Government of South Australia
Department for Transport,
Energy and Infrastructure

NEW JETTY AT RAPID BAY
GEOTECHNICAL INVESTIGATION

Client: Project Director, Office of Major Projects and Infrastructure
Mr Robert B Jenkins

GSU NO: 1247

Date: March 2007

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1. Introduction

The current Jetty at Rapid Bay is deteriorating and has passed its design life. The government has proposed to build a new 300 metre long jetty between 10 and 30 metres east of the existing jetty. The proposed new jetty will provide safe access for divers, anglers and tourists to the deep waters.

The existing Rapid Bay Jetty is located approximately 100 kms to the south of Adelaide on the Fleurieu Peninsula. The current jetty was constructed in 1941 by BHP Pty Ltd for the purpose of shipping limestone from the adjacent quarry to Whyalla. The jetty also supported a significant conveyor system.

Adelaide Brighton Cement later used the jetty for the same purpose, with the last shipment occurring in 1991. The conveyor system was dismantled in 1998. Ownership of the jetty was transferred to the Department of Marine and Harbours in 1982. From approximately mark 120m the Rapid Bay Jetty has been closed to the public due to further deterioration.

In response to the request by Mr Robert B Jenkins (Project Director, Office of Major Projects and Infrastructure), a geotechnical investigation has been undertaken. This report presents the results of this investigation.

2. Investigations

Detailed site inspections were conducted on September and December 2006. As a reasonably comprehensive investigation had been performed in 1938 for the existing jetty, it was considered that no additional geotechnical investigation was required. The results of the 1938 investigation are summarised in the "Results" section of this report.

Historical information was gathered relating the construction of the existing jetty from the *"Friends of Rapid Bay Jetty"* website and *"The Use and Abuse of Jetties – State Government Control in the Construction and Maintenance of Jetties in South Australia"* thesis.

The thesis *"The Structural Geology of the Rapid Bay – Second Valley Area, Fleurieu Peninsula, South Australia"* was used to gather information regarding the geology of the area.

Meeting with contractors were held to discuss the complexity of pile driving at this location.

3. Results

3.1 Site investigation results

The existing Rapid Bay Jetty is located at the township of Rapid Bay, approximately 100 kms to the south of Adelaide on the Fleurieu Peninsula. Rapid Bay is situated in a valley as shown in Figure 1. At the bottom of the valley the river crosses the camping ground and finishes at sea. The area consists of rolling hills with small creek networks. The hills descend towards the sea.

