 100) ④
No recovery - driller reports silt				1								
LIMESTONE cemented carbonate grains and shell fragments 0.1 to 2mm Calcareous cement. No obvious bedding. No recovery, driller reports silt				2		Core in pieces 2-8cm	No fractures apparent. Minor solution features 1-2cm. Core breaks irregularly Cavity - probably infilled to some extent.		Below hole level			Not tested
				3								
				4								
				5								
				6								
LIMESTONE as above. Horizontal and cross bedding present. Speckled grey & cream as above				7		Core in pieces 1-8cm - breaks along bedding planes	No fractures present. Minor solution features 1-2cm.					
				8								
LIMESTONE as above, bedding not obvious. 0-9m BRIDGEWATER FORMATION LIMESTONE - comprised mainly of bryozoal fragments, 5-10mm. Shelly Cemented by carbonate - softer than above. No obvious bedding				9		Core in fragments to max 4cm chipping. Core in large pieces 8-35cm breaks irregularly by	No fractures present, core very broken - suggestive of abundant solution features - some chippings may be infilling from cavity above. No fractures evident. Some solution features 1-2cm.					
				10								

① ROCK SUBSTANCE

STRENGTH TERM
VS–Very Strong
S–Strong
MS–Medium Strong
W–Weak
VW–Very Weak
SO–Soil properties

CONDITION TERM
Fresh
Weathered
Altered
Soil properties

Numbers give diametral point load strength (Is) in MPa.

② Substances with soil properties remoulded and classified by Unified System

③ ROCK QUALITY DESIGNATION
0–25% Very poor
25–50% Poor
50–75% Foir
75–100% Good to excellent

④ (350) Maximum effective pressure (kilopascals) reached during test.

DRILL TYPE Mindrill	LOGGED BY: AFW
CIRCULATION: Water	DATE: 18/1/79
HOLE ANGLE: Vertical	BEARING: —
START: 13/1/79	TRACED BY:
FINISH: 13/1/79	DATE:

SHEET 1 OF 2

PROJECT: ROBE SLIPWAY

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

LOG OF DIAMOND DRILL HOLE

HOLE NO. MC60

UNIT/STATE NO.

LOCATION OR CO-ORDS:

SERIAL NO.

SEC. HD. EL Surface EL ref. point Datum

FOLDER NO.

GEOLOGICAL DESCRIPTION OF CORE	② GROUP SYMBOL	① STRENGTH TERM VS S MS W VW SO	HOLE Dia.	DEPTH m	GRAPHIC LOG	③ R.Q.D.% 75 50 25	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT CORE LOSS% 10 5 50	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0 100	WATER PRESSURE TESTS LUGEONS 0.5 1 5 10 50 ④
LIMESTONE as above - softer. 0 - 13.4m GAMBIER LIMESTONE				11 12 13 14		drilling core broken into 5mm chips at 10.0, 10.3, 11.3, 11.5m	No fractures - solution features as above. T.D. 13.4m		Below lake bed	Nil		Not tested

① ROCK SUBSTANCE

STRENGTH TERM	CONDITION TERM
VS–Very Strong	Fresh
S–Strong	Weathered
MS–Medium Strong	Altered
W–Weak	Soil properties
VW–Very Weak	
SO–Soil properties	

Numbers give diametral point load strength (Is) in MPa.

② Substances with soil properties remoulded and classified by Unified System

③ ROCK QUALITY DESIGNATION
0–25% Very poor
25–50% Poor
50–75% Fair
75–100% Good to excellent

④ (350) Maximum effective pressure (kilopascals) reached during test.

DRILL TYPE	LOGGED BY: AFW
CIRCULATION:	DATE: 18/1/79
HOLE ANGLE:	BEARING:
START:	TRACED BY:
FINISH:	DATE:

SHEET 2 OF 2

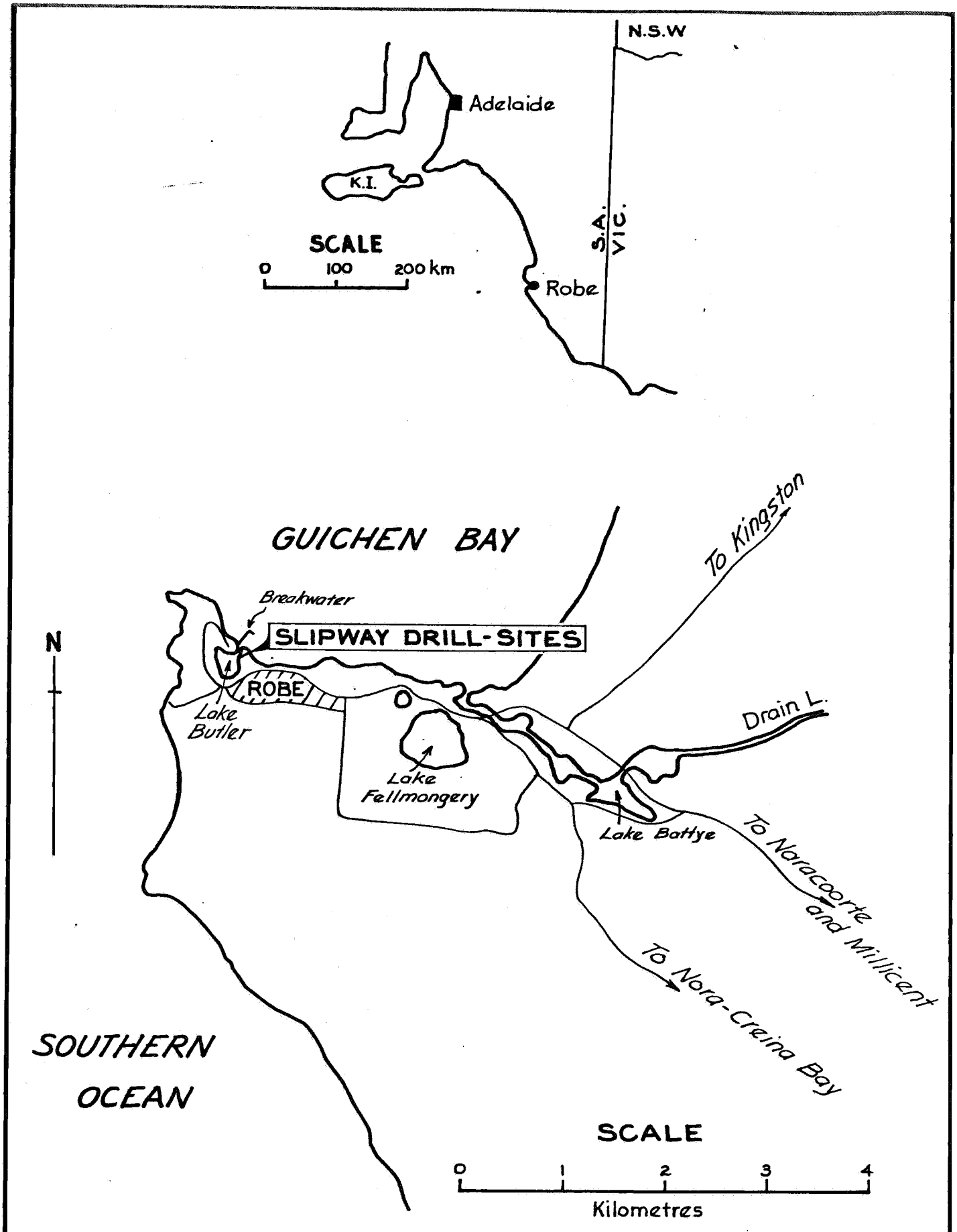
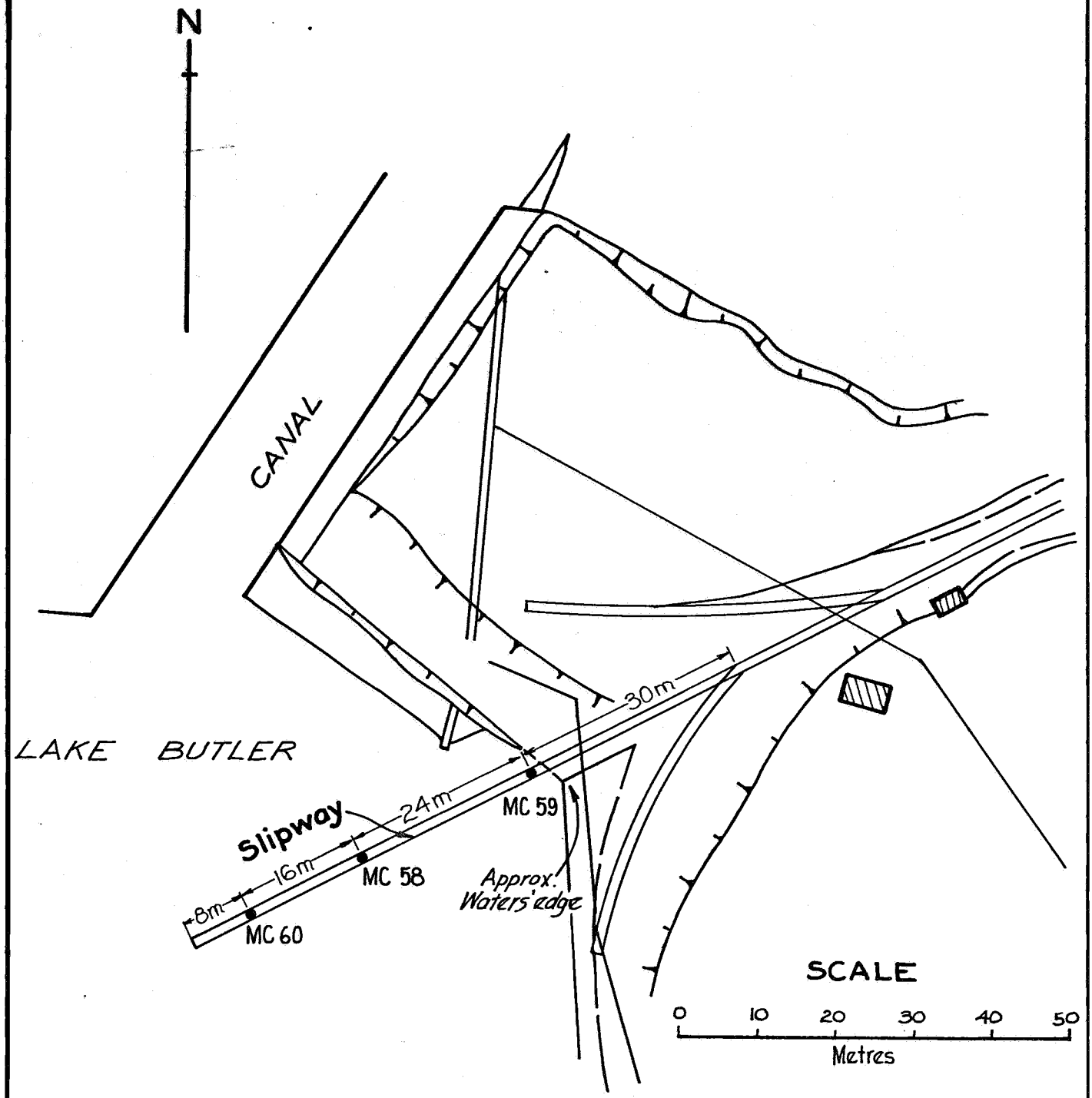


