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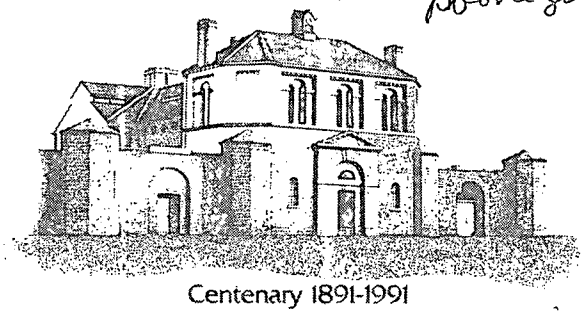
31092-4-89

Aboriginal — Ground Radar Report 93.1



Centenary 1891-1991

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Date: 21 February, 1991

Your Ref:

Our Ref: 89136
PR:CS
Enquiries: P.Randolph

Dr C Back
Chief Executive
Rottnest Island Authority
PO Box R1246
Perth WA 6001

TRIAL GROUND PROBING RADAR SURVEY, TENTLAND AREA, ROTTNEST ISLAND, WESTERN AUSTRALIA

Please find enclosed a copy of the report of the Trial Ground Probing Radar (GPR) Survey. A full colour original with complete Appendix D can be viewed at the Department of Aboriginal Sites, if required.

The report concludes that there are trench-like zones at the road intersection site at the southern boundary of Tentland that can, with some degree of confidence, be identified as burial sites. The survey also located a number of possible ground disturbances, two in the northern part of Tentland, that are worthy of further investigation.

We intend to carry out the recommendations of the report, namely further GPR surveying east, west and south of the road intersection area already investigated, and the possible ground disturbance occurrences in the northern part of Tentland. A tentative date, agreeable to Graham Merritt, spokesperson for the Rottnest Island Deaths Group, of 17-23 March is being considered. It would be appreciated if accommodation could be available at this time.

Following discussion of the report with Graham Merritt, the Rottnest Island Deaths Group, have once more requested that the Tentland area south and east of the sealed track through the northern section be fenced. We urge the Rottnest Island Authority to consider this request and make provision to safeguard the identified and possible areas referred to in the report.

A copy of the report and the above information has also been sent to G Merritt (Rottnest Island Deaths Group), C Wyatt (AAPA), D McDonald (ATSIC) and V Wilson (Curtin University).

V. Novak
Vera Novak
Registrar
DEPARTMENT OF ABORIGINAL SITES

TRIAL GROUND PROBING RADAR SURVEY

TENTLAND AREA

ROTTNEST ISLAND W.A.

FOR

DEPARTMENT OF ABORIGINAL SITES
W.A. MUSEUM

Curtin University of Technology
Department of Exploration Geophysics
Date: February 1991

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Department of Aboriginal Sites
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ATT: Registrar Of Aboriginal Sites

Dear Ms. Novak

We are pleased to submit our report " Trial Ground Probing Radar Survey, Tentland Area, Rottnest Island, W.A."

The survey has identified trenching at the site which, from information provided, would appear most likely to have been completed for burial sites.

We are most grateful for the every assistance provided by personnel from your Department which has helped make this survey a success.

Yours Sincerely

Dean Wilson 15/2/91

V.C.Wilson

SENIOR LECTURER

INDEX

1. INTRODUCTION

The Department of Aboriginal Sites, W.A. Museum requested Mr V. Wilson, Department of Exploration Geophysics, Curtin University in May 1990 to advise as to whether any geophysical method was capable of locating and delineating 19th century burial sites on Rottnest Island, W.A. A method was required that would not disturb the burials and could be used close to buildings, power lines and roads and where subsurface trenching had taken place to position sewer lines and water pipes.

Based on the interpretation of results from a ground probing radar (G.P.R.) survey he had completed at Rottnest in 1983 Mr Wilson advised that this technique could be successful. However before going to the expense of testing G.P.R. the Department of Exploration Geophysics offered its equipment and personnel to visit Rottnest on the 8th June 1990 to test whether ground magnetic, earth conductivity and seismic refraction techniques could delineate the known 19th century graves at the Rottnest cemetery. When it was clear that these techniques were unsuccessful it was recommended that a test G.P.R. survey be completed of the site of known burials at the road intersection adjacent to the southern boundary of Tentland.

This report is based upon a three day trial G.P.R. survey (during the period 10th to 12th December 1990) over the road intersection site to determine whether the method is effective in locating the burial sites. In addition it reports on the results of two lines of G.P.R. profiling completed on the northern part of Tentland.

2. JOB PHILOSOPHY

The ground probing radar survey at Rottnest in 1983 had shown the technique was capable of showing stratification in the near surface sediments. It was considered that any digging that had taken place, and resultant in - fill, would be represented in the G.P.R. data as a zone of change in the natural stratification.

Because of the amount of noise expected from cultural interference it was considered that signal processing of the acquired data would be important. Because of the extensive experience of Curtin personnel in seismic processing and the excellent computing and image processing facilities at Curtin it was firstly envisaged that Curtin would hire a G.P.R. set and perform all tasks of the test survey. However in the latter part of 1990 Waveform Pty Ltd became the first G.P.R. contractor to be based in Perth. Because of the signal processing experience of their personnel they were invited to quote on the work. They were eventually contracted to provide data acquisition equipment and operator and provide data processing to the profile sections, plus plans and photographs included in this report. Special acknowledgement is made to the highly professional and very helpful assistance provided by Mr C. Frampton and Mr M. Bawden during the site survey and the completion of the report.

To test the effectiveness of the method a three day trial was planned. The single aim of the trial survey was to examine in great detail, the area from which burials had been reported in 1969 - 1970 and to see if there was any correlation with the G.P.R. results.

A detailed grid was set up over the test area, being adjacent to the road intersection south of Tentland (see FIG 1). Line spacing of one metre was used and readings were completed at 0.2 metre intervals along the 10°m trending lines (Lines 01E - 19E). Two cross lines were run (Lines 01N and 02N) showing data orthogonal to the other lines, readings being at 0.2 metre intervals.

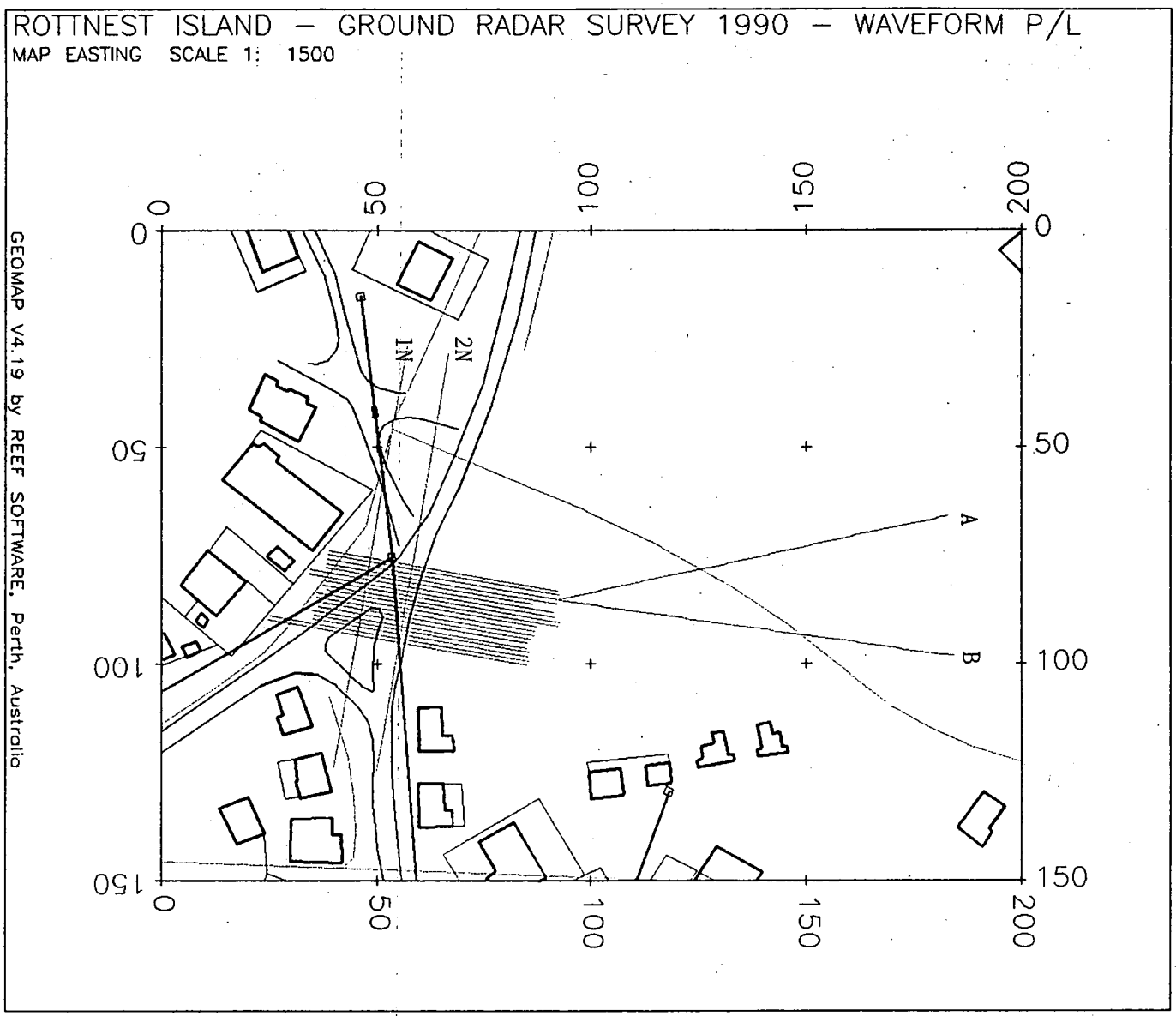

FIG I LOCALITY PLAN

Thus a large amount of data was measured in the area where previously burials had been reported.

