ANNEX J

Groundwater Report

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

12 November 2007

Fagan Mather & Duggan Pty Ltd
2/29 Shearwater Drive
TAYLORS BEACH NSW 2318

Attention: Andrew Daly

Dear Andrew

RE: PROPOSED DEVELOPMENT
FERN BAY SEASIDE VILLAGE SUBDIVISION
HYDROGEOLOGICAL ASSESSMENT

Since 1992 various studies have been carried out to assess the potential impact of the proposed development on the groundwater.

- Coffey Partners International Pty Ltd – Project 3087 Water Resources Division 'Fern Bay Engineering Study Stage 1 Report', June 1992;
- Coffey Partners International Pty Ltd – N5904/1-AC 'Assessment of Groundwater Quality and Acid Sulfate Soils', January 1996;
- Coffey Partners International Pty Ltd – N5904/2-AC 'Additional Geotechnical Work, July 1996;
- Douglas Partners Pty Ltd – 1998 – Geotechnical Investigation;
- RCA Australia Pty Ltd – 2006 – Geotechnical Investigation Entry Road;
- Parsons Brinkerhoff – 2006 – Geotechnical Investigation for Subdivision.

These studies assessed the underlying geological profile, soil types and their capacity to infiltrate rain water and runoff water from the area into the aquifer and monitored natural variations in groundwater levels, groundwater movement and chemistry.

These studies were then used by Urban Water Cycle Solutions to develop an urban Water Cycle Management Strategy. This comprehensive study incorporates water sensitive urban design features and philosophy and produces a strategy for implementation of these philosophies. Reference should be made to the report and in particular the outcome of WSUD treatment of water inputs and the zero impact upon existing aquifer and groundwater levels.

The WSUD have been incorporated into the design and as a result no overall change in groundwater level and chemistry is expected.

Due to the construction of sealed surfaces such as roads, houses, driveways which intercepts the direct precipitation into the aquifer some local variations in groundwater would be expected, but this is balanced by increased infiltration in the grass swales and infiltration areas. Due to the large lateral extent and depth of the aquifer these local variations are not expected to have any significant effect on the aquifer and groundwater levels are expected to remain within the normal existing levels.

To confirm this conclusion the client has recently commissioned Coffey to install seven (7) piezometers located throughout the area, but concentrating on the infiltration pond areas, these piezometers will allow monitoring of the groundwater levels during and after development of the subdivision. These bores will be installed on about 19 November 2007 well before the start of site works associated with construction of the subdivision.

The subdivision has been carefully designed using WSUD principals and thus should have no significant impact on the groundwater beneath this site. The installation of monitoring wells will allow confirmation of the success of these designs.

If you have any questions regarding this matter please contact Jason Lee or the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd

Arthur Love

Principal Geotechnical Engineer

Attachments:

Important Information about your Coffey Report

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

CMPS & F Pty Ltd

Howship Holdings

PROPOSED DEVELOPMENT
FERN BAY
ADDITIONAL GEOTECHNICAL WORK

Report No. N5904/2-AC July 1996

Coffey Partners International Pty Ltd
A.C.N. 003 692 019

Consulting Engineers, Managers and Scientists
Environment • Geotechnics • Mining • Water Resources

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A.C.N. 003 692 019

Consulting Engineers, Managers and Scientists
Environment • Geotechnics • Mining • Water Resources

N5904/2-AC SRM:KLW
3 July 1996

13 Mangrove Road
Sandgate NSW 2304
Australia

Fax (049) 67 5402
Telephone (049) 67 6377

CMPS & F Pty Ltd
67 Albert Avenue
CHATSWOOD NSW 2067

Attention: Mr Michael Grey

Dear Sir

RE: PROPOSED DEVELOPMENT - FERN BAY
ADDITIONAL GEOTECHNICAL WORK

Please find enclosed our report on additional geotechnical work carried out on the Fern Bay Development site. The work is supplementary to a previous geotechnical assessment carried out in late 1995 and reported in our Report No. N5904/1-AC.

If you have any questions regarding this matter please contact Mr Arthur Love or the undersigned.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

STEVEN MORTON

TABLE OF CONTENTS

1.0 INTRODUCTION

This report describes geotechnical studies carried out for CMPS & F Pty Ltd on behalf of Howship Holdings Pty Ltd, on the site of the proposed Fern Bay Development. The work was commissioned by Mr Michael Grey of CMPS & F Pty Ltd.

The work described herein is supplementary to a previous assessment (Ref. N5904/1-AC, January 1996) which addressed groundwater quality and acid sulphate soil potential at the site. The aim of the work described herein was to:-

- Provide information on groundwater quality beneath the central areas of the site.
- Make an assessment of infiltration rates through the ground surface and at depths of about 1.5m.

The above information is required to assist in the design of the proposed stormwater drainage system which involves infiltration to the subsurface profile.

2.0 SCOPE OF WORK

Field work was carried out on 5, 21 and 22 June 1996 and involved the following:-

- Sampling and testing of groundwater from three boreholes (CMPS13, CMPS14 and CMPS15) drilled using a bobcat mounted drilling rig equipped with hollow stem augers.
- Testing of surface infiltration rates using a double ring infiltrometer. Six tests were carried out over three different surface types - two on natural vegetation, two on bare surfaces and two on turf. The tests were carried out in accordance with Test Method ASTM D3385-75 using a potable water supply.
- Testing of infiltration rates over a depth interval of 1.3m to 1.6m using falling head permeability tests in a 50mm diameter PVC casing, installed using hand auger methods.

Borehole logs are presented in Appendix A, together with explanation sheets defining terms and symbols used in their preparation. The infiltration test results are presented in Appendix B. Borehole and test locations are shown on Drawing No. N5904/2-1.

Groundwater samples were tested in the field for the following parameters:-

- Temperature
- Conductivity
- pH
- Dissolved oxygen

Samples were also submitted to NATA registered chemical laboratories for the following analyses:-

- Total Organic Carbon
- Total Dissolved Carbon
- Total Dissolved Salts
- Nitrate
- Total Phosphorous
- Alkalinity as $CaCO_3$

Laboratory test results are presented in Appendix C.

3.0 GROUNDWATER QUALITY

3.1 Results

Groundwater parameters measured in the field are summarised in Table 1.

TABLE 1 - GROUNDWATER FIELD PARAMETERS

BORE No.	TOTAL DEPTH (m)	DEPTH TO WATER (m)	SURFACE RL (m, AHD)	WATER LEVEL (m, AHD)	TEMP (°C)	PH	CONDUCTIVITY (µS/cm)	DISSOLVED OXYGEN (ppm)
CMPS13	6.0	3.8	5.6	1.8	18.7	4.9	400	0
CMPS14	7.3	4.95	6.0	1.05	19.2	5.0	300	0
CMPS15	4.5	1.55	2.5	0.95	19.4	4.7	200	0

Laboratory results are summarised in Table 2, in comparison with water quality criteria.