FIG. 1

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE: As shown
COMPILED A.F.W.	ROBE SLIPWAY - LAKE BUTLER	DATE: 1/2/79
DRN P.D. CKD	LOCALITY PLAN	PLAN NUMBER S13873
M.D.R.		

JOB No. 1185



Traced from S.A.H.B plan 17469/68 28/10/63

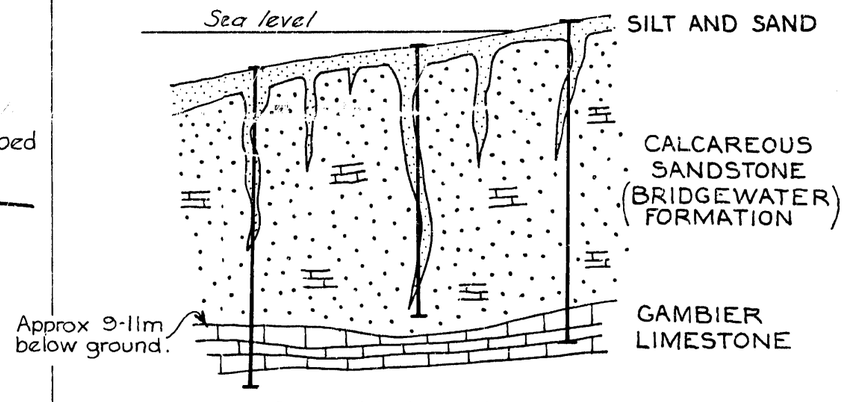
Site positions from R.Dunn S.A.H.B., Beachport.

FIG. 2

JOB No. 1185

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE As shown
COMPILED A.F.W.	ROBE SLIPWAY - LAKE BUTLER	DATE 1/2/79
DRN P.D. CKD W.J.R.	DRILL HOLE LOCATIONS (Approximate)	PLAN NUMBER S13874

78m
8m
70m
MC 60
16m
54m.
MC 58
24m
30m
MC 59
30m
00m
4% or 1 in 25 slope
Up to 1·3m SILT & SAND Covering Slipway.
End of Slipway
Probably silt
Probably silt
Cavity infilled to some extent. Probably vertical or near vertical.
BRIDGEWATER FORMATION
Cavities infilled to some extent. Probably vertical or near vertical.
T.D. 10·0m
Clay interbed
GAMBIER LIMESTONE
T.D. 12·2m.
T.D. 13·4m.
5m
4m
3m
2m
1m
0m
Vertical scale



GEOLOGICAL MODEL
(Not to scale)

FIG. 3

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE As shown.
COMPILED A.F.W.	ROBE SLIPWAY - LAKE BUTLER	DATE 5/1/79
DRN P.D. CKD	GEOLOGICAL PLAN	PLAN NUMBER 79-101
M.L.R.		

JOB No. 1185