At the request of the Department of Aboriginal Sites, two lines (A and B) were read over the northern part of Tentland. These lines were located to determine if they could provide evidence of burials beneath them.

3. GROUND PENETRATING RADAR (G.P.R.) METHOD

The G.P.R. technique is designed to show a cross-section of the earth layers. An electromagnetic pulse is sent into the ground where it is reflected by boundaries within the earth and returned to the surface. The received pulse is digitised and stored for later display.

The pulse is of the order of 10 nanoseconds long and has a bandwidth of between 10 to 200 MegaHertz. The reflecting boundaries in the earth are changes in conductivity. As the velocity of the electromagnetic wave is very fast (of the order of 0.1 metres/nanosecond) the "listening time" is very short. Typical values of 700 nanoseconds to record to 30 metres depth. With this short "listening time" and the stationarity of the pulse wavelet, it is possible to record many times at one point and sum the recordings together. This improves the signal to random noise ratio and values of 100 to 300 stacks of waveform are usual.

The G.P.R. technique is very similar to the seismic exploration used in the oil industry. Previous G.P.R. systems recorded the data onto small thermal paper plotters in the field. All information was recorded by analog. The state-of-the-art equipment over the last year now uses digitisation of the recorded signals to store the data in 16 bit samples. This increases the dynamic range of the system greatly. The major differences from the seismic to the G.P.R. techniques are that the seismic wave is reflected by impedance (velocity/density) contrasts in the earth, whereas the G.P.R. wave is reflected by conductivity contrasts.

Penetration of the G.P.R. signal is limited by the water content and salinity and clay content of the earth layers. In ideal conditions, penetration can be up to 50 metres depth. In areas of very high clay content, penetration can be limited to 10 metres. Further research into low frequency G.P.R. antennas and more powerful transmitters is pushing the limits deeper.

4. ACQUISITION

Data was acquired between the 10th and 12th December 1990 by C. Frampton and M. Bawden of Waveform P/L. Supervision and assistance was by V. Wilson of Curtin University. Assistance was also given by personnel from Curtin University, W.A. Museum Aboriginal Sites, AAPA, and Mr G. Merritt.

The G.P.R. system used was the Pulse EKKO IV (manufactured by Sensors & Software, Canada). This was the latest equipment utilising fibre optic cables between antennas and console. The system consists of separate transmitter and receiver dipole antennas. The receiver antenna digitises the signal at the antenna before passing the data to the console via the fibre optic cable.

Antennas used were the 100MHz antenna with a 400 volt transmitter. the 50 MHz antenna with a 1000 volt transmitter was not tested.

Walkaway test was conducted at one location. For this test one antenna is kept stationary while the other is gradually "walked" away over a distance. Any reflections which appear on the G.P.R. section will demonstrate hyperbolic curves. From these curves we can calculate the velocity of the G.P.R. pulse through the earth layers and hence use this to convert from time to depth.

On the First Day (10/12/90) a test between 100 MHz and 200 MHz pulses was performed using two lines recorded over the same position. It was decided that the 200 MHz gave an improved higher frequency content and this was used for the rest of the survey.

It was decided to concentrate a G.P.R. 3-D grid over the area West of Sewer Manhole 32. This being a known site. An area of 20 metres by 50 metres was was to be covered. Line separation was 1 metre and trace spacing 0.2 metres.

These lines were recorded at 10° magnetic. These are lines 1E to 19E. Wooden pegs were driven into the ground to mark the northern end of these lines.

The base line referred to in Appendix B was a line through the mid point of manhole 32 bearing 100°m. Paint was marked on the road where each north bearing line crossed the base line.

Please note that all distances on the processed sections for the lines 3E - 19E are referred to a grid of which the southern end of line 19E is 00N. These are the distances listed in Table 1. Only in Appendix B are distances relative to origins at the southern end of each line.

Two cross lines were recorded, lines 1N and 2N. The 50m E stations on these lines were offset 5 metres from the centre of manhole 32, at bearings of 190° M and 10° M respectively.

Two lines, A and B, were recorded into the northern part of Tentland.

See Table 1 for Survey Line Listing and Appendix B for Line Description.

TABLE 1 - SURVEY LINES

Line	Traces	Intersection of Base Line (m)	Grid Distance (M)
1 E	247	15.0	11.2 - 60.4
2 E	250	14.0	12.2 - 62.0
3 E	272	14.8	11.4 - 65.6
4 E	275	15.0	11.2 - 66.0
5 E	274	15.0	11.2 - 65.8
6 E	275	15.0	11.2 - 66.0
7 E	291	18.6	7.6 - 65.6
8 E	293	18.6	7.6 - 66.0
9 E	282	18.6	7.6 - 63.8
10 E	280	15.0	11.2 - 67.0
11 E	260	16.2	10.0 - 61.8
12 E	260	16.0	10.2 - 62.0
13 E	254	15.2	11.0 - 61.6
14 E	249	15.2	11.0 - 60.6
15 E	257	15.8	10.4 - 61.6
16 E	256	15.8	10.4 - 61.4
17 E	257	16.0	10.2 - 61.4
18 E	308	0.4	0.4 - 61.8
19 E	308	0.2	0.2 - 61.6
1 N	500	—	0.2 - 100.0
2 N	496	—	0.2 - 99.2
A	463	—	0.2 - 92.6
B	465	—	0.2 - 93.0

5. PROCESSING

Processing trials were conducted on line 16E to determine the optimum parameters. No trace mixing or spatial filtering was applied as it was necessary to retain detail.

The G.P.R. data was improved by scaling and filtering to show higher frequency events in the shallow region and balance the trace amplitudes.

The G.P.R. data in processed form is suitable for loading onto the "Landmark" seismic workshop at Curtin University. This can be used to look at data recorded in a 3-D grid.

The velocity used for time-depth conversion was chosen from a Walkaway Test. This showed velocities from 0.13m/ns to 0.12m/ns. A velocity of 0.13m/ns was chosen for the G.P.R. data as being representative of the shallow region 0m to 4m.

Line 10E could not be processed as Waveform could not retrieve the data from the acquisition system.

Processes Used

Time Zero Drift Correction
A time static correction applied trace by trace to remove small timing jitters.

Signal Saturation Correction
Removes the low frequency interference caused by antenna-ground coupling.

Amplitude Gain Recovery
A time varying gain correction is applied to compensate for amplitude losses due to spherical spreading and ohmic dissipation of the signal.

Wavelet Shaping
Process to improve balance of amplitude spectrum

F-K Filter

A frequency-wave number or 2-Dimensional Filter. Used to remove data with specified dip limits from the G.P.R. section.

Mix

Trace summation in a rollalong fashion. Weights are given in percentages. Used to increase coherent signal and attenuate random noise.

Bandpass Filter

This filter excludes frequencies above and below certain limits with a taper to each limit. The filter is applied to remove frequencies which are outside the signal range or that contain noise.

Scaling

Time variant scaling of the AGC (Automatic Gain Control) variety to balance the trace temporally. The AGC uses a window of samples and computes a factor to apply as gain. The window then moves down one sample and computes a new factor. A percentage of the ungained data can be mixed to the gained data.

Display

Colour Amplitude - The amplitudes of each trace are displayed in colour. The positive amplitudes tend towards red, while the negative amplitudes tend towards blue.

6. RESULTS

The results are presented in Appendix D as profile sections.

Line 10E is not presented as the data could not be obtained from the memory of the acquisition computer.

7. INTERPRETATION

The profiles have been interpreted and evidence found of 2.5 metre deep zones showing discontinuous reflection. These zones are distinguishable from noise due to their continuous trends and a likely explanation for them would be man made trenches. Their locations on each line presented as Table 2. A map showing their location and continuity is presented at Appendix A.