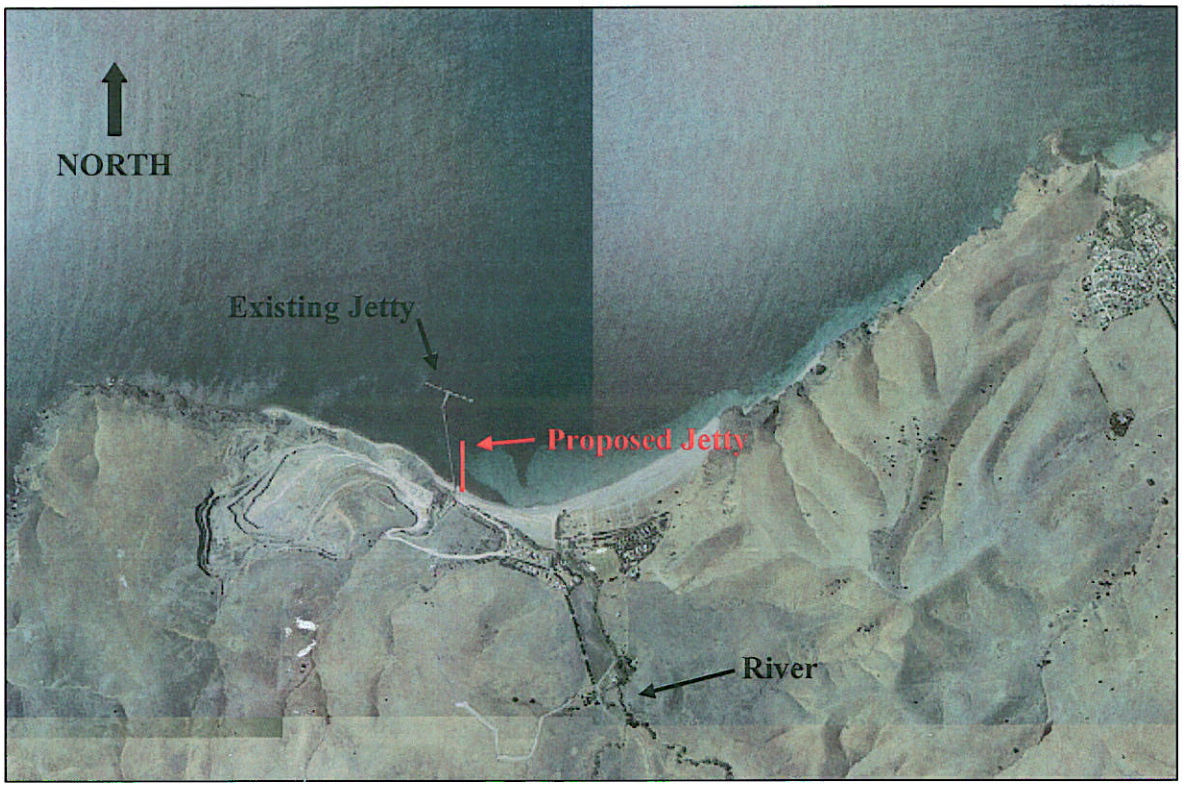

Figure 1 – Aerial photograph of Rapid Bay (2000)

3.2 Geology of the Rapid Bay Area.

The Rapid Bay-Second Valley area is located within the Southern Adelaide Fold-Thrust Belt, on the Fleurieu Peninsula. The lithology of the area consists of the Neoproterozoic Umberatana and Wilpena groups, and the Cambrian Normanville and Kanmantoo Groups. Table 1 below shows a simple stratigraphic column for the Rapid Bay-Second Valley area, and Map 1 shows the distribution of these lithologies. The location of the proposed jetty is also shown on map 1 in Appendix A.

Stratigraphy of the Rapid Bay-Second Valley Area		
Quaternary	Soils	Cover
Cambrian	Kanmantoo Group	Backstairs Passage Fm
		Carrickalinga Head Fm
	Normanville Group	Heatherdale Shale
		Forktree Limestone
		Sellick Hill Limestone
		Wangkonda Limestone
		Mount Terrible Formation
Pre - Cambrian	Wilpena Group	A.B.C. Quartzite
		Brachina Fm
	Umberatana Group	Angepena Fm
		Brighton Limestone
		Tapley Hill Fm

Table 1 - Stratigraphy of the Rapid Bay-Second Valley Area

The proposed new jetty sits in the Forktree Limestone sequence unit which belongs to the Normanville Group. The Forktee Limestone unit has been significantly thickened due to tectonic folding. The unit consist of a massive marble member, and a mottled argillaceous limestone member. The marble unit is a blue colour, with white bands throughout, whilst the limestone unit is a blue grey limestone with bands of grey brown argillaceous material.

The Unit has been intensively deformed in the Rapid Head area. In the south eastern section of the area, the unit is significantly less deformed, with bedding and cleavage more readily observable.

3.3 Results from the 1938 Investigation

Geotechnical drilling was conducted in 1938 over two possible jetty alignments (i.e. No1 Jetty and No2 Jetty). Approximately 22 bore and 19 bores were conducted for No1 Jetty and No2 Jetty respectively. Refer to Drawing S3013 in Appendix B for further details.

The geotechnical investigation for Jetty No1 revealed that approximately for the first 200m from shore, rock (broken or solid) has been encountered at shallow depths (approximately 150mm). Beyond this point the rock is encountered from approximately 1 to 2m depth. The material overlaying the rock generally consists of three layers being alluvial wash, Clayey Sand or Silty Sand and gravel.

A cross–section for the soil profile along Jetty N°1 can be seen in Appendix B, Figures 1.

Pile driving tests were conducted for the existing jetty using a 24 cwt drop weight falling 5 feet. The piles refused at approximately 3.5m depth with a final set of approximately 1 to 2mm per blow. This test indicated that the rock has sufficient bearing capacity. On the other hand the test also suggested that from

approximately 3m onwards, the driving set would start to decrease significantly indicating strong rock and difficult pile driving conditions. It is not known whether the test piles were conducted before or after blasting.