TABLE 2 - SUMMARY OF LABORATORY RESULTS
(all in mg/L other than conductivity and pH)

ANALYTE	ANZECC CRITERIA (Ref. 1 and 2)		IRRIGATION WATER (Ref. 2)	CMPS13	CMPS14	CMPS15
	Drinking Water	Aquatic Ecosystems				
LABORATORY						
Total Organic Carbon	0.05	xx	-	0.78	0.65	1.9
Total Dissolved Salt	-	-	0 - 500	210	175	110
Nitrate	10	xx	-	1.1	0.27	0.22
Total Phosphorus	0.05	xx	-	0.19	0.16	0.34
Alkalinity as $CaCO_3$	500	xx	-	<1	<1	<1
FIELD						
pH	6.5 - 8.5	6.5 - 8.5	4.5 - 9.0	4.9	5.0	4.7
Dissolved Oxygen	6.5	6	-	0	0	0
Conductivity (µS/cm)	-	-	0 - 800	400	300	200

xx = Acceptable levels dependent on background levels within the aquatic ecosystem.

3.2 Discussion

The results attached herein, in conjunction with those presented in Report No. N5904/1-AC, provide information on the background water quality for groundwater contained in the unconfined sand aquifer beneath the Fern Bay site.

The results show a general agreement with those presented in the earlier report and indicate the groundwater within the aquifer to be slightly acid, of low to medium salinity and with a high organic content.

As shown by Table 2, the groundwater beneath the Fern Bay site does not meet the criteria for a potable water supply in its present state, due to low pH, high organic carbon and high phosphorus concentrations.

As for the samples described in the previous report, the results indicate the water to be generally suitable for irrigation provided irrigation rates, irrigation methods and crop selection take into account salinity levels which vary across the site.

4.0 INFILTRATION TEST RESULTS

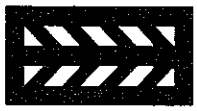
The results of double ring infiltrometer and falling head permeability tests carried out on the site are presented in Appendix B. Infiltration rates calculated from the results are presented in Table 3.

TABLE 3 - SUMMARY OF INFILTRATION RATES (from results in Appendix B)

TEST No.	LOCATION	TYPE	DEPTH TO WATER TABLE (m)	INFILTRATION RATE (cm/hour)
1	Adjacent to CMPS3	Natural vegetation on loose sand. (DRI)	2.72	81
2	Adjacent to CMPS3	Bare surface of fine grained medium dense to dense sand. (DRI)	2.72	32
3	Adjacent to CMPS5	Natural vegetation on loose to medium dense sand. (DRI)	1.1	43
4	Adjacent to CMPS5	Bare surface with fine grained medium dense to dense sand. (DRI)	1.1	0.54
5	Adjacent to nearby Caravan Park	Turf, low lying area. (DRI)	1.0	17
6	Adjacent to nearby Golf Course	Turf, elevated dunal area. (DRI)	1.5	39
7	Adjacent to CMPS3	Sand, 1.3m to 1.6m below surface. (FH)	2.72	67
8	Adjacent to CMPS6	As above. (FH)	3.0	46

Note: DRI represents double ring infiltrometer test.
FH represents falling head test.

The results indicate high infiltration rates on currently vegetated areas of the site and at depth within the existing sand. Lower infiltration rates were obtained on the and turfed areas of the site. Such



results are typical for sandy sites and are attributable to the trafficking of the surface and the higher proportion of fines which accumulate in a topsoiled and turfed surface in comparison with natural sand deposits

Infiltration rates on bare sand surfaces were also significantly lower than corresponding naturally vegetated areas. Such results are not uncommon and may be attributable to the densification of the upper surface of the sand which occurs during inundation by water.

The infiltration rates presented should be taken into account when designing stormwater disposal systems for the proposed development.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report:

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation, or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership; or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts.Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

Coffey Partners International Pty Ltd
Incorporated in NSW

descriptive terms soil and rock

COFFEY

Explanation Sheet 1

SOIL DESCRIPTIONS

Classification of Material based on Unified Classification System (refer SAA Site Investigation Code AS1726–1975 Add. No. 1 Table D1).

Moisture Condition based on appearance of soil

dry	Looks and feels dry; cohesive soils usually hard, powdery or friable, granular soils run freely through hands.
moist	Soil feels cool, darkened in colour; cohesive soils usually weakened by moisture, granular soils tend to cohere, but one gets no free water on hands on remoulding.
wet	Soil feels cool, darkened in colour; cohesive soils weakened, granular soils tend to cohere, free water collects on hands when remoulding.

Consistency based on unconfined compressive strength (Qu) (generally estimated or measured by hand penetrometer).

term	very soft	soft	firm	stiff	very stiff	hard
Qu kPa	25	50	100	200	400	

If soil crumbles on test without meaningful result, it is described as **friable.**

Density Index (generally estimated or based on penetrometer results).

term	very loose	loose	medium dense	dense	very dense
density index I_D %	15	35	65	85	

ROCK DESCRIPTIONS

Weathering based on visual assessment

term	criterion
Fresh:	Rock substance unaffected by weathering.
Slightly Weathered:	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Moderately Weathered:	Rock substance affected by weathering to the extent that staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Highly Weathered:	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and signs of chemical or physical decomposition of individual minerals are usually evident. Porosity and strength may be increased or decreased when compared to the fresh rock substance, usually as a result of the leaching or deposition of iron. The colour and strength of the original fresh rock substance is no longer recognisable.
Extremely Weathered:	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.

Strength based on point load strength index, corrected to 50 mm diameter - Is(50) (refer I.S.R.M., Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1). (Generally estimated: x indicates test result).

classification	extremely low	very low	low	medium	high	very high	extremely high
Is (50) MPa	0.03	0.1	0.3	1	3	10	

The unconfined compressive strength is typically about 20 x I_{S50} but the multiplier may range, for different rock types, from as low as 4 to as high as 30.

Defect Spacing

classification	extremely close	very close	close	medium	wide	very wide	extremely wide
spacing m	0.03	0.1	0.3	1	3	10	

Defect description uses terms contained on AS1726 table D2 to describe nature of defect (fault, joint, crushed zone, clay seam (etc.) and character (roughness, extent, coating etc.):

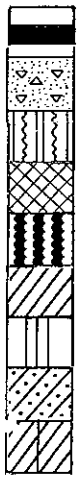
Coffey Partners International Pty Ltd
ACN 003 692 019

graphic symbols soil and rock

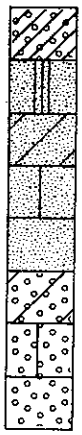
COFFEY

Explanation Sheet 2

SOIL



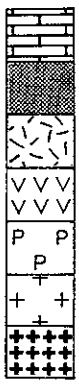
- Asphaltic Concrete or Hotmix
- Concrete
- Topsoil
- Fill
- Peat, Organic Clays and Silts (Pt, OL, OH)
- Clay (CL, CH)
- Silt (ML, MH)
- Sandy Clay (CL, CH)
- Silty Clay (CL, CH)