TABLE 2 LOCATION OF INTERPRETED DISTURBED GROUND

Line	Grid Positions along Lines (Metres)				
01 E	26.2 - 28.7	29.5 - 30.6	31.2 - 31.8		
02 E	16.5 - 21.0	22.4 - 24.6	26.8 - 28.0	31.0 - 32.0	
03 E	29.6 - 30.7	30.9 - 32.0			
04 E	28.2 - 29.8	30.5 - 31.8			
05 E	20.6 - 23.0	28.4 - 29.2	30.2 - 31.3		
06 E	21.0	27.4 - 29.4	30.2 - 30.8		
07 E	25.8 - 27.8	29.0 - 30.0	30.8 - 31.8		
08 E	19.0 - 21.0	24.0 - 25.0	26.0 - 28.2	29.7 - 30.2	31.6
09 E	19.5 - 22.0	23.4 - 25.0	26.5 - 28.0	31.2 - 33.0	
10 E					
11 E	14.8 - 16.8	21.0 - 23.0	23.2 - 25.0	26.8 - 28.4	30.0 - 32.
12 E	13.0 - 16.0	21.0	23.3 - 25.4	27.0 - 28.8	
13 E	21.4	27.0 - 29.0			
14 E	19.5 - 21.6	26.8 - 29.0	30.4 - 33.0		
15 E	18.4 - 20.4	26.4 - 29.2			
16 E	17.8 - 19.6	26.0 - 29.7			
17 E	14.0 - 19.2	27.4 - 30.0			
18 E	12.5 - 17.5	28.0 - 29.4			
01 N	52.6 - 54.0	61.0 - 62.0	63.2 - 64.5		
02 N	51.0 - 53.7	55.5 - 56.7	59.6 - 61.4		
A		NIL			
B		NIL			

The following line intervals exhibit characteristics that may be associated with disturbed ground. However it is not possible to be certain due to the limited amount of data obtained in their vicinity. Additional lines adjacent to these would allow greater certainty to their geometry and cause:

01 N	6.0 - 9.5	47.5 - 49.5	81.0 - 82.5
A	59.0 - 61.0	71.0 - 74.0	

Reflections of the radar signal from fencing and from subsurface water pipe, sewerage lines and Telecom cable have produced major noise to the measured data. However the noise affected data prevented a clear interpretation to be made only within two metres of the object causing the noise. After processing reflections from trees produced only a minor affect on the data.

8. CONCLUSIONS

The trial ground penetrating radar survey over the road intersection site at the southern boundary of Tentland has identified trench - like zones of disturbed ground. These zones extend to a uniform depth of approximately 2.5 metres, and vary in width from one to five metres near the surface diminishing with depth. It is most likely they are man made.

It is clear that if these zones represent burial sites then the sewerage line between buildings B11 and manhole 32, dug to a depth of three metres, would be likely to uncover burials. It is understood this was the case.

It is concluded that the survey has successfully located and delineated burial sites on Rottnest Island.

9. RECOMMENDATIONS

Ground probing radar surveys should be undertaken to the east, west and south of the road intersection area already investigated. This will enable the delineation of this burial site.

Parameters for the survey should be parallel lines, 1 metre apart bearing 10° M with orthogonal lines at a maximum separation of 5 metres. Data should be read at a station interval of 2 metres.

To properly investigate the northern part of Tentland, parameters for a survey should provide a similar data density as described above. The grid should include the northern end of Line A and extend west.

APPENDIX A

INTERPRETATION PLAN

ROTTNEST ISLAND — GROUND RADAR SURVEY 1990 — WAVEFORM P/L — BEACON 'A'

MAP EASTING SCALE 1 : 250

CURTIN UNIV — INTERPRETED 15/3/91
V. WITTEN

INTERPRETATION PLAN

LINE-A

LINE-B

LINE-02N

LINE-01N

HUT B11

HUT B12

OLD HOSPITAL

CATEGORY A ANOMALY

POSSIBLE ANOMALY

GEOMAP V4.1B by REEF SOFTWARE, Perth, Australia

APPENDIX B

LINE DESCRIPTIONS

ROTTNEST ISLAND SURVEY LINE COMMENTS

Distances are from start of line.

Bearings are in °ms magnetic (°m).

Lines-01E to -19E shot parallel on bearing 10°m.

Lines-01N and -02N shot perpendicular to East Lines.

Lines-A and -B shot North from end of Line-05E through Tentland.

BASELINE INTERSECTIONS

Baseline was at bearing 100°m from centre of manhole 32. This line intersected the north bearing lines at the following distances along them :

Line	Distance(m)	Line	Distance(m)
01E	15.0	11E	16.2
02E	14.0	12E	16.1
03E	14.85	13E	15.15
04E	14.9	14E	15.2
05E	14.9	15E	15.7
06E	15.0	16E	15.75
07E	18.5	17E	15.9
08E	18.5	18E	25.75
09E	15.5	19E	26.1
10E	15.0		

LINE BEARINGS

Line-01E Bearing 10°m ; offset 5.0m at bearing 190°m from manhole 32.

Line-02E Bearing 10°m ; offset 10.0m at bearing 100°m from Line-01E

Line-01N Bearing 100°m.
55.0mE on Line-01N = 9.9mN on Line-01E
59.8mE on Line-01N = 9.2mN on Line-02E
Offset 5.0m at bearing 190°m from centre manhole 32

Line-02N Bearing 100°m

19.6mN on Line-01E = 55.1mE on Line-02N
18.8mN on Line-02E = 60.1mE on Line-02N
Offset 5.0m at bearing of 10°m from centre of manhole 32.

Line-A Commenced at Peg [Line-05E;55.0mN]
at bearing 348°m

Line-B Commenced at Peg [Line-05E;55.0mN]
at bearing 8°m

LINE-01E

(5m East of Manhole 32 Centre)
(15mN on Baseline through Manhole 32)

Distance(m)N	Comment
-4.0	Fibro Fence
4.0	Overhanging Tree starts
8.0	Tree Trunk - 2m West offline - 1m wide trunk
10.0	Overhanging Tree stops
12.0	Telecom inground cable apparent
14.0	Bitumen Road starts
15.0	PEG-5.0m at 100degM from centre of manhole 32
15.0-16.0	Apparent location of Sewerage Trench
22.8	Bitumen Road ends
31.0	Tree at 9m West
34.0	Tree at ??m West
36.5	Concrete Bench - Start 0.5m East.
39.6	Concrete Bench - End
44.0	Tree at 2.5m West
50.0	Tree at 3.0m North
50.0	Steel Bin at 5m North

LINE-02E

(10m East of Manhole 32 Centre)
(14mN on Baseline through Manhole 32)

Distance(m)N	Comment
0.0	At Base of Tree to South ; Metal Light Pole 3mEast
9.0	Bitumen Road Start
14.0	Paint Spot on Road
15.0	"Edge" of East-West Road- still on bitumen
20.7	Bitumen Road stops
37.2	Road Metal on surface to 41.5m
43.0	Concrete Pad - 5cm thick, 0.2m West
47.0	Tree
49.5	Steel Bin at 0.5m East
50.0	Tree at 1m North

LINE-03E

(Set 1m East of middle of manhole32)
(14.85mN on Baseline through Manhole 32)

Distance(m)N	Comment
0.0	Asbestos Fence at 0.5m South
8.0	Tree at 0.5m East - Branches overhang
9.6	Peg - "Line-01N"-50mE at 1m West
12.5	Branches Overhang End
14.3-15.5	Concrete Manhole Wall at 0.3m West

14.85	Line 280 °m through centre of manhole cuts Line-03E.
16.7	Bitumen Starts
24.0	Bitumen Stops
24.0-28.0	Embankment to lawn area, elevation drop of 1 metre approx.
29.0	Tree Overhang starts
30.0	Tree at 5m West
34.6	Tree at 2m West
38.0	Concrete Table 3.5m East
44.0	Trees at 1m East and 4m West
49.5	Tree at 4.5m West
53.7	Tree at 0.5m West
55.0	Line Finish

LINE-04E (2m East of Manhole Centre)
(14.9mN on Base Line of Manhole 32)

Distance(m)N	Comment
-0.5	Asbestos Fence
8.0	Tree at 0.0m
15.0	Concrete Sewer Hatch 1.0m South
16.5	Bitumen starts
24.0	Bitumen stops
30.5	Tree at 5.0m South
35.0	Tree at 3.0m South
35.5	Tree at 7.0m South
37.0-39.0	Tree at 2.0m North

44.0	Trees at 0.0m and 4.0m
45.0	Tree at 8.0m South
45.5	Water pipe - shallow
48.0	Tree at 7.0m North
49.5	Tree at 5.0m South
54.0	Trees at 3.0m North and 1.5m South
55.0	Line Finish

