Cardno MBK

Engineering the Future

HUTCHINSON BUILDERS PTY LTD

CASUARINA BEACH
NORTH PRECINCT

DETAILED SITE INVESTIGATION REPORT

17 AUGUST 2001

JOB NO: 7079/1-77

DETAILED SITE INVESTIGATION REPORT

NORTH PRECINCT, CASUARINA BEACH, NSW

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DETAILED SITE INVESTIGATION REPORT

NORTH PRECINCT, CASUARINA BEACH, NSW

1.0 INTRODUCTION

As part of the on going site investigation of mineral sand residues with elevated radioactivity levels reported in the "Preliminary Site Investigation Report Casuarina Beach North Precinct" by Cardno MBK, 25 July 2001, Cardno MBK (Qld) Pty Ltd was commissioned by Hutchinson Builders to conduct a detailed site investigation to establish the following:

- The extent and level of soil radioactivity on the Casuarina Beach site;
- Potential effects of radioactive material on public health;
- A suitable remediation/management strategy.

The investigation was carried out in accordance with NSW Government Department of Health – Radiation Branch publication, "No. 12 Clean-Up and Disposal of Radioactive Residues from Commercial Operations Involving Mineral Sands".

This report covers:

- The results of the on-site in-situ analysis of the investigation area;
- The vertical and horizontal extent of the contaminated material identified on site;
- The preliminary assessment of all other areas of the development; and
- Recommendations for ongoing site management/remediation.

2.0 LOCATION AND SITE DESCRIPTION

2.1 Location

The area under detailed investigation is located in the Northern Precinct of the Casuarina Beach development.

The Local Authority is the Tweed Shire Council and the Regulating Authority, with respect to radioactive material is the NSW Environmental Protection Authority – Radiation Control.

2.2 Site Description

The site under investigation is part of a major urban development.

A summary of the features of the site is presented in the detailed layout in Attachment I.

3.0 SITE HISTORY

Based on interviews with former mineral sand mining operators and desktop searches, it was noted that the site has been subject to mineral sand mining activities in the past. Mineral sand mining activities in the area were conducted between 1954 and 1976 (refer to past aerial photographs presented in attachment III). When mining activities ceased the area was partially rehabilitated. Development of the site for residential purposes commenced in 1999, and is likely to continue for approximately 10 years. The area in which radioactivity has been determined is the Northern Precinct of the development, which is presently awaiting approval by Tweed Shire Council for release of a Subdivision Certificate. The area currently remains under the control of the developer.

It has been established from former sand mining employees who worked on the site that waste deposits were isolated to the southern portion of the Northern Precinct,, which was the location of a dry separation mill. Past aerial photograph 3 in Attachment III identifies the dry mill and disposal area (area circled) in operation during 1971.

4.0 SITE INSPECTION

A number of detailed site inspections took place between the 2nd August and the 10th August 2001 by representatives of Cardno MBK and Queensland Department of Health Scientific Services, which acted as a specialist sub-consultant on this project. The aims of these investigations were to determine the following:

- The horizontal and vertical extent of the potentially radioactive soil material identified in the eastern swale.
- The levels of radioactivity present on the site.
- The identification of any other areas within the development with higher than background levels of radioactivity.
- Remediation/management options.

4.1 Topography and Vegetation

The topography in the local area consists of relatively flat land, interspersed with newly constructed stormwater swales and urban development.

Native vegetation in the area consists of Casuarina and Banksia species inhabiting the coastal dune area to the east and south of the area under investigation. Residential lots and stormwater swales in the vicinity of the investigation area had recently been seeded with various native and introduced grasses, although the coverage remains relatively sparse. Residential lots have also been covered with mulch to prevent wind and runoff erosion.

4.2 Filling

The existing landform on the site has been achieved by significant earthworks. However, no imported fill was used in this process, other than in road construction. In essence, the soil material on the site has simply been redistributed to form drainage swales and ridges to complement the urban development activity.