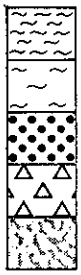
- Gravelly Clay (CL, CH)
- Sandy Silt (ML)
- Clayey Sand (SC)
- Silty Sand (SM)
- Sand (SP, SW)
- Clayey Gravel (GC)
- Silty Gravel (GM)
- Gravel (GP, GW)

ROCK

- Claystone (massive)
- Siltstone (massive)
- Shale (laminated)
- Sandstone (undifferentiated)
- Sandstone, fine grained
- Sandstone, coarse grained
- Conglomerate



- Limestone
- Coal
- Dolerite, Basalt
- Tuff
- Porphyry
- Granite
- Pegmatite



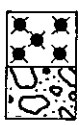
- Schist
- Gneiss
- Quartzite
- Talus
- Alluvium

SEAMS

- Seam >0.1 m thick (on a scale 1:50)
- Seam 0.01 m to 0.1 m thick (on a scale 1:50)

INCLUSIONS (Special purposes only)

- Rock Fragments
- Swamp



- Ironstone Gravel, Laterite
- Shale Breccia in Sandstone

Water Level

Surfaces ——— Known Boundary | — — — Probable Boundary | ——?——? Possible Boundary

T78 - 105

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: CMPS13
sheet 1 of 2

office job no: N5904/2

client:	CMPS & F PTY LTD	hole commenced:	05-06-96
principal:	HOWSHIP HOLDINGS	hole completed:	05-06-96
project:	FERN BAY DEVELOPMENT	logged by:	SRM
borehole location:	SEE DRAWING N5904/2-1	checked by:	SAM
drill model and mounting:	BOBCAT DRILL	slope: -90 DEG	R.L.Surface: 5.6 m
hole diameter:	100mm	bearing:	datum: AHD

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
		Nil			5		SP	SAND: fine to medium grained, dark grey-grey, some roots in top 0.3m.	M	MD / D		AEOLIAN SAND
					1		SP	SAND: fine to medium grained, light grey, little or no fines				AEOLIAN SAND
					4							
					2							
					3							
					3							
					2		SP	SAND: fine to medium grained, dark brown,	W	VD		SLIGHTLY INDURATED SAND. Water temperature 18.4 degrees
					4							

COFBORE VERSION 83 — 3/7/96 14:16:16 — MO1

METHOD
- AS auger screwing*
- AD auger drilling*
- RR roller/tricone
- W washbore
- CT cable tool
- HA hand auger
- DT diatube
- *bit shown by suffix
- B blank bit
- V V bit
- T TC bit
- e.g. ADT

SUPPORT
- Nil no support
- M mud
- C casing

PENETRATION 1 2 3 4 — little resistance ranging to very slow progress

WATER
- * not measured
- 0 none observed
- water level
- water outflow
- water inflow

SAMPLES, TESTS, ETC
- U undisturbed sample (mm)
- D disturbed sample
- Bs bulk sample
- E environmental sample
- N standard penetration test
- Nk SPT + sample recovered
- Nc SPT with solid cone
- VS vane shear
- PM pressuremeter
- DP dynamic penetrometer
- WS water sample
- PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

CONSISTENCY/DENSITY INDEX
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: CMPS13
sheet 2 of 2

office job no: N5904/2

client:	CMPS & F PTY LTD	hole commenced:	05-06-96
principal:	HONSHIP HOLDINGS	hole completed:	05-06-96
project:	FERN BAY DEVELOPMENT	logged by:	SRM
borehole location:	SEE DRAWING N5904/2-1	checked by:	SRM
drill model and mounting:	BOBCAT DRILL	slope: -90 DEG	R.L. Surface: 5.6 m
hole diameter:	100mm	bearing:	datum: AHD

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
					5.6		SP	SAND: fine to medium grained, dark brown,		VD		SLIGHTLY INDURATED SAND
					1							
					5							
					0							
					6							
								Borehole CMPS13 Terminated at 6.00 m				
					-1							
					7							
					-2							
					8							

METHOD
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
*bit shown by suffix
B blank bit
V V bit
T TC bit
e.g. ADT

SUPPORT
Nil no support M mud
C casing
PENETRATION 1 2 3 4
little resistance
ranging to
very slow progress
WATER
* not measured O none observed
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
N standard penetration test:
Nx SPT + sample recovered
Nc SPT with solid cone
VS vane shear
PM pressuremeter
DP dynamic penetrometer
WS water sample
PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

CONSISTENCY/DENSITY INDEX
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: CMPS14
sheet 1 of 2

office job no: N5904/2

client:	CMPS & F PTY LTD	hole commenced:	05-06-96
principal	HOWSHIP HOLDINGS	hole completed:	05-06-96
project:	FERN BAY DEVELOPMENT	logged by:	SRM
borehole location:	SEE DRAWING N5904/2-1	checked by:	SRM
drill model and mounting:	BOBCAT DRILL	slope: -90 DEG	R.L.Surface: 6.0 m
hole diameter:	100mm	bearing:	datum: AHD

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
		NIL			6		SP	SAND: fine to medium grained, dark grey.	M	MD / D		AEOLIAN SAND
							SP	SAND: fine to medium grained, light grey-white.				AEOLIAN SAND
					5 1							
					4 2							
							SP	SAND: fine to medium grained, light brown-brown				AEOLIAN SAND BANDS OF SLIGHT INDURATION
					3 3							
					2 4							

METHOD
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
*bit shown by suffix
B blank bit
V V bit
T TC bit
e.g. AD/T

SUPPORT
Nil no support M mud
C casing

PENETRATION
1 2 3 4
1 little resistance
2 ranging to
3 very slow progress
4

WATER
¥ not measured 0 none observed
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
N standard penetration test:
N* SPT + sample recovered
Nc SPT with solid cone
VS vane shear
PM pressuremeter
DP dynamic penetrometer
WS water sample
PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

CONSISTENCY/DENSITY INDEX
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: CMPS14
sheet 2 of 2

office job no: N5904/2

client:	CMPS & F PTY LTD	hole commenced:	05-06-96
principal:	HOWSHIP HOLDINGS	hole completed:	05-06-96
project:	FERN BAY DEVELOPMENT	logged by:	SAM
borehole location:	SEE DRAWING N5904/2-1	checked by:	SAM
drill model and mounting:	BOBCAT DRILL	slope: -90 DEG	R.L.Surface: 6.0 m
hole diameter:	100mm	bearing:	datum: AHD

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
					2		SP	SAND: fine to medium grained, light brown-brown.		D		AEOLIAN SAND BANDS OF SLIGHT INDURATION
			▽		1 5			As above but more heavily indurated.				Water temperature 19.2 degrees
					0 6							
					-1 7							
								Borehole CMPS14 Terminated at 7.30 m				
					-2 8							

METHOD
- AS auger screwing*
- AD auger drilling*
- RR roller/tricone
- W washbore
- CT cable tool
- HA hand auger
- DT diatube
- *bit shown by suffix
- B blank bit
- V V bit
- T TC bit
- e.g. ADT

SUPPORT
- Nil no support
- M mud
- C casing

PENETRATION
1 2 3 4 — little resistance ranging to very slow progress

WATER
- * not measured
- D none observed
- ▽ water level
- water outflow
- water inflow