LINE-05E (3m East of Manhole Centre)
(14.9mN on Base Line of Manhole 32)

Distance(m)N	Comment
-1.5	Asbestos Fence
8.0	Tree at 1.0m South
15.0	Peg. - Concrete Sewer at 2.0m South
15.5	Bitumen start
24.0	Bitumen stop
30.5	Tree at 6.0m South
35.0	Trees at 4.0m South and 8.0m South
37.0-39.0	Tree at 1.0m North
55.0	Line Finish

LINE-06E (4m East of Manhole Centre)
(15.0mN on Base Line of Manhole 32)

Distance(m)N	Comment
-2.0	Metal Gate on Asbestos Fence
4.5	Overhang of Tree

8.0	Tree at 2.0m West
14.95	Bitumen start
23.4	Bitumen stop
34.5	Tree at 4.0m West
36.9-39.3	Concrete Table
44.0	Tree at 2.0m West
53.5	Tree at 1.0m East
55.0	Line Finish

LINE-07E (6m East of Manhole Centre)
(18.5mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Asbestos Fence 0.1m South
3.1-4.8	Wooden Board Walk to Gate
12.0	Tree at 5.0m West
17.0	Bitumen start
26.3	Bitumen stop
40.3-42.0	Concrete Table
47.0	Concrete Slab - corner 0.5m East
48.0	Tree at 4.0m West
52.0	Tree at 3.0m East
57.0	Tree at 1.0m West
59.0	Line Finish

LINE-08E (7m East of Manhole Centre)
(18.5mN on Base Line of Manhole 32)

Distance(m)N	Comment
-1.0	Asbestos Fence
11.5	Tree at 4.0m South
15.5	Bitumen starts
18.5	Line of pegs for 280°m line
18.5	Concrete sewer 6.0m West
26.0	Bitumen stops
29.0	Peg on line
38.0	Tree at 7.0m West
41.0-43.0	Concrete Table at 1.0m West
47.0	Tree at 4.0m West
51.5	Tree at 2.0m East
54.0	Tree at 6.0m East
54.0	Steel Bin at 4.0m East
55.5	Tree at 4.0m East
57.0	Trees at 2.0m East,2.0m West and 6.0m West
59.0	Line Finish

LINE-09E (8m East of Manhole 32 centre)
(15.5mN on Base Line of Manhole 32)

Distance(m)N	Comment
-4.0	Asbestos Fence
0.0	Tree at 5.0m East
3.0-4.2	Board walk to gate
9.0	Tree at 7.0m West
12.2	Bitumen starts

15.5	Line of pegs for 280°m line
15.5	Concrete Sewer at 8.0m East
22.4	Bitumen stops
38.0	Concrete Table at 3.0m West
43.2	Concrete Pad start
45.5	Concrete Pad stops
48.7	Tree at 1.5m East
53.7	Tree at 1.5m East
59.0	Line Finish

LINE-10E (9m East of Line-08E)
(15.0mN on Base Line of Manhole 32)

Distance(m)N	Comment
-5.0	Asbestos Fence
0.0	Large Bush
11.0	Bitumen starts
15.0	Base Line from manhole at 280°mm.
22.1	Bitumen stops
43.75	Concrete Pad starts
45.6	Concrete Pad stops
48.7	Tree at 0.5m East
51.4	Steel Bin at 1.5m East
52.8	Tree at 1.5m East
53.8	Tree at 0.2m East

LINE-11E (11m East of Manhole 32 centre)
(16.2mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Tree branch overhanging at 0.5m South
2.7	Metal Light Pole at 2.0m East
9.2	Bitumen starts
12.0-12.3	Telecom - evidence of undergound cable
16.5-20.1	Sewerage Trench - area of road dug up
22.8	Bitumen stops
26.0	Tree at 9.0m East
39.0-42.2	Pile of road metal under line
45.0	Concrete Pad at 2.0m West
47.8	Water Pipe on surface crossing to tap

LINE-12E (12m East of Manhole 32 Centre)
(16.1mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Tree branch at 0.1m South
0.0	Tree at 0.5m East
2.5	Metal Light Pole at 1.0m East
3.5	Change from Grass to Sand
8.1	Bitumen starts
11.6-12.1	Telecom - evidence of trench beneath tarmac
16.4-20.2	Sewer Trench - evidence on surface
22.2	Bitumen stops

24.0	Tree at 8.0m East
39.0	Pile of blue metal starts
42.7	Pile of blue metal stops
45.0	Tree at 2.5m West
47.85	Metal Water Pipe under line
49.0	Tree at 2m West
52.0	Metal Bin 1.5m West ; Tree 1m NW ; Tree 2m East

LINE-13E (13m East of Manhole 32 centre)
(15.15mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Tree and Branch at 1.0m South
1.5	Metal Light Pole
2.5	Change from Grass to Sand
6.0	Bitumen start
13.9	Bitumen stops
15.9	Bitumen starts
15.9	Sewer Trench starts
19.5	Sewer Trench stops
21.1	Bitumen stops
43.2	Overhang of tree canopy
47.5	Water pipe - metal
48.1	Tree at 3.0m West
50.4	Tree at 1.0m East
50.7	Steel Bin at 2.5m West

LINE-14E (14m East of Manhole 32 centre)
(15.2mM on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Horizontal Tree on Ground
1.6	Metal Light Pole at 1.0m West
2.4	Change from Grass to Sand
5.1	Bitumen starts
10.45-10.70	Telecom - evidence
12.5	Bitumen stops
15.85	Bitumen starts
16.5-19.8	Sewerage Trench - evidence
20.9	Bitumen stops
23.2	Tree at 6.0m East
37.0	Overhanging trees to end of line
48.0	Metal Tap at 3.0m East
48.3	Tree at 4.0m West
50.6	Tree at 1.7m East
50.6	Steel Bin at 2.5m West

LINE-15E (15m East of Manhole 32 Centre)
(15.7mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Horizontal Tree at 0.1m South
2.0	Metal Light Pole at 2.0m West
4.7	Bitumen starts
11.5	Bitumen stops

10.5-10.85	Telecom - evidence of trench
15.7	Base Line from manhole
16.3	Bitumen starts
17.3-20.6	Sewer Trench - evidence
21.0	Bitumen stops
23.5	Tree at 5.0m East
30.4	Tree at 8.0m East
40.3	Tree at 7.0m East
44.2	Tree at 5.0m East
47.6	Tree at 3.5m East
48.4	Tap at 2.2m
50.5-51.5	Tree trunk at 0.2m West

LINE-16E (16m East of Manhole 32 centre)
(15.75mN on Base Line of Manhole 32)

Distance(m)	Comment
0.0	Tree at 0.05m South-Trunk lying on ground
1.6	Tree at 3.0m West
3.55	Bitumen starts
10.4-10.7	Telecom trench - evidence
15.75	Bitumen starts
15.75	Base line from manhole
19.9	Bitumen stops
23.6	Tree at 4.0m East
30.5	Tree at 7.5m East
34.6	Overhanging tree canopy to end of line

37.3	Tree at 8.0m East
40.6	Tree at 6.0m East
43.8	Tree at 4.0m East
47.5	Tree at 2.5m East
48.0	Water Pipe - metal
48.3	Tap Standpipe at 1.5m
51.00	Tree at 1.2m West

LINE-17E (17m East of Manhole 32 centre)
(15.9mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Tree trunk on ground at 0.2m
3.15	Bitumen starts
9.3	Bitumen stops
10.5	Telecom trench - evidence
15.9	Base Line from manhole
16.2	Bitumen starts
19.6	Bitumen stops
23.9	Tree at 3.0m East
30.4	Tree at 6.5m East
35.0	Overhanging tree canopy to end of line
40.7	Tree at 6.0m East
44.2	Tree at 3.5m
47.6-47.9	Bricks around tap stand - wall single brick
48.5	Tap Stand at 0.5m East
48.8-49.1	Bricks around tap stand - wall single brick
50.8	Tree at 2.5m West

LINE-18E (18m East of Manhole 32 centre)
(25.75mN on Base Line of Manhole 32)

Distance(m)N	Comment
0.0	Tree at 2.0m West
4.5	Tree at 2.5m East
9.0	End of Hanging tree
11.0	Bitumen starts
17.8	Bitumen stops
25.9	Bitumen starts
29.0	Bitumen stops
34.0	Tree at 2.0m East
41.0	Tree at 5.5m East
44.0	Overhanging tree canopy to end of line
51.0	Tree at 5.0m East
57.6	Tree at 0.5m East
57.6-58.0	Brick wall to tap stand (single brick)
58.5	Tap Stand
58.9-59.1	Brick wall to tap stand
61.0	Tree at 3.5m West

LINE-19E (19m East of manhole 32 centre)
(26.1mN on Base Line of Manhole 32)

Distance(m)N	Comment
9.3	Bitumen starts
16.2	Bitumen stops

25.9	Bitumen starts
26.1	Base line from manhole
29.0	Bitumen stops
33.9	Tree at 2.0m East
33.9	Overhanging tree canopy to end of line
40.4	Tree at 6.0m East
47.5	Tree at 7.0m East
50.8	Tree at 4.3m East
54.2	Tree at 1.5m East
57.6	Tree at 0.3m West
58.85	Tap Stand at 1.5m West
61.0	Trees at 4.3m West,4.0m East
61.0	Steel Bins at 5.5m NW and 8.3m.