4.3 Geology

Substantial investigations on sub-surface conditions have been completed as part of the planning and design work for this project. The eastern parts of the site, including all of the area in the Northern Precinct, are underlain by beach and dune sand. In fact, there is no topsoil present on this site, with the soil profile consisting entirely of sand to depths well below the area of earthworks disturbance.

5.0 DETAILED RADIATION SURVEY METHODOLOGY

5.1 Radiation Survey of Southern Swale, and Lots 82, 70, 69, 67, 66

A detailed site investigation of the vertical and horizontal extent of radioactive sand mining residues discovered on site was carried out by drilling a series of boreholes and inserting a 90mm PVC pipe into the newly constructed bore. Borehole locations were selected by elevated surface radiation readings. A radiation activity count metre was lowered into the bore and minute radiation long counts were taken at 500mm intervals to 6 metres from surface level. The borehole locations are shown on Figure 1.

5.2 Radiation Survey of Areas Outside the Detailed Investigation Area

A comprehensive surface assessment of areas outside the scope of the detailed investigation area was conducted to determine the presence or otherwise of above-background radioactivity elsewhere on site. Every allotment in the Northern, Central and Southern precincts was analysed by walking transects and monitoring surface radioactivity levels. A patterned grid search procedure was adopted, such that measurements were taken within 10 to 15 m of every point on each allotment.

This assessment was conducted using a hand held SE International Radiation Alert Monitor 4 radiation detector. Any areas showing a level above 0.1 µG/h were earmarked for further investigation by Queensland Department of Health Scientific Services to validate the preliminary reading. A calibrated Bicron Micro Sievert survey monitor was used for this purpose.

No levels above background were recorded in the Southern and Central Precincts. A number of areas with radiation levels ranging up to 0.3 µG/h were identified in the Northern Precinct and subjected to more detailed assessment.

6.0 ANALYTICAL RESULTS

6.1 External Gamma Radiation survey

A Bicron Micro Sievert (serial number B251S) survey monitor was used to measure surface gamma radiation levels within areas subjected to detailed assessment. The instrument was calibrated by Scientific Services, traceable to the primary Australian Standard, specifically for environmental measurements in µGray per hour.

All site radiation level measurements were performed one metre above the ground surface. Using this measurement geometry and with typical soil densities, approximately 90% of the measured exposure rate originates from the top 200mm of material over an 8m radii (NCRP 1998). Soil moisture corrections can be considered as negligible under the weather conditions experienced during the survey, and were not applied to the results. A natural background surface gamma radiation level of 0.1 µGy/hr can be considered as normal for the area.

Surface radiation levels in excess of 0.3 µGy/hr were detected only on a small portion of lot N82, representing an area of less than 100 m^2.

6.2 Assessment Method Limitations

The surface gamma radiation survey technique is suitable only for measurement of material present in the top 200mm - 300mm of soil. Material below this depth shows no appreciable surface exposure rate.

In-situ down hole logging, sampling and subsequent laboratory analysis or the use of open inspection trenches and gamma survey can be considered the only suitable techniques for establishing the presence and extent of buried, radiologically enhanced material.

Visual inspection of soil/sand colour should not be considered as an alternative to radioactivity measurement due to the possibility of contaminants other than the black mineral ilmenite being present (e.g. monazite, a pale green / yellow mineralisation).

6.3 Downhole Logging

Downhole logging techniques allow for in-situ measurement of gamma radiation emitting materials. Results from the field measurements can be calibrated against samples using high resolution gamma ray spectrometry to establish possible gamma exposure rates associated with buried material.

A total of 10 bore holes were established to a depth of approximately 6m (or water table) and cased with 90mm PVC piping. The logging tool was then lowered in the bore hole and results logged every 0.5m. Several laboratory samples were collected from known depths for system calibration.

The results of this analysis are presented in Figure 2 attached to the Queensland Health report. In summary, it was determined that an area of approximately 3,500 m^2 beneath Lot N82 was likely to be affected by levels of radiation up to about 1 µGy/hr, if the requisite soil material was brought to the surface and placed in a layer 200 mm thick. This radioactive material also underlies the southern drainage swale. It in noted that existing surface levels on both areas are lower than the Guideline values of 0.7 and 2.5 µGy/hr adopted by the NSW Department of Health for residential and open space areas respectively.