SAMPLES, TESTS, ETC
- U undisturbed sample (mm)
- D disturbed sample
- Bs bulk sample
- E environmental sample
- N standard penetration test
- N* SPT + sample recovered
- Nc SPT with solid cone
- VS vane shear
- PM pressuremeter
- DP dynamic penetrometer
- WS water sample
- PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

CONSISTENCY/DENSITY INDEX
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

COFBORE VERSION 03 — 3/7/96 14:20:5 — A01

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: CMPS15
sheet 1 of 2

office job no: N5904/2

client:	CMPS & F PTY LTD	hole commenced:	05-06-96
principal:	HOWSHIP HOLDINGS	hole completed:	05-06-96
project:	FERN BAY DEVELOPMENT	logged by:	SAM
borehole location:	SEE DRAWING N5904/2-1	checked by:	SRM
drill model and mounting:	BOBCAT DRILL	slope: -90 DEG	R.L. Surface: 2.5 m
hole diameter:	100mm	bearing:	datum: AHD

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
		Nil			2		SP	SAND: fine to medium grained, dark grey.	M	MD		AEOLIAN SAND
					1		SP	SAND: fine to medium grained, light grey-white.				AEOLIAN SAND
			▽		0		SP	SAND: fine to medium grained, brown.				AEOLIAN SAND
					-1							
					4							

METHOD
- AS auger screwing*
- AD auger drilling*
- RR roller/tricone
- W washbore
- CT cable tool
- HA hand auger
- DT diatube
- *bit shown by suffix
- B blank bit
- V V bit
- T TC bit
- e.g. ADT

SUPPORT
- Nil no support
- M mud
- C casing

PENETRATION
1 2 3 4 — little resistance ranging to very slow progress

WATER
- * not measured
- 0 none observed
- ▽ water level
- water outflow
- water inflow

SAMPLES, TESTS, ETC
- U undisturbed sample (mm)
- D disturbed sample
- Bs bulk sample
- E environmental sample
- N standard penetration test
- N* SPT + sample recovered
- Nc SPT with solid cone
- VS vane shear
- PM pressuremeter
- DP dynamic penetrometer
- WS water sample
- PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

CONSISTENCY/DENSITY INDEX
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

COFBORE VERSION B3 W01 56 14.21 3/ 7/96 187

Coffey Partners International Pty. Ltd.
ACN 003 692 019

engineering log - borehole

borehole no: CMPS15
sheet 2 of 2

office job no: N5904/2

client:	CMPS & F PTY LTD	hole commenced:	05-06-96
principal:	HOWSHIP HOLDINGS	hole completed:	05-06-96
project:	FERN BAY DEVELOPMENT	logged by:	SAM
borehole location:	SEE DRAWING N5904/2-1	checked by:	SAM
drill model and mounting:	BOBCAT DRILL	slope:	-90 DEG
hole diameter:	100mm	bearing:	
R.L.Surface:	2.5 m		
datum:	AHD		

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics; colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
					2		SP	SAND: fine to medium grained, brown.		MD		AEOLIAN SAND
								Borehole CMPS15 Terminated at 4.50 m				

METHOD
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
*bit shown by suffix
B blank bit
V V bit
T TC bit
e.g. ADT

SUPPORT
Nil no support M mud
C casing

PENETRATION
1 2 3 4
1 little resistance
2 ranging to
3 very slow progress

WATER
* not measured 0 none observed
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
N standard penetration test
Nx SPT + sample recovered
Nc SPT with solid cone
VS vane shear
PM pressuremeter
DP dynamic penetrometer
WS water sample
PZ piezometer

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

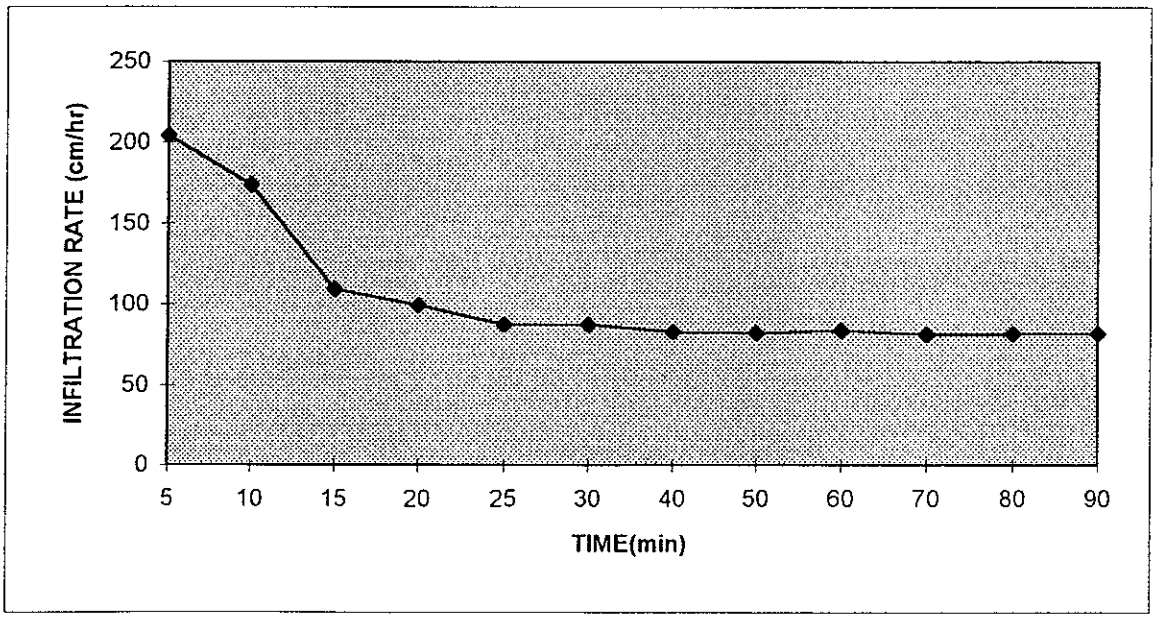
CONSISTENCY/DENSITY INDEX
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Client: CMPS&F PTY. LTD. Job No. N5904/2
Principal: HOWSHIP HOLDINGS PTY LTD By: SRM
Project: FERN BAY DEVELOPMENT
Location: FERN BAY

TEST RESULTS - DOUBLE RING INFILTROMETER

Test No. 1 Depth to water table: 2.72m
Surface Condition: Natural vegetation
Inner Ring Diameter (mm):265
Outer Ring Diameter (mm): 600

TIME (min)	WATER ADDED(mL)		INFILTRATION RATE (cm/hr)
	Per period	Cumulative	
5	9400	9400	204.5064
10	8000	17400	174.048
15	5000	22400	108.78
20	4550	26950	98.9898
25	4000	30950	87.024
30	4000	34950	87.024
40	7600	42550	82.6728
50	7550	50100	82.1289
60	7700	57800	83.7606
70	7450	65250	81.0411
80	7500	72750	81.585
90	7500	80250	81.585