LINE-A (Heading is to "K" end of "Kleenheat" name and gas cylinder. Through Northern Site-Tentland. Bearing 348 °mm.)

Distance(m)N	Comment
0.0	at Peg Line-05E at 55.0m
0.0	Tree canopy overhead throughout line at 2.0m to 4.0m high
0.0	Tree at 3.0m South
8.0	Tree at 8.0m East
14.0	Tree at 0.5m West
16.0	Tree at 4.0m West
18.0	Iron Stakes at 2.0m East
23.5	Tree at 1.0m East
25.5	Tree at 3.0m West

30.0	Tree at 1.0m West
37.0	Tree at 5.0m East
40.0	Tree at 0.5m West
40.0	Steel Bin at 4.0m East
47.0	Steel Bin at 6.0m West
47.0	Tree at 5.0m East
49.7	Tree stump at 1.0m East
51.6	Tree at 2.0m West
58.0	Steel Bin at 2.0m East
59.5	Tree stump at 3.0m East
61.0	Tree at 1.0m West
63.3	Peg
70.5	Tree at 0.5m East
74.0	Tree at 8.0m West
77.0	Tree at 3.0m West
81.0-88.0	Hut at 3.0m West
85.0	Steel Gas Canister at 3.0m West
92.0	Tree at 5.0m South
92.7	Line Finish (Road Bitumen starts at 94.0m)

LINE-B (Through Northern Site-Tentland. Bearing 08 °m. Start of line is at peg "Line:05E; 55mN which is also 0mN of Line:A)

Distance(m)N	Comment
0.0	Start of Line - Peg at Line-05E 55.0m
17.3	Two Metal Star Pickets at 5.0m West
21.9	Tree at 3.0m East

22.5	Tree at 7.0m West
28.5	Tree at 4.0m West
34.0	Metal SignPost at 3.5m East
36.3	Tree at 0.5m East
36.3	Stump at 4.5m West
43.6	Steel Bin at 4.0m East
48.0	Tap at 8.0m West
48.0	Power Pole at 7.0m West
50.0	Tree at 1.0m West
50.0	Tree at 4.0m East
53.6	Concrete Table at 3.0m West
54.3	Steel bin at 7.0m East
58.7	Steel Bin at 3.0m West
64.5	Tree at 1.0m East
65.1	Tree at 5.0m West
68.6	Powerline crossing line
69.4	Barbecue at 11.0m West
73.5	Metal Power Pole at 2.0m West
75.8	Steel Bin at 4.0m West
85.9-89.0	Concrete Table - concrete slab with bench.
93.0	Line Finish (Steel Bin at 3.0m West)

LINE-01N

(Offset 5m at bearing 190°m from manhole 32. Bearing of line is 100°m.)

Distance(m)	**Comment**
0.0	Trees at 2.0m South and 4.0m North

0.8-6.0	Sandy track into road
10.0	Tree at 2.0m
10.0	Metal Gates on Fibro Fence at 15m South
12.0	Tree at 3.0m North
27.0	Metal cap of water line at 1.0m South
27.0	Sandy Road start
37.4	Corner of Asbestos fence of house 1.0m South
38.0	Telecom - concrete box
50.0	Peg is 5.0m South of main manhole
51.5	Tree at 1.5m South
55.0	Overhang of foliage from previous tree
55.0	Equivalent to 9.9m on Line-01E
59.7	Bitumen start
59.8	Equivalent to 9.2m on Line-02E
64.0-65.5	Telecom underground cable -evidence in bitumen
65.5	Bitumen stops
65.5	Start of sandy centre portion of intersection
80.0	Bitumen starts
88.0	Bitumen stops
89.0	Telecom concrete hatch at 1.0m South
100.0	Concrete path of 2nd house

LINE-02N

(Offset 5m at bearing of 10°m from manhole 32. Bearing of line is 100°m)

Distance(m)	Comment

0.0	Timber/metal grill fence at 6.0m East
0.0	Middle of sandy track to road
2.3	Change from sandy track to grass
5.8	Tree at 2.0m North
9.6	Tree at 0.1m South
15.0	Tree at 1.0m North
21.0	Tree at 0.5m North
26.2	Green Domed Lid at 0.5mSouth"Electric Cables"
27.0	Tree at 1.0m North
34.8	Tree at 1.0m South
36.5	Tree at 1.0m South
46.3	Bitumen starts
55.1	Equivalent to 19.6m on Line-01E
60.1	Equivalent to 18.8m on Line-02E
63.0-71.0	Sewer Trench - possible apparent width
65.0	Bitumen stops
70.5	Tree at 3.0m North
81.3	Bitumen starts
86.0	West Wall of house B11 at 6.0m North
96.0	East Wall of house B11 at 7.0m North

APPENDIX C

PHOTOGRAPHS OF LOCALITY

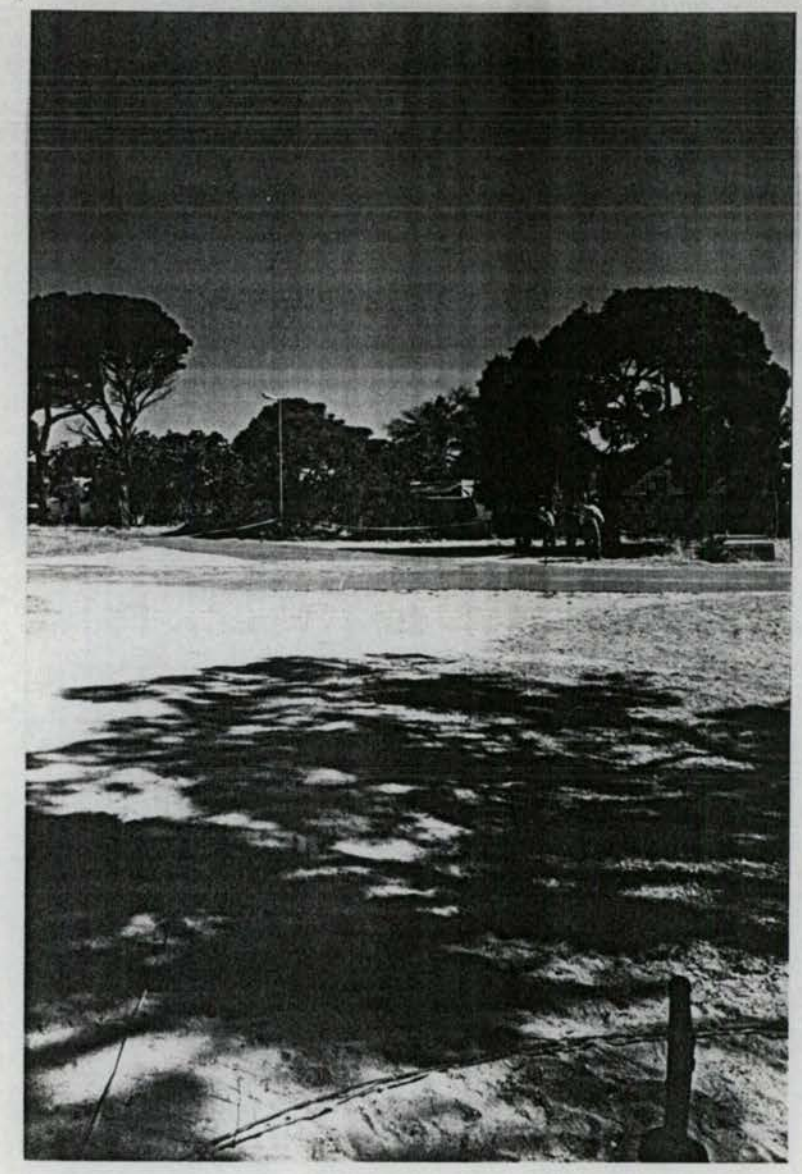

Photo : Looking at 3-D Grid Area
Showing Metal Pole and Fibro Fence in background
Viewing at bearing 190°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