3.4 Construction History of Existing Jetty

The historical research of the existing jetty revealed that the presence of bedrock close to the surface of the seabed slowed progress for the first 183m as drilling and blasting was required before the piles could be driven into the ground.

Piles used in the jetty were either ironbark or turpentine (eucalyptus trees). The diameters of these piles were up to 915mm. For the first 38 bents of the existing jetty piles were driven to a depth of approximately 3.1m into the ground. From this point onwards and including the T-head piles were driven approximately 3.5m into the ground.

4. Design and Construction of the New Jetty

4.1 Jetty Design

One proposal is that the new jetty be constructed using components from Rocla's M-Lock bridge system and that it consists of bents spaced at 12metres. Each bent would be supported by two 610mm diameter circular steel tube piles raked at 1h to 5v. These piles would be driven open ended. It is expected that an embedment of 4 metres into the underlying rock would be sufficient to enable these piles to resist design loads. Questions have been raised as to the suitability of this type of pile for this site. This is discussed below.

4.2 Piled Footings

From the findings of soil investigation and history of the site, i.e. hard rock at shallow depth, careful consideration has to be given to installation of piles. Discussions were held with piling contractors on possible difficulties during driving of piles. These difficulties include:

- Piles can refuse before achieving the required embedment.
- Damage to piles during driving, particularly raked steel tube piles
- Piles going off-line during driving and becoming locked in the leader.

As mentioned above, blasting was used to fracture the rock prior to driving of piles for the existing jetty. **As this site is occupied by several endangered marine species it is unlikely that blasting will be permitted to allow installation of piles for the new jetty.**

If heavy driving is needed to install piles, the use of heavy steel H or box section piles is indicated. It is also considered that there is more likelihood of success in installing these piles if they are driven vertically rather than raked.

4.3 Test Piling

In view of the uncertainty as to which type of pile and method of installation is suited to this site, a test piling program is indicated. One such test piling program is given in the accompanying document "New Rapid Bay Jetty – Brief and Specification for Test Piling".

4.4 Gravity Footing

As this site is underlain by rock, the use of a gravity type footing may be worth exploring.

5. Recommendations

If piled footings are to be used for the proposed jetty, a program of test piling be conducted to determine the most economical type of pile and installation method suited to this site. In addition this program should demonstrate a type of pile and installation method certain to be successful in these conditions, that is, a "backup pile". This test should be performed prior to award of contract for construction of the new jetty.

Prepared:

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5/3/07

Checked:

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5/3/07

References

- "Friends of Rapid Bay Jetty" website and "The Use and Abuse of Jetties – State Government Control in the Construction and Maintenance of Jetties in South Australia" thesis, written by Julie Ford in 1999.

- Thesis *"The Structural Geology of the Rapid Bay – Second Valley Area, Fleurieu Peninsula, South Australia"* Lyon Barrett B.Sc. November 1995. The University of Adelaide, Department of Geology and Geophysics.

- S.A.H.B RAPID BAY – Jetty for B.H.P.C°L^{TD} – Test and Observation Piles Drawing N° 8714/65

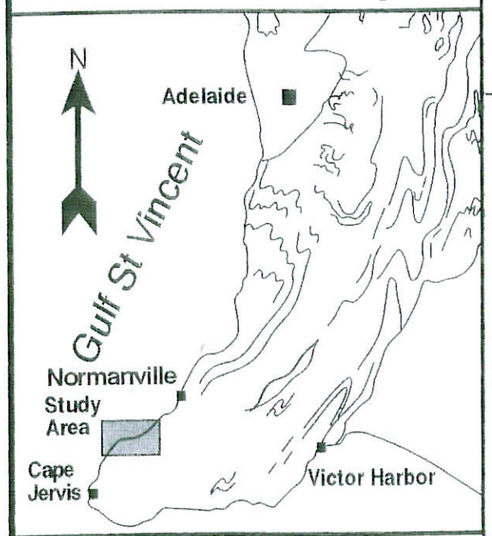
- Survey Rapid Bay – Soundings and Borings, Drawing N° S3013