Client: CMPS&F PTY. LTD.
Principal: HOWSHIP HOLDINGS PTY LTD
Project: FERN BAY DEVELOPMENT
Location: FERN BAY

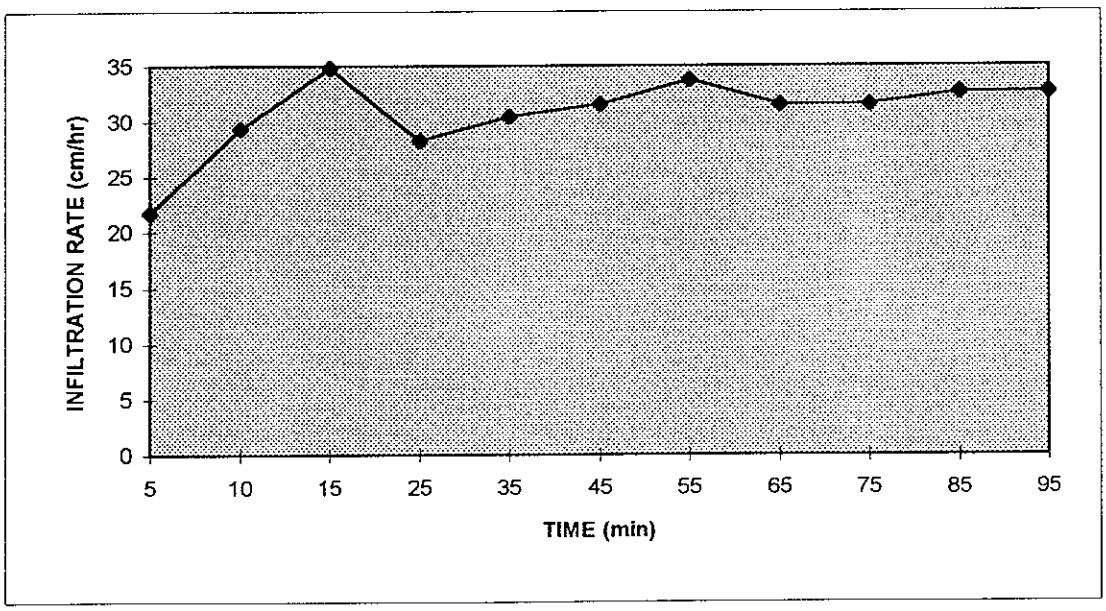
Job No. N5904/2
By: SRM

TEST RESULTS - DOUBLE RING INFILTROMETER

Test No. 2
Surface Condition: Unvegetated surface
Inner Ring Diameter (mm):265
Outer Ring Diameter (mm): 600

Depth to water table: 2.72m

TIME (min)	WATER ADDED(mL)		INFILTRATION RATE (cm/hr)
	Per period	Cumulative	
5	1000	1000	21.756
10	1350	2350	29.3706
15	1600	3950	34.8096
25	2600	6550	28.2828
35	2800	9350	30.4584
45	2900	12250	31.5462
55	3100	15350	33.7218
65	2900	18250	31.5462
75	2900	21150	31.5462
85	3000	24150	32.634
95	3000	27150	32.634



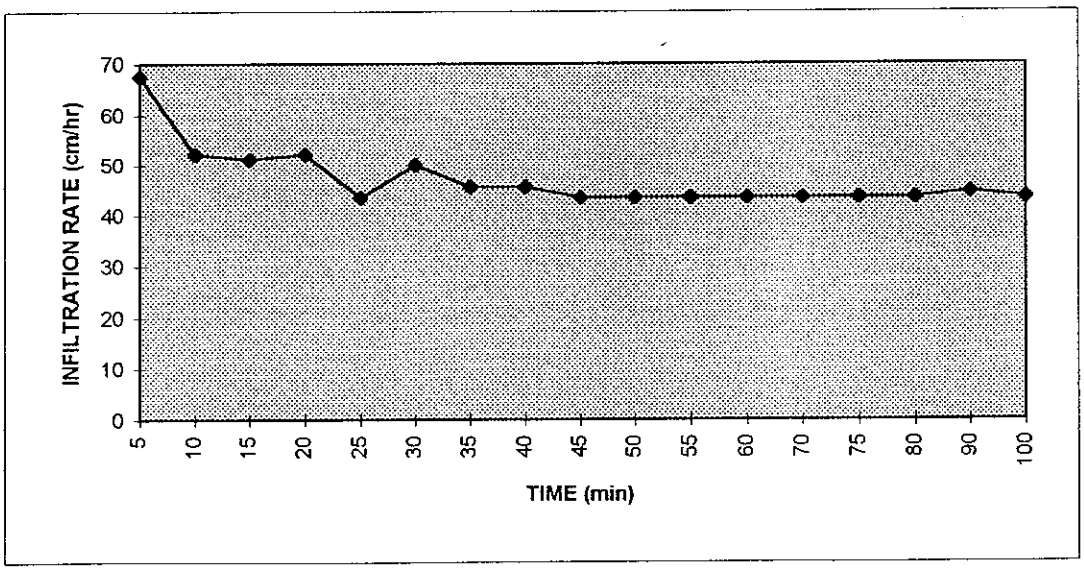
Client: CMPS&F PTY. LTD.
Principal: HOWSHIP HOLDINGS PTY LTD
Project: FERN BAY DEVELOPMENT
Location: FERN BAY

Job No. N5904/2
By: SRM

TEST RESULTS - DOUBLE RING INFILTROMETER

Test No. 3
Depth to water table: 1.1m
Surface Condition: Natural vegetation
Inner Ring Diameter (mm):265
Outer Ring Diameter (mm): 600

TIME (min)	WATER ADDED(mL)		INFILTRATION RATE (cm/hr)
	Per period	Cumulative	
5	3100	3100	67.4436
10	2400	5500	52.2144
15	2350	7850	51.1266
20	2400	10250	52.2144
25	2000	12250	43.512
30	2300	14550	50.0388
35	2100	16650	45.6876
40	2100	18750	45.6876
45	2000	20750	43.512
50	2000	22750	43.512
55	2000	24750	43.512
60	2000	26750	43.512
70	4000	30750	43.512
75	2000	32750	43.512
80	2000	34750	43.512
90	4100	38850	44.5998
100	4000	42850	43.512



Client: CMPS&F PTY. LTD.
Principal: HOWSHIP HOLDINGS PTY LTD
Project: FERN BAY DEVELOPMENT
Location: FERN BAY