6.4 Preliminary Assessment of Areas Outside the Detailed Investigation Scope

The preliminary assessment of lots outside the detailed investigation area identified 11 residential lots in the northern precinct with surface radiation levels above 0.1 µGy/hr, but not exceeding 0.3 µGy/hr. Queensland Health subsequently validated these lots with the preliminary levels being confirmed between 0.2 and 0.3 µGy/hr. The locations of these lots are presented in Attachment I.

Dark mineral staining was also identified in the crown road reserve on the northern boundary of the northern precinct, which serves as a stormwater infiltration basin presently. A radiation survey was conducted on this area and recorded surface radiation levels ranging from 0.1 to 0.6 µGy/hr in a localised area of approximately 50m^2.

No elevated surface radiation readings were detected in the Central and Southern Precincts of the Development.

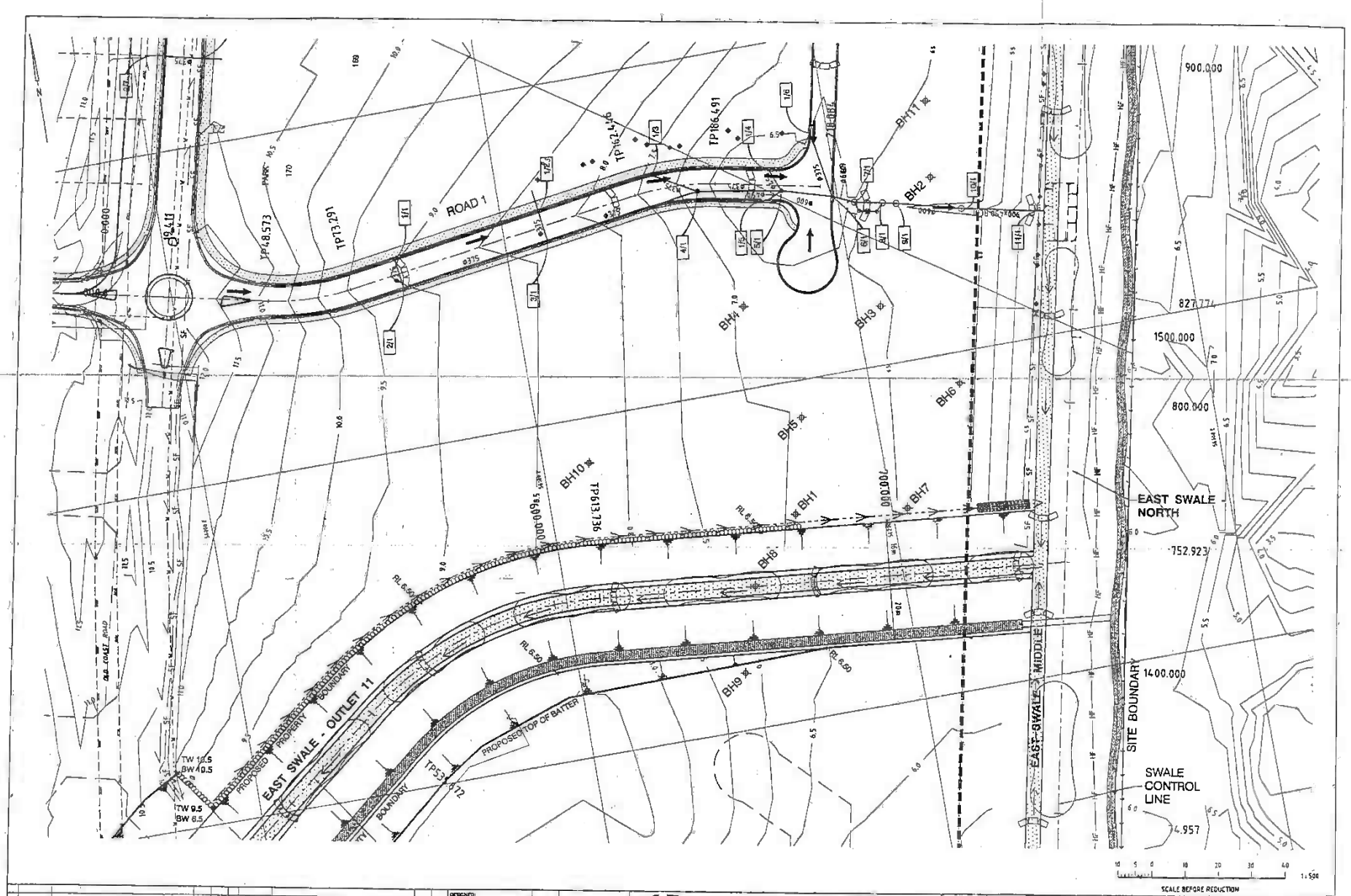


Figure 2b

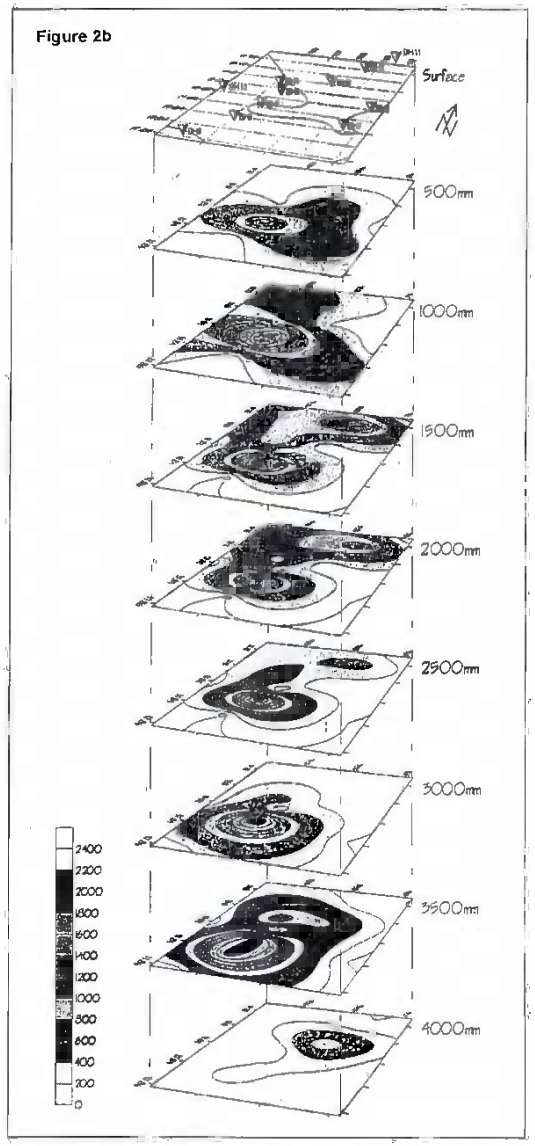
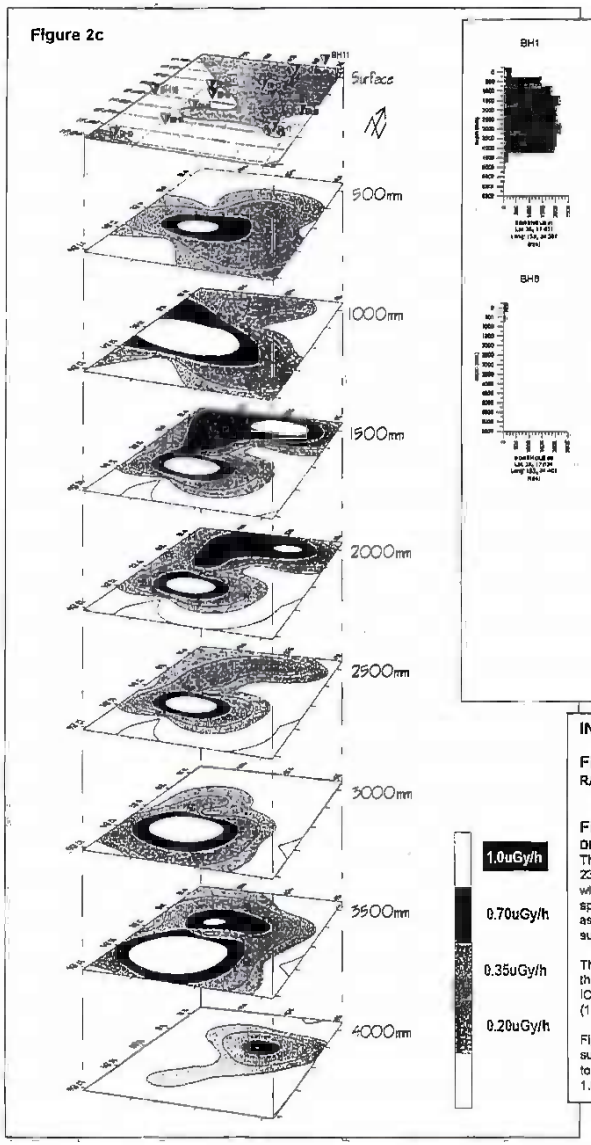