Appendix A

Geological and Locality Map

Map 1 Geological Map of the Rapid Bay-Second Valley Area

Location Map



Stratigraphy

Quaternary Soils		Cover
Kanmantoo Group		Backstairs Passage Fm
		Carrickalinga Head Fm
Normanville Group		Heatherdale Shale
		Forktree Limestone
		Sellick Hill Limestone
		Wangkonda Limestone
		Mount Terrible Fm
Wilpena Group		A.B.C. Quartzite
		Brachina Fm
Umberatana Group		Angepena Fm
		Brighton Limestone
		Tapley Hill Fm

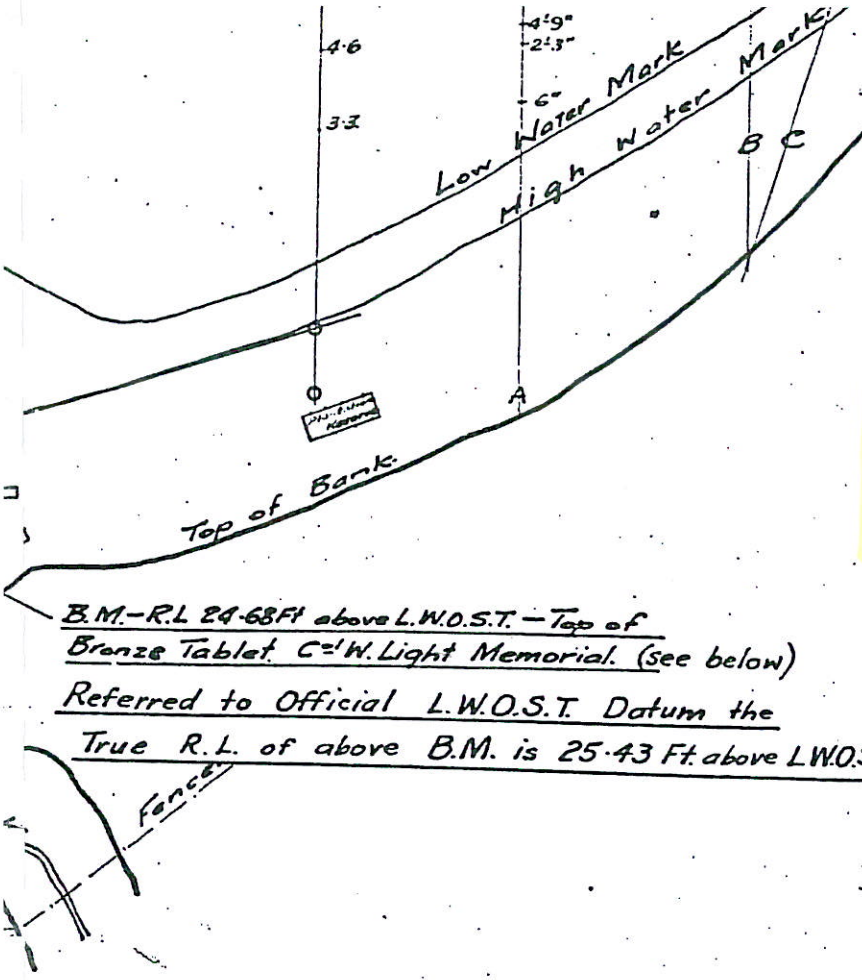
Legend

- Lithological Boundary
- Lithological Boundary (inferred)
- Bedding (S_0)
- Cleavage (S_1)
- Overturned Bedding (S_0)
- Transposed Bedding/Cleavage (S_0 & S_1)
- Intersection Lineation (L^1_0)
- Elongation Lineation (L_1)
- Younging Direction
- Overturned Anticline
- Overturned Syncline
- Fold Plunge direction
- Thrust Fault Surface

2410000mE
0 1 km
Scale
6066000mN
N
Rapid Head Sheared Zone
Mount Rapid Folded Zone
Yohoe Creek Thrust Sheet
2410000mE
6059500mN
Rapid Head
EXISTING JETTY
PROPOSED NEW JETTY
Rapid Bay
Rapid Bay Thrust
A
B
B'
C
Second Valley
2475000mE
6066000mN
Randalsea
To Normanville
Yohoe Creek Thrust
River Yangolinga
No Where Else Creek
Yohoe/Stockyards Creek
A'
Delamere
To Cape Jervis
6059500mN
2475000mE

Appendix B

Jetty N°1 – Drilling Record & Soil Profile Cross Section



B.M.–R.L 24·68 Ft above L.W.O.S.T.–Top of Bronze Tablet C.W. Light Memorial. (see below)

Referred to Official L.W.O.S.T. Datum the True R.L. of above B.M. is 25·43 Ft. above L.W.O.S.T.