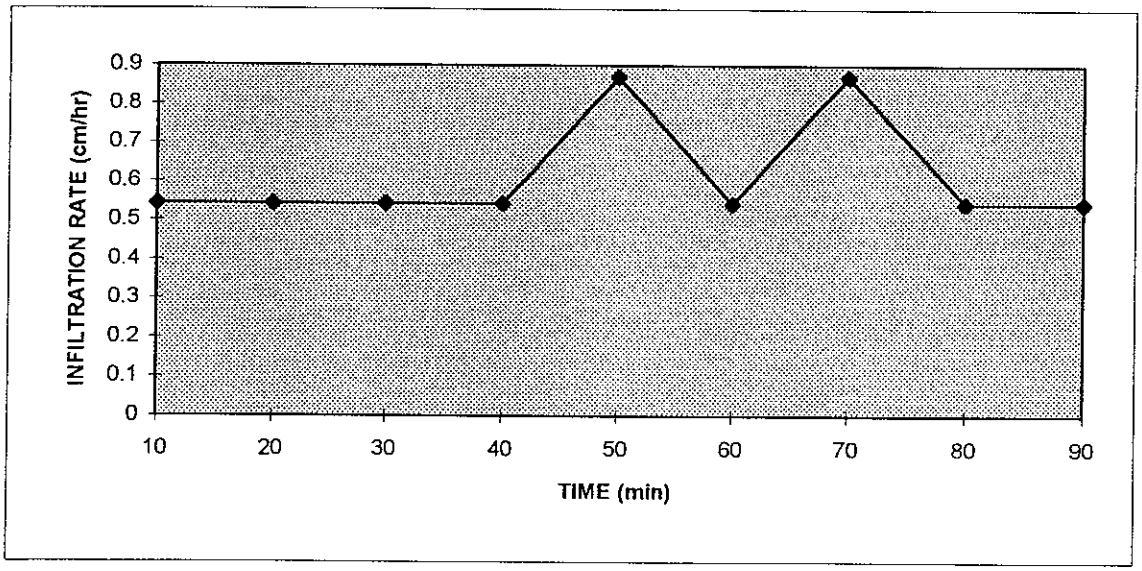
Job No. N5904/2
By: SRM

TEST RESULTS - DOUBLE RING INFILTROMETER

Test No. 4
Surface Condition: Unvegetated
Inner Ring Diameter (mm):265
Outer Ring Diameter (mm): 600

Depth to water table: 1.1m

TIME (min)	WATER ADDED(mL)		INFILTRATION RATE (cm/hr)
	Per period	Cumulative	
10	50	50	0.5439
20	50	100	0.5439
30	50	150	0.5439
40	50	200	0.5439
50	80	280	0.87024
60	50	330	0.5439
70	80	410	0.87024
80	50	460	0.5439
90	50	510	0.5439

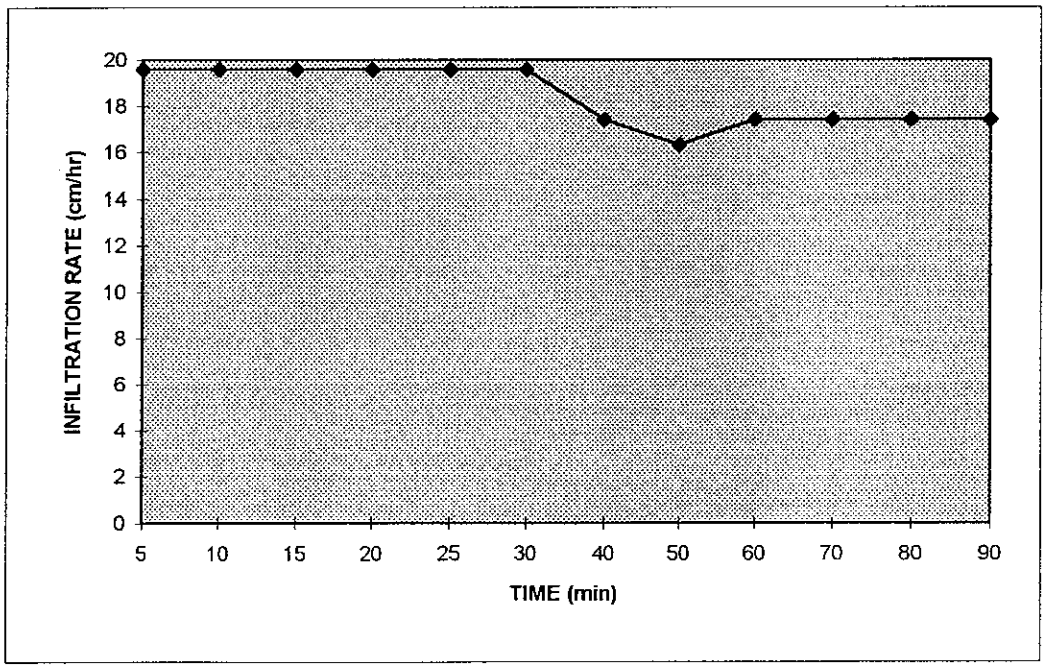


Client: CMPS&F PTY. LTD. Job No. N5904/2
Principal: HOWSHIP HOLDINGS PTY LTD By: SRM
Project: FERN BAY DEVELOPMENT
Location: FERN BAY

TEST RESULTS - DOUBLE RING INFILTROMETER

Test No. 5 Depth to water table: 1.0 (approx.)
Surface Condition: Turf
Inner Ring Diameter (mm):265
Outer Ring Diameter (mm): 600

TIME (min)	WATER ADDED(mL)		INFILTRATION RATE (cm/hr)
	Per period	Cumulative	
5	900	900	19.5804
10	900	1800	19.5804
15	900	2700	19.5804
20	900	3600	19.5804
25	900	4500	19.5804
30	900	5400	19.5804
40	1600	7000	17.4048
50	1500	8500	16.317
60	1600	10100	17.4048
70	1600	11700	17.4048
80	1600	13300	17.4048
90	1600	14900	17.4048



Client: CMPS&F PTY. LTD.
Principal: HOWSHIP HOLDINGS PTY LTD
Project: FERN BAY DEVELOPMENT
Location: FERN BAY