Figure 2c



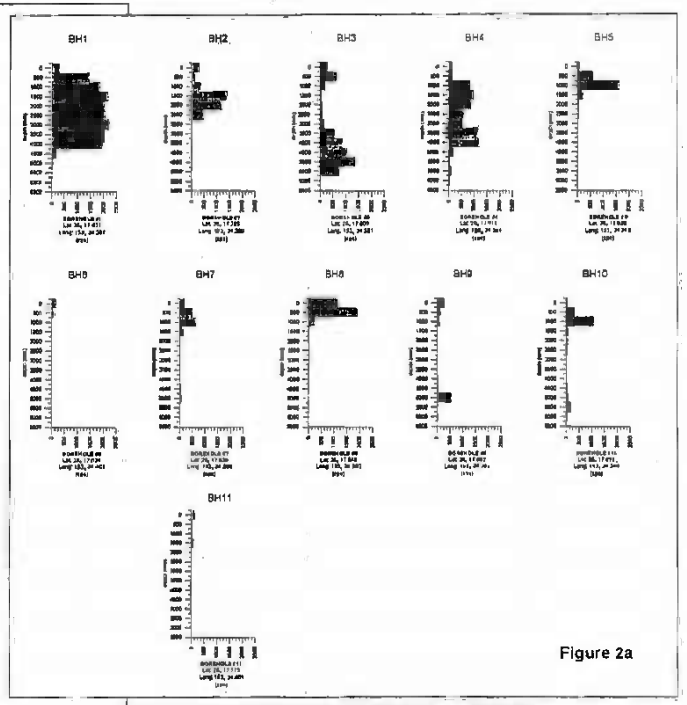


Figure 2a

INTERPRETATION OF DATA

Figure 2b
RAW DATA: DEPTH vs ACTIVITY

Figure 2c
DERIVED SURFACE EXPOSURE RATE

The raw logging data has been converted to a combined uranium 238 + thorium 232 activity concentration by comparing log count rate with specific activity determined by high resolution gamma spectrometry. Based on the gamma spectrometry results, it is assumed that there is a 1:2.5 U/Th activity ratio for all material surveyed.

The combined uranium 238 + thorium 232 activity concentration is then converted to surface exposure rate based on data provided by ICRU Report 53, *Gamma-Ray Spectrometry in the Environment* (1994).

Figure 2c shows the extent of buried material that, if bought to the surface and distributed to a depth of approx. 200mm, would give rise to surface gamma radiation levels of between 0.20uGy/h (green) and 1.0uGy/h (yellow).