14:2:39

H.B. DATUM NOW OFFICIALLY RECOGNISED
CORRECT L.W.O.S.T.
RTRACT 9 INS. FROM ALL SOUNDINGS.

Revision :- Soundings and contours extended eastward 10-11-38 along lines A, B & C.

Jetty to be built shown. 27-3-40 W.O.B

DRILLING. RECORD.

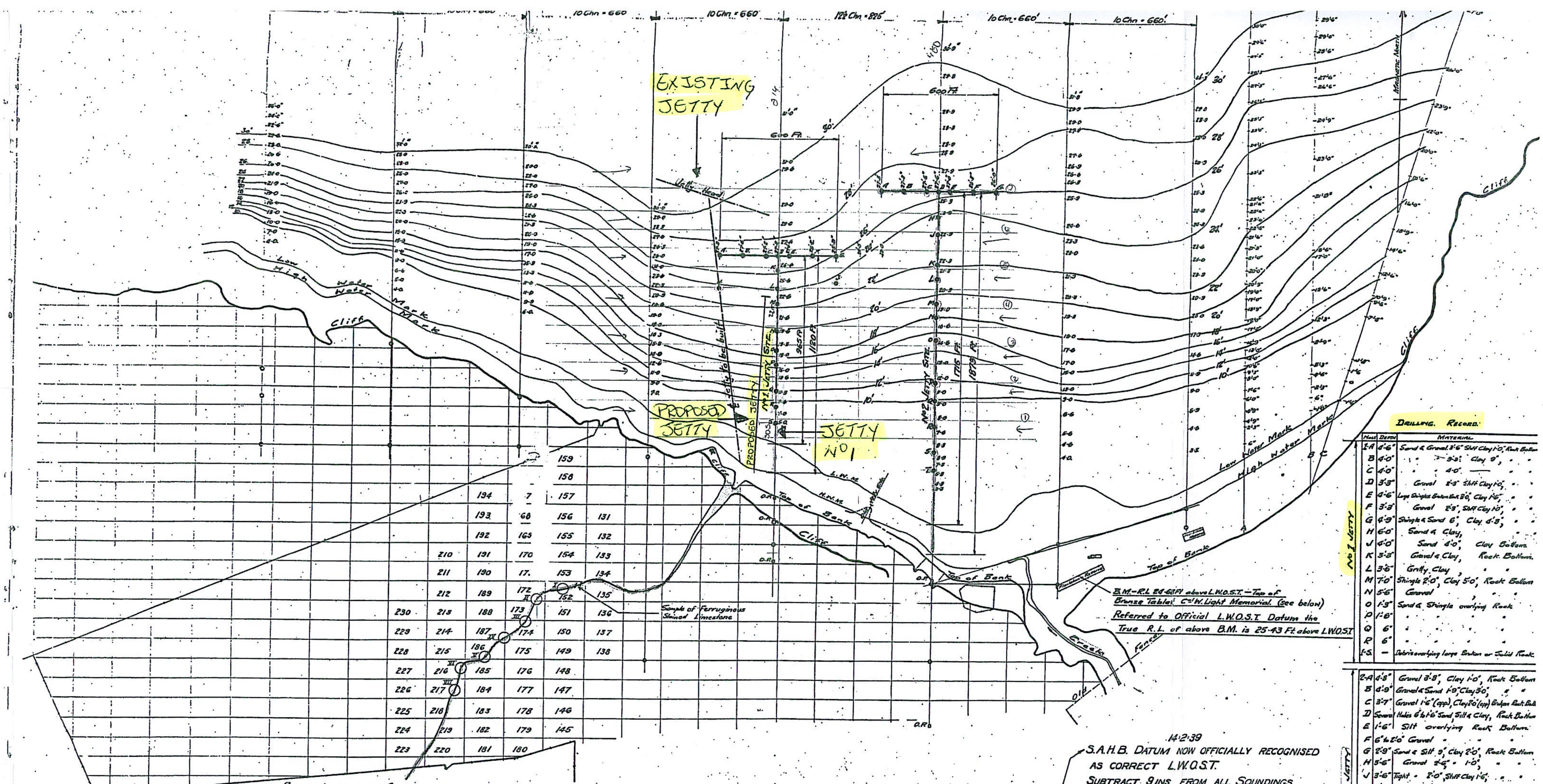
	Hole	Depth	Material
No 1 Jetty	1-A	4'-6"	Sand & Gravel 3'-6" Stiff Clay 1'-0" Rock Bottom
	B	4'-0"	" " 3'-3" Clay 9", " "
	C	4'-0"	" " 4'-0" —— " "
	D	3'-3"	Gravel 2'-3" Stiff Clay 1'-0", " "
	E	4'-6"	Large Shingles Broken Rock 3'-0", Clay 1'-6", " "
	F	3'-3"	Gravel 2'-3", Stiff Clay 1'-0", " "
	G	4'-9"	Shingle & Sand 6", Clay 4'-3", " "
	H	6'-0"	Sand & Clay, " "
	J	4'-0"	Sand 4'-0", Clay Bottom.
	K	3'-3"	Gravel & Clay, Rock Bottom.
	L	3'-6"	Gritty Clay, " "
	M	7'-0"	Shingle 2'-0", Clay 5'-0", Rock Bottom
	N	5'-6"	Gravel " "
	O	1'-3"	Sand & Shingle overlying Rock