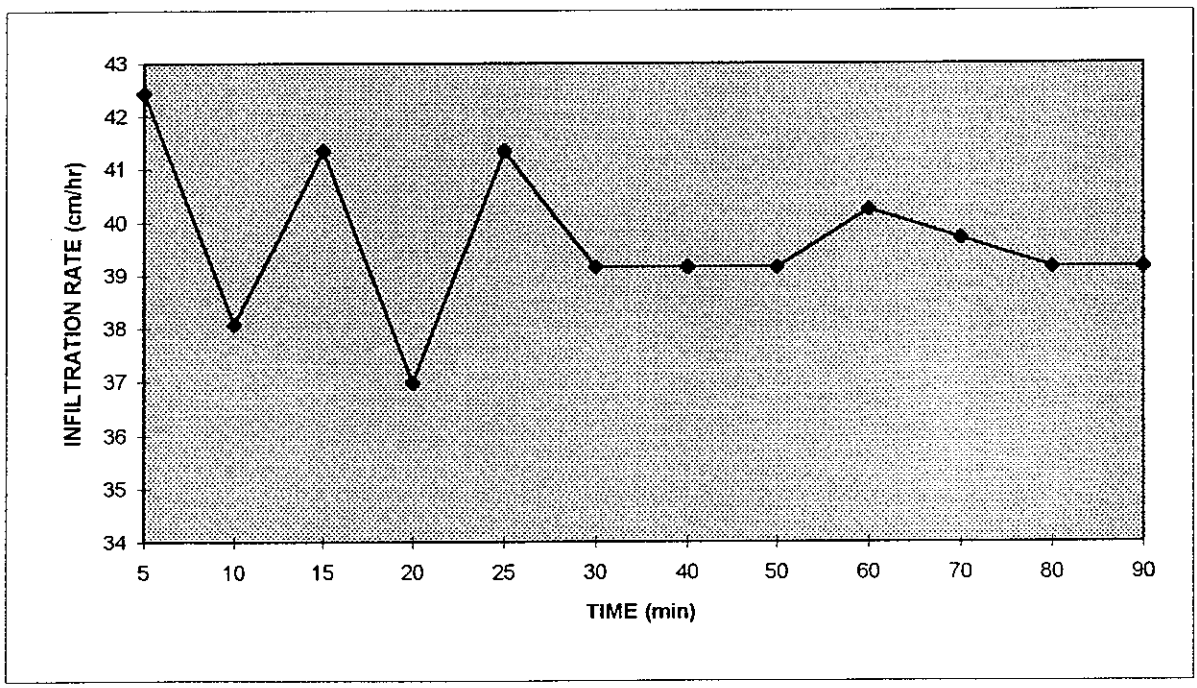
Job No. N5904/2
By: SRM

TEST RESULTS - DOUBLE RING INFILTROMETER

Test No. 6
Surface Condition: Turf
Inner Ring Diameter (mm):265
Outer Ring Diameter (mm): 600

Depth to water table: 1.5m

TIME (min)	WATER ADDED(mL)		INFILTRATION RATE (cm/hr)
	Per period	Cumulative	
5	1950	1950	42.4242
10	1750	3700	38.073
15	1900	5600	41.3364
20	1700	7300	36.9852
25	1900	9200	41.3364
30	1800	11000	39.1608
40	3600	14600	39.1608
50	3600	18200	39.1608
60	3700	21900	40.2486
70	3650	25550	39.7047
80	3600	29150	39.1608
90	3600	32750	39.1608



Coffey Partners International Pty. Ltd. (ACN 003 692 019)

rising or falling head test analysis

case no: test7

sheet 1 of 1

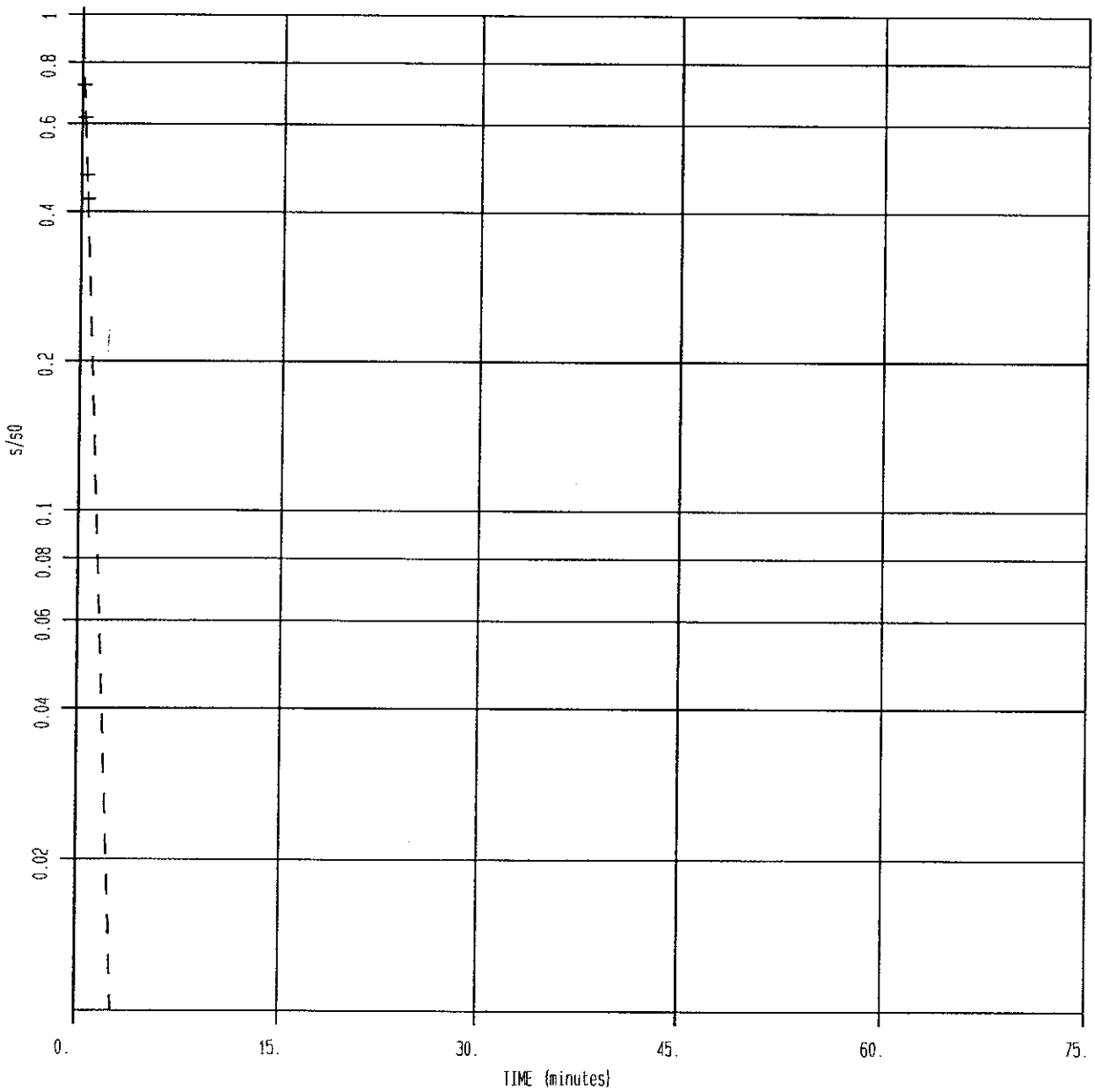
client:	CMPSGF PTY LTD	office job no:	N5904/2
principal:	HOWSHIP HOLDINGS	date:	3/7/96
project:	PROPOSED RESIDENTIAL DEVELOPMENT	carried out by:	SRM
location:	FERN BAY	checked by:	ABL

TEST RESULTS

Hvorslev's method (1951)

$$K = \frac{r^2 (\ln(L/R))}{2LTo}$$

QUANTITY		UNITS	VALUE
Initial water level reading		m	2.72
Water level reading at t=0		m	0.08
Casing radius	(r)	m	0.050
Bore radius	(R)	m	0.065
Slotted length	(L)	m	0.30
Characteristic time To		min	0.58
CALCULATED PERMEABILITY	(K)	m/d	16.