FIGURE 2: Area 1 downhole logging results
Queensland Health Scientific Services

I:\707901 Casuarina Beach\77\Reports\01pq72.contour plot1f.doc

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Requested by: Simon Groth
Cardno MBK (Qld) Pty Ltd
Commercial Centre, Isle of Capri
GOLD COAST Q 4217

Reference: Casuarina Beach Development

SUBSURFACE RADIATION INVESTIGATION REPORT No. 01PQ227
Extension to Report No. 01PQ72

North Precinct, Casuarina Beach Development
TWEED SHIRE NSW

Date Request Received: 25 January 2002

Report Description: Subsurface Radiation Investigation, North Precinct Casuarina Beach Development, Kingscliff, NSW.

1.0 SCOPE OF WORK

A subsurface radiation investigation of the North Precinct, Casuarina Beach development was conducted to compliment prior subsurface characterisation of the site (QHSS 2001).

A radiation exposure pathway analysis has been developed using experimental data collected by logging a number of bore holes in designated subject areas. The scope of the report is limited to those areas identified by Cardno MBK (Qld) as to be included in the investigation.

The locations of the subject areas are shown in Figure 1, a generalised plan of the development area provided by Cardno MBK (Qld).

Queensland Health Scientific Services was commissioned by Cardno MBK (Qld) to perform the additional subsurface investigation for inclusion in a report to the site developer.

2.0 ASSESSMENT STRATEGY

2.1 Exposure Pathways

A number of radiation exposure pathways may be considered in assessing the impact of a mineral sand deposit containing enhanced levels of radioactive materials. The pathways include external gamma irradiation, inhalation of particulates and the radioactive gas radon, and ingestion of the material. The physical and chemical properties of the mineral sand materials present on the site do not promote significant exposure contributions from ingestion and inhalation of particulates in a residential / suburban land use situation. It is also unlikely that a significant inhalation exposure would be derived from radon due to local weather conditions and prevailing sub tropical construction practices, i.e. open plan, well ventilated structures.

2.2 Subject Area

The subject area includes the site described in the Stage1 report. Mr Allan Burton and Mr Gordon Gee, Queensland Health Scientific Services and a representative of Cardno MBK (Qld) performed the investigation on 05 February 2002.

Description: Area 1 (Figure 1, Inset 1)
Assessment Method: Downhole logging to water table.

2.3 Downhole Logging

Down hole logging techniques allow for in-situ measurement of gamma radiation emitting materials. Results from the field measurements can be calibrated against samples using high resolution gamma ray spectrometry to establish possible gamma exposure rates associated with buried material.

Bore holes were established to a depth of approximately 6m (or water table) and cased with 90mm PVC piping. The logging tool was then lowered in the bore hole and results logged every 0.5m. Previously assayed laboratory samples were used for system calibration.

3.0 RESULTS

Results of the downhole logging data are provided in Figure 2. Figure 2a shows isoactivity contours for 0.5m depth slices to 5.5m. Figure 2b shows the material buried at depth that, if distributed on the surface, may give rise to surface gamma radiation activities in the range of $0.2\mu Gy.h^{-1}$ to $2\mu Gy.h^{-1}$.

Figure 3 shows a comparison of previous downhole mapping results (QHSS 2001) with the more detailed current data. It is obvious that large quantities of material are present at depth and that the extent of the bulk material has not been fully mapped. Surface gamma radiation surveys have not detected the presence of this buried material.

4.0 CONCLUSIONS

The additional logging of bore holes in the subject area, in addition with observations made in open test pits, has further defined the extent of radiologically enhanced mineral sand material at depths to at least the water table (approx. 6m).

The scope of this report does not allow for a blanket characterisation of the extent of buried materials that may be present in the remainder of the development. It is recommended that an extensive subsurface investigation program be instigated should full characterisation of the site be required by the relevant authorities.

In the event that radiologically enhanced material is removed off site, including transport on public roads, relevant authorities should be contacted regarding transport and disposal regulatory requirements.

An occupational health and safety plan should be developed for any remediation activities implemented for the site. Control of dust and external radiation exposure should be considered in conjunction with exposure monitoring of workers.

5.0 LIMITATIONS OF REPORT

Scientific Services has prepared this report for use by Cardno MBK (Qld) in accordance with generally accepted consulting practice. It may not contain sufficient information for the purposes of other parties or other uses.