	P	1'-6"	" " " "
	Q	6"	" " " "
	R	6"	" " " "
	1-S.	—	Debris overlying large Broken or Solid Rock.
No 2. Jetty	2-A	4'-8"	Gravel 3'-8", Clay 1'-0", Rock Bottom
	B	4'-9"	Gravel & Sand 1'-9", Clay 3'-0", " "
	C	3'-7"	Gravel 1'-6" (app), Clay 2'-0" (opt) Broken Rock Bott
	D	Several	Holes 6" to 1'-6" Sand, Silt & Clay, Rock Bottom
	E	1'-6"	Silt overlying Rock Bottom.
	F	6" to 2'-0"	Gravel " " "
	G	2'-9"	Sand & Silt 9", Clay 2'-0", Rock Bottom
	H	3'-6"	Gravel 2'-6" & 1'-0", " "
	J	3'-6"	Tight & 2'-0", Stiff Clay 1'-6", " "
	K	2'-2"	Shingle 1'-8", Clay 6", " "
	L	2'-7"	Rough Gravel overlying Rock
	M	1'-6"	Shingle " "
	N	1'-8"	Broken Rock overlying Solid Rock
	O	2'-3"	Broken Rock - Drill bottomed in large Broken or Solid Rock
	P	2'-0"	Broken Rock overlying Rock
	Q	6"	" " " "
	R	1'-0"	" " " "
	S	6"	" " " "
	2-T.	6"	Sand overlying large Broken or Solid Rock.