rising or falling head test analysis

case no: test8

sheet 1 of 1

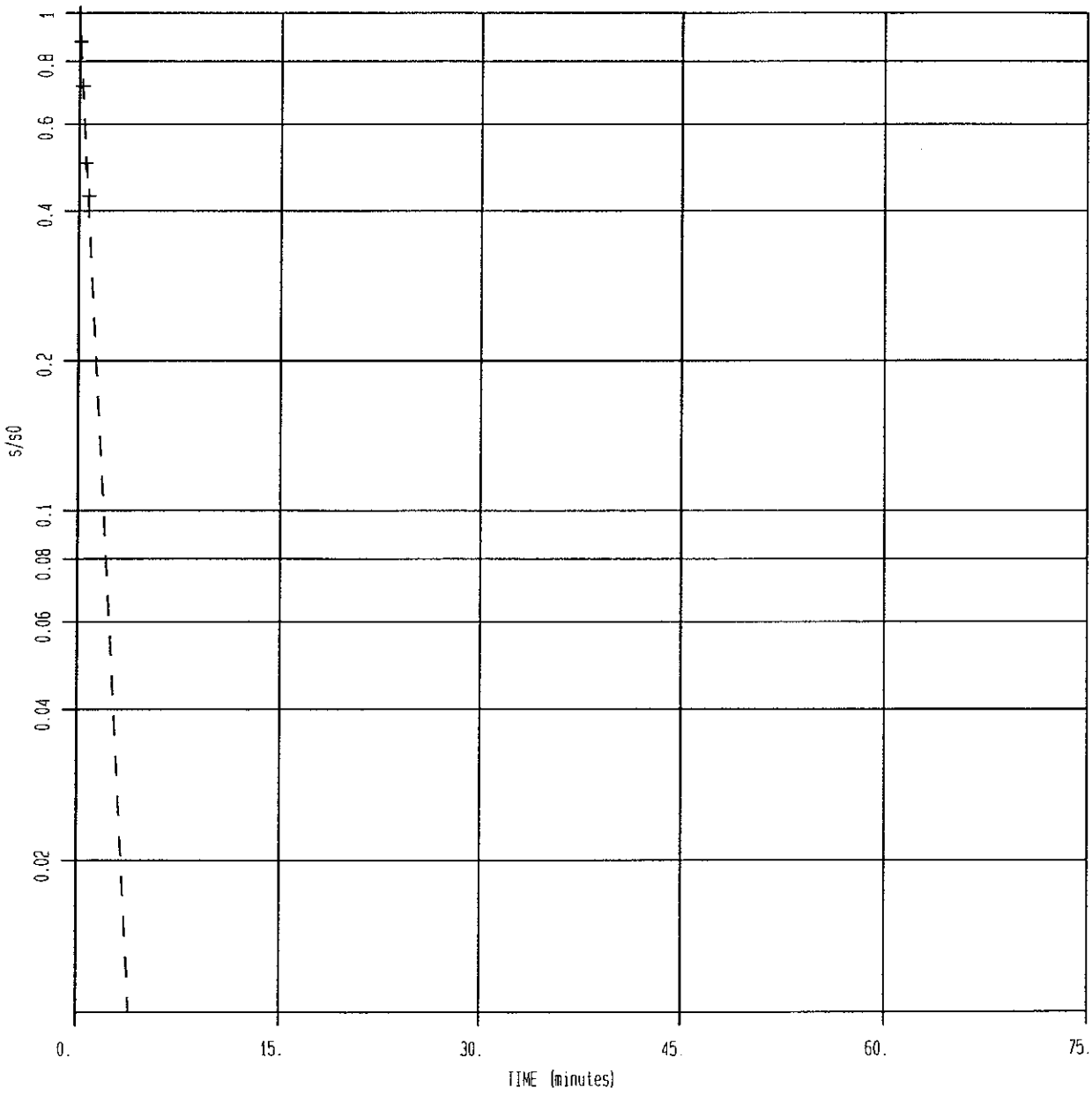
client:	CMPS&F PTY LTD	office job no:	N5904/2
principal:	HOWSHIP HOLDINGS	date:	3/7/96
project:	PROPOSED RESIDENTIAL DEVELOPMENT	carried out by:	SRM
location:	FERN BAY	checked by:	ABL

TEST RESULTS

Hvorslev's method (1951)

$$K = \frac{r^2 (\ln (L/R))}{2LTo}$$

QUANTITY		UNITS	VALUE
Initial water level reading		m	2.80
Water level reading at t=0		m	0.00
Casing radius	(r)	m	0.050
Bore radius	(R)	m	0.065
Slotted length	(L)	m	0.30
Characteristic time To		min	0.86
CALCULATED PERMEABILITY	(K)	m/d	11.



COFSLUG VERSION A1 ND5 3/7/96 14:57:20

AUSTRALIAN GOVERNMENT ANALYTICAL LABORATORIES
An ISO 9001 Quality Systems Certified Organisation

REPORT OF ANALYSIS

CLIENT : Coffey Partners International Pty Ltd
13 Mangrove Road
SANDGATE NSW 2304

ATTENTION : Steve Morton

JOB NUMBER : N5904/2

SAMPLE DESCRIPTION : Water

LABORATORY NUMBERS : N96/034948 - N96/034950

DATE RECEIVED : 6/06/96

METHODS
TOC : USEPA 9060
DOC : USEPA 9060 after filteration through a 0.45um filter.

RESULTS OF ANALYSIS

LRN	N96/034948	N96/034949	N96/034950
Client Reference	CMPS13	CMPS14	CMPS15
Total Organic Carbon	780	650	1900
Dissolved Organic Carbon	16	13	14

QUALITY ASSURANCE

Spike Recovery results are given below :

TOC : Control Spike - 100%, Matrix Spike - 104%

DOC : Control Spike - 99%, Matrix Spike - 90%

S. Agranoff
Environment Section
18 June, 1996

SYDNEY
ANALYTICAL
LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 838 8903
Fax: (02) 838 8919
A.C.N. 003 614 695
NATA Reg. 1884

ANALYTICAL REPORT for:

COFFEY PARTNERS INTERNATIONAL PTY LTD

13 MANGROVE ROAD
SANDGATE 2304

ATTN: STEPHEN MORTON

JOB NO: SAL4655

CLIENT ORDER: N5904/2

DATE RECEIVED: 06/06/96

DATE COMPLETED: 14/06/96

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 3

.....
Issued on 22/06/96
Lance Smith
(Chief Chemist)

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL4655
CLIENT ORDER: N5904/2

DATE OF COLLECTION		05/06/96	05/06/96	05/06/96
SAMPLES		CMPS 13	CMPS 14	CMPS 15
Total Dissolved Solids	mg/L	210	175	110
Nitrate NO3-	mg/L	1.1	0.27	0.22
Total Alkalinity as CaCO3	mg/L	<1	<1	<1
Total Phosphorus	mg/L	0.19	0.16	0.34

SYDNEY
ANALYTICAL
LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL4655
CLIENT ORDER: N5904/2

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 18th Edition, or other approved methods listed below:

2540C	Total Dissolved Solids
4500F	Nitrate NO3-
2320B	Total Alkalinity as CaCO3
4500BE	Total Phosphorus

A preliminary report was faxed on 14/06/96