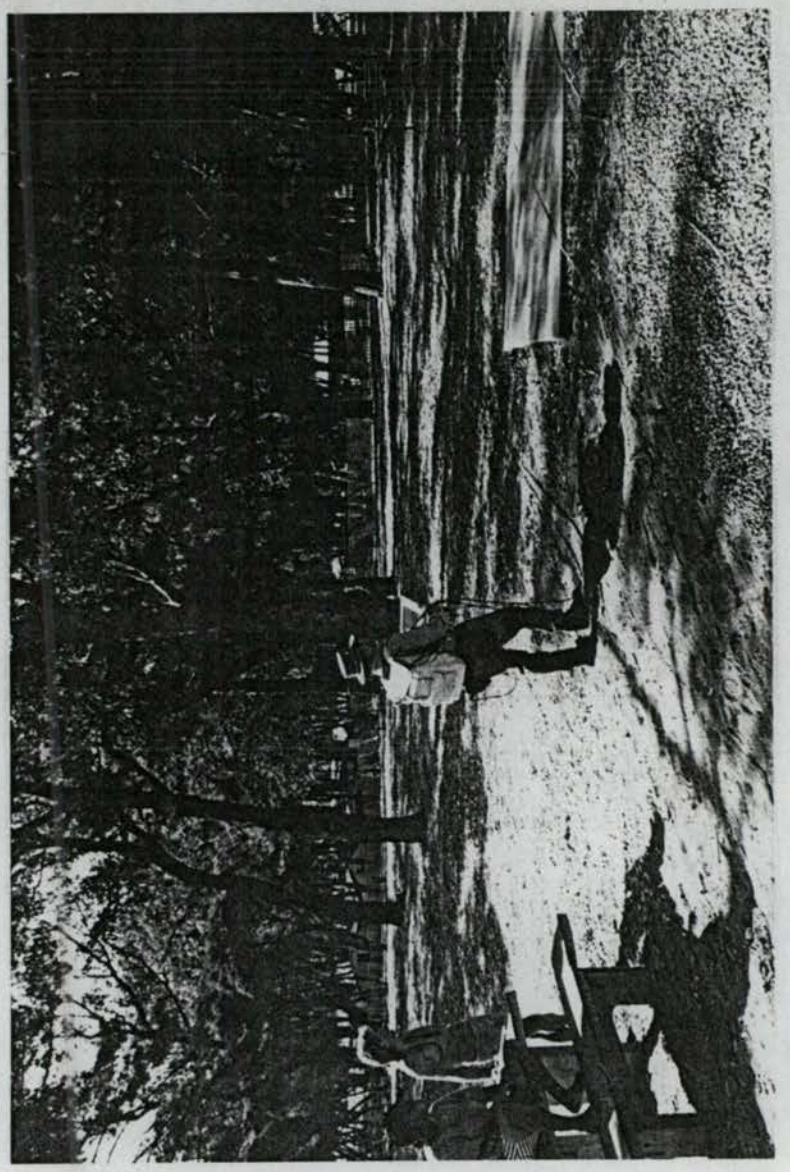

Photo : Looking at 3-D Grid Area
GPR Backpack System on Vern Wilson(Curtin Univ.)
Viewing at bearing 10°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

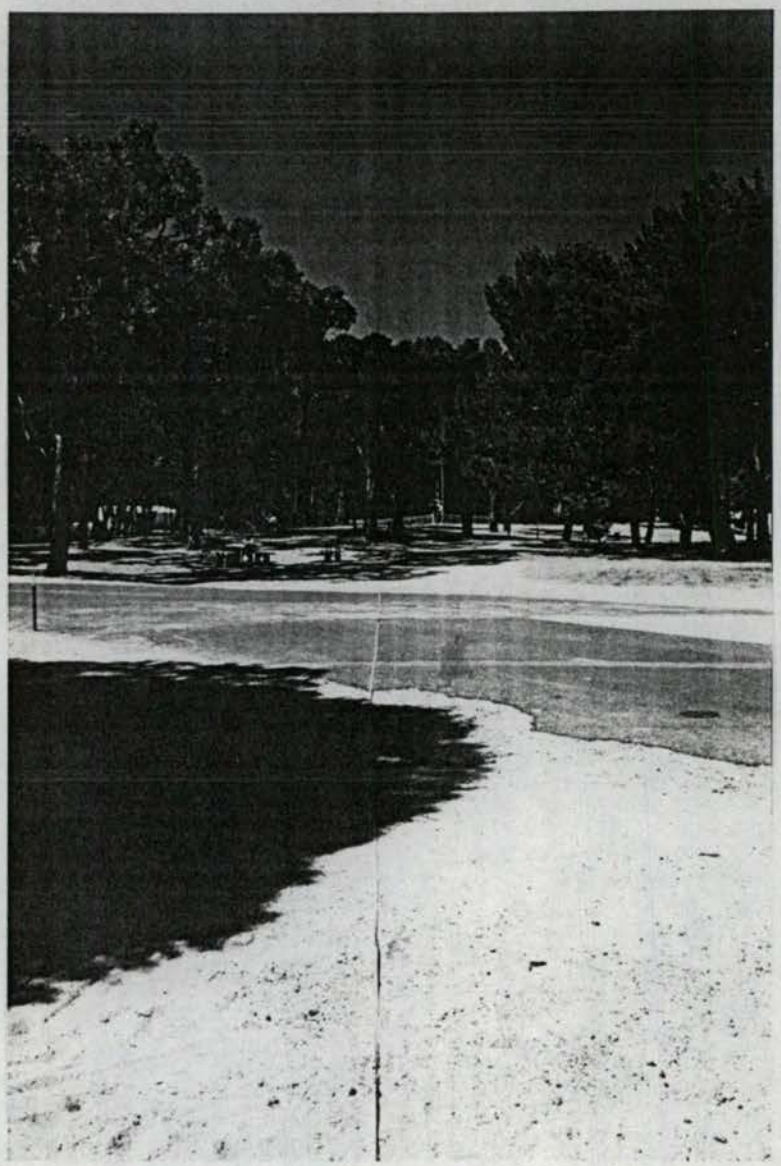

Photo : Looking at 3-D Grid Area
Bitumen Road shows in middle ground
Viewing at bearing 10°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

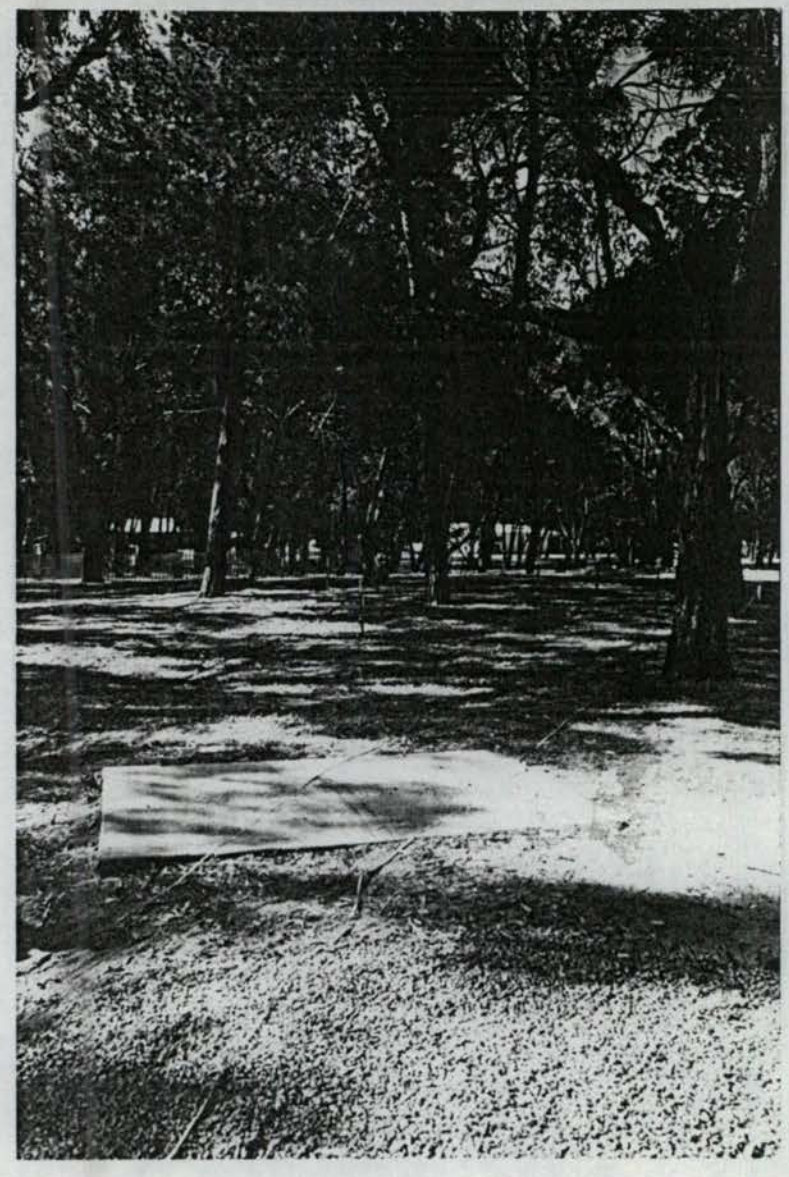

Photo : Looking at 3-D Grid Area
Showing Concrete Pad and Blue Metal Pile
Viewing at bearing 10°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