REFERENCE DRAWING NO

3014 SECTIONS PROPOSED JETTY SITES AND CURRENTS.

SURVEY RAPID BAY	
SOUNDINGS & BORINGS.	
B. H. P. Co. Ltd. WHYALLA. S.A.	
Scale 1" = 200 Ft.	18. 1. 38
Drawn. C.F.T.	
Traced. W.B.M	

DRG No S3013



— Bulk Limestone Sample —

Equal Amounts of Stone quarried from Benches I to VII shown above. Parcel weighed 810 tons, Shipped from Second Valley 25-5-38 per S.S. "Kapara"; Unloaded at Newcastle 31-5-38.

Laboratory Report (see Newcastle Letter 10-6-38)

Mineral	Bulk Analysis of Stone in Stock Pile at Newcastle	Bench Samples: Size – Minus 6" Plus ¾" I	II	III	IV	V	VI	VII	Size – Minus ¾" I	II	III	IV	V	VI	VII	Sample of Ferruginous Stained Stone
Calcium Oxide CaO	47·64	43·22	44·58	50·28	47·40	49·06	48·70	46·66	39·52	41·24	49·90	44·24	46·33	48·24	44·84	49·00
Magnesium Oxide MgO	4·61	7·74	7·24	2·78	5·76	3·62	4·12	2·17	9·14	9·10	3·24	7·77	3·70	4·05	2·55	0·50
Iron Oxide Fe_2O_3	0·52	2·02	0·59	0·28	0·40	0·70	0·48	0·81	3·03	0·84	0·51	0·46	2·07	0·51	1·11	2·07
Aluminium Oxide Al_2O_3	1·52	1·65	1·38	1·16	1·20	1·29	1·32	2·79	1·89	1·56	1·03	1·34	1·53	1·25	3·33	1·57
Manganese Oxide MnO	0·22	0·34	0·25	0·16	0·27	0·22	0·22	0·11	0·34	0·24	0·28	0·28	0·33	0·20	0·05	0·45
Silica SiO_2	3·60	3·40	4·28	2·24	3·00	3·30	3·44	9·24	4·94	5·14	2·56	3·28	3·20	3·72	10·22	7·62
Ignition Loss	41·25	41·53	41·53	43·13	41·84	41·70	41·65	37·92	41·07	41·70	42·20	42·45	41·95	41·74	37·68	38·64
Insoluble		5·58	6·30	3·80	5·46	5·48	5·54	13·90	7·06	7·34	4·22	5·30	5·12	6·00	15·24	10·00

Traces of Lead (Pb) present. Sample No V Minus ¾" contained 0·67% Pb.

Sample No S.1307 ... Analysis of Samples taken over the whole Limestone Outcrop in April 1926

Drilling Record.

	Hole	Depth	Material
No 1 Jetty	1-A	4'-6"	Sand & Gravel 3'-6" Stiff Clay 1'-0", Rock Bottom
	B	4'-0"	" " 3'-3" Clay 9", " "
	C	4'-0"	" " 4'-0" — " "
	D	3'-3"	Gravel 2'-3" Stiff Clay 1'-0", " "
	E	4'-6"	Large Shingle Broken Rock 3'-0", Clay 1'-6", " "
	F	3'-3"	Gravel 2'-3", Stiff Clay 1'-0", " "
	G	4'-9"	Shingle & Sand 6", Clay 4'-3", " "
	H	6'-0"	Sand & Clay, " "
	J	4'-0"	Sand 4'-0", Clay Bottom
	K	3'-3"	Gravel & Clay, Rock Bottom.
	L	3'-6"	Gritty Clay, " "
	M	7'-0"	Shingle 2'-0", Clay 5'-0", Rock Bottom
	N	5'-6"	Gravel, " "
	O	1'-3"	Sand & Shingle overlying Rock
	P	1'-6"	" " " "
	Q	6"	" " " "
	R	6"	" " " "
	1-S.	—	Debris overlying large Broken or Solid Rock
No 2 Jetty	2-A	4'-8"	Gravel 3'-8", Clay 1'-0", Rock Bottom
	B	4'-9"	Gravel & Sand 1'-9", Clay 3'-0", " "
	C	3'-7"	Gravel 1'-6" (app), Clay 2'-0" (app) Broken Rock Bott
	D	Several	Holes 6" to 1'-6" Sand, Silt & Clay, Rock Bottom
	E	1'-6"	Silt overlying Rock Bottom.
	F	6" to 2'-0"	Gravel " " "
	G	2'-9"	Sand & Silt 9", Clay 2'-0", Rock Bottom
	H	5'-6"	Gravel 4'-6" " 1'-0", " "
	J	3'-6"	Tight " 2'-0", Stiff Clay 1'-6", " "
	K	2'-2"	Shingle 1'-8", Clay 6", " "
	L	2'-7"	Rough Gravel overlying Rock
	M	1'-6"	Shingle " "
	N	1'-8"	Broken Rock overlying Solid Rock
	O	2'-8"	Broken Rock – Drill bottomed in large Broken or Solid Rock
	P	2'-0"	Broken Rock overlying Rock
	Q	6"	" " " "
	R	1'-0"	" " " "
	S	6"	" " " "
	2-T.	6"	Sand overlying large Broken or Solid Rock.

14·2·39
S.A.H.B. DATUM NOW OFFICIALLY RECOGNISED AS CORRECT L.W.O.S.T.
SUBTRACT 9 INS. FROM ALL SOUNDINGS.

Drill Holes in Sea Bed shown thus. :— ●

Survey Pegs established Jany 1938, shown thus ⊢ o

Jetty Site Observation Posts. shown thus :— □ O.R

Soundings & Sounding Contours shown in Feet below L.W.O.S.T. level

Mean Low Water Level established in 1926 is 0·50 Ft above L.W.O.S.T.

Note:– 10-11-38 S.A.H.B. datum for soundings at this date is 9" lower than L.W.O.S.T. on this drawing.

1" = 200 Ft

1" = 3·03 Chn. = 200 Ft

Revision:– Soundings and contours extended eastward 10-11-38 along lines R.B.&C.

Jetty to be built shown. 27-3-40 W.O.B

Reference Drawing No

S 5014 Sections Proposed Jetty Sites and Currents.

SURVEY RAPID BAY	
SOUNDINGS & BORINGS	
B. H. P. Co. Ltd. WHYALLA. S.A.	
Scale 1" = 200 Ft	18. 1. 38
Drawn. C.F.T.	Drg No S3013c
Traced. W.B.M	

Jetty N° 1

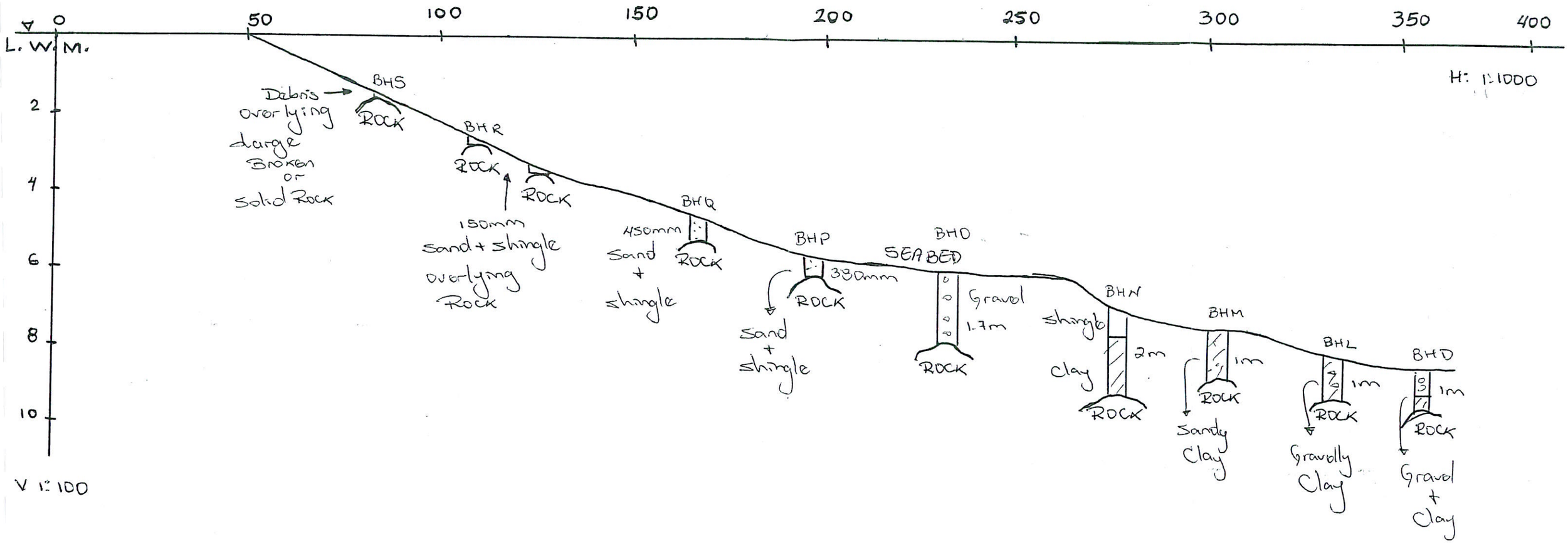


Figure 1 – Soil Profile along Jetty N° 1
(From 1938 Report)

Scale
V 1:100
H 1:1000