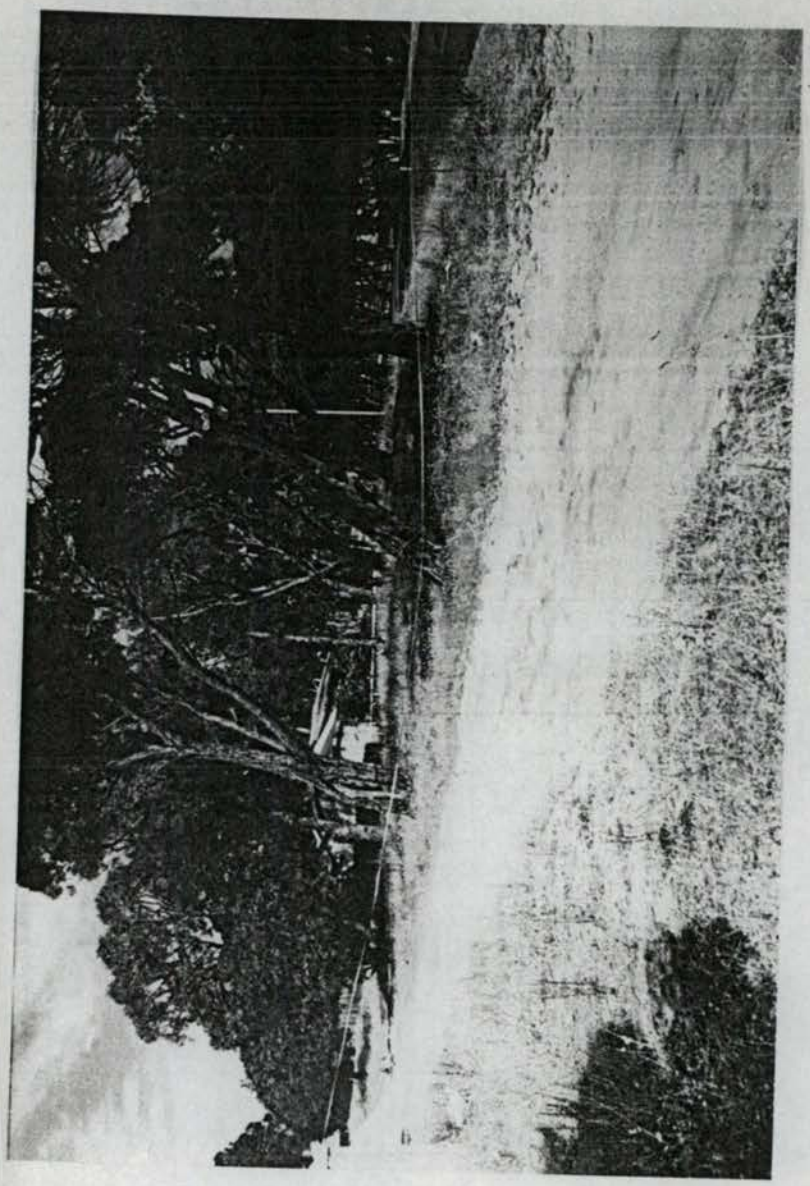

Photo : From Manhole 32 looking at start of LINE:1N
Viewing at bearing 280°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

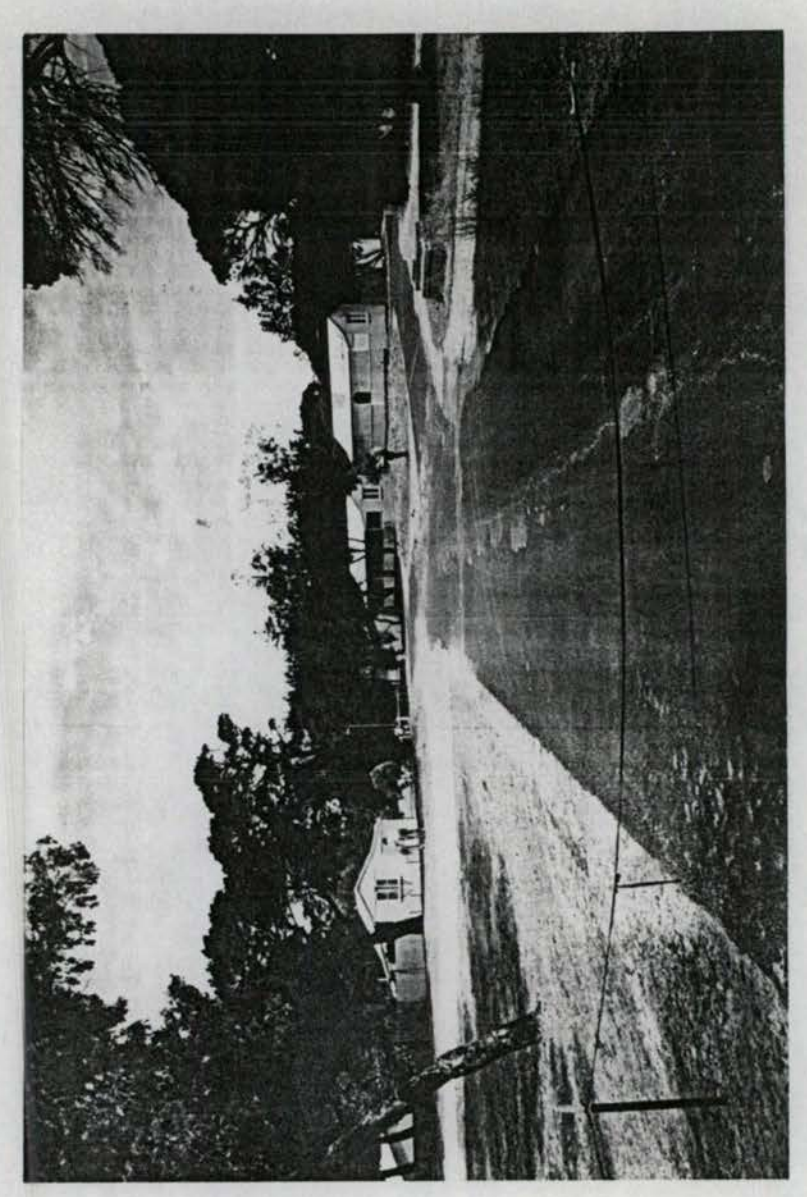

Photo : GPR shooting in background
Viewing at bearing 110°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

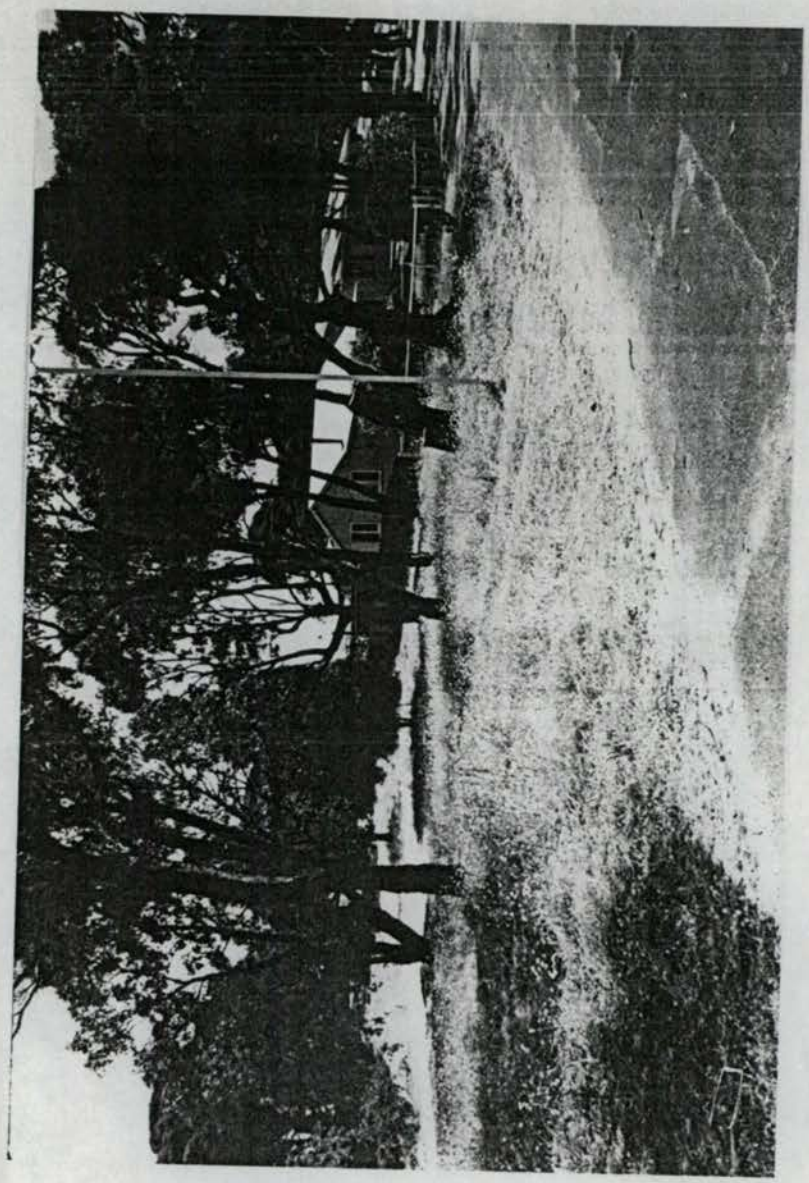

Photo : Looking at 3-D Grid Area
From Bitumen Road shows huts B11 & B12
Viewing at bearing 80°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

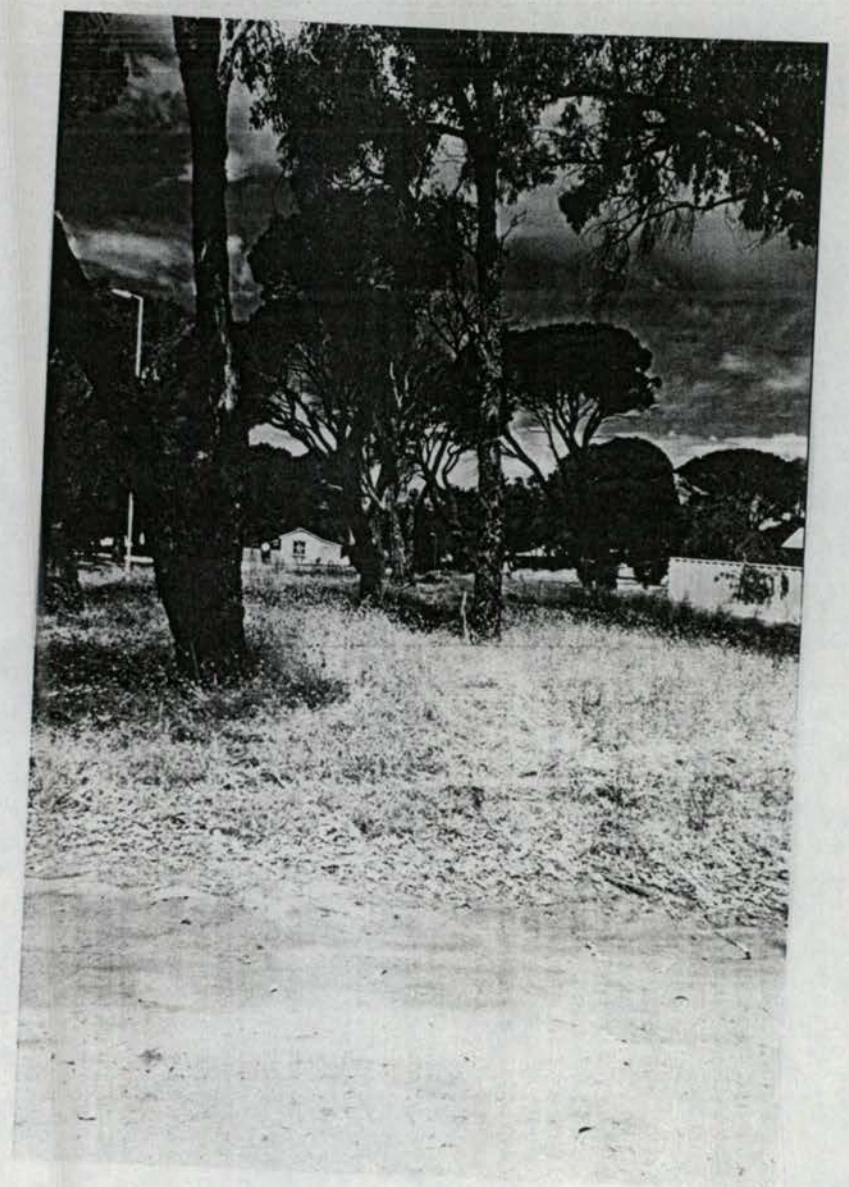

Photo : Offset from 3-D Grid Area
From 0m of LINE:1N shows start of line through grass
Viewing at bearing 110°m

GPR REPORT - CURTIN UNIVERSITY/ROTTNEST ISLAND
PHOTOGRAPHS

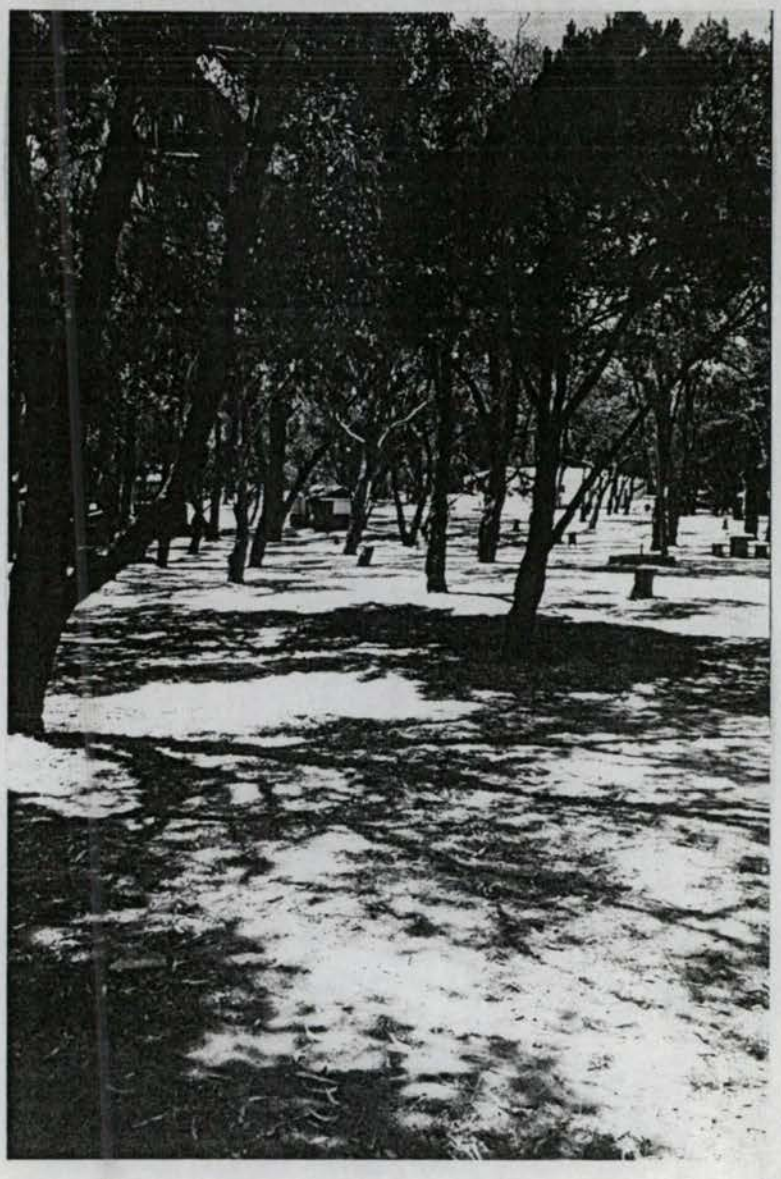

Photo : Northern Area
From 0m of LINE:A - Hut in background
Viewing at bearing 348°m

APPENDIX D

PROCESSED PROFILE SECTIONS

CURTIN UNIV./ WA MUSEUM

COUNTRY : Western Australia LINE : 11E
AREA : ROTTNEST ISLAND TRACES : 1 - 260

TITLE : Processed Section - GPR

Acquisition

GPR System	: PulseEKKO IV	Pulser Voltage	: 400
Frequency (MHz)	: 200	Antenna Spacing (m)	: 0.5
Number of Stacks	: 128	Recording Time (ns)	: 256
Sample Rate (ps)	: 800	Date of Recording	: 12/12/90
Trace Spacing (m)	: 0.2	Direction recorded	: 10 °mag

Processing

1. Time Zero Drift Correction:
2. Signal Saturation Correction:
3. Amplitude Recovery Gain:
4. Wavelet Shaping :
5. Bandpass Filter : 50 - 200 MHz. @ 0 ns.
6. Scaling : AGC using 100 ns windows
7. Static Correction: -2 ns. Zero Offset
8. Distances : 10.0m - 61.8m.
9. Depth Velocity : 0.13 metres/ns.
10. Display Datum : surface level

WAVEFORM P/L SCALE 1 : 66