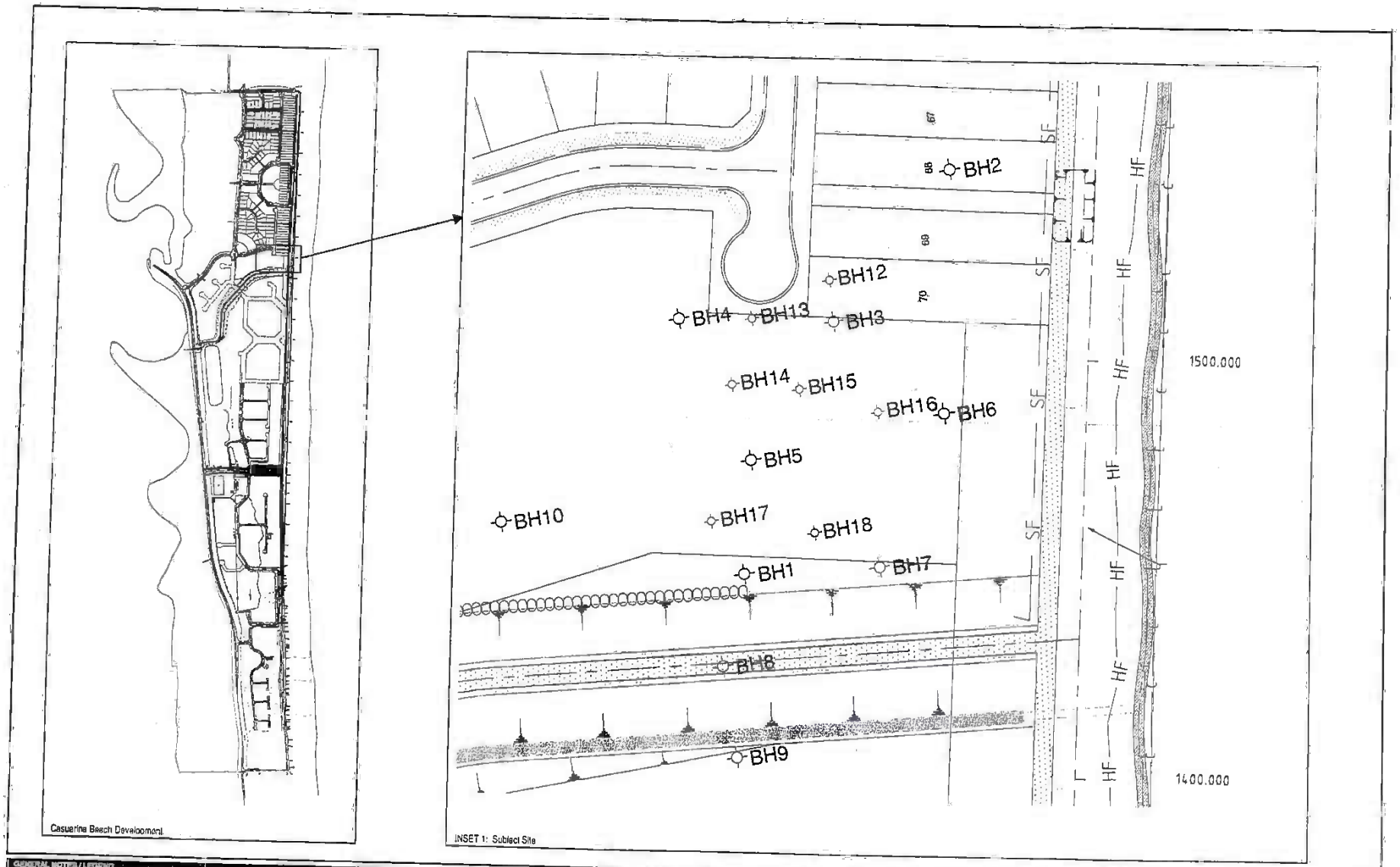
To the best of our knowledge the information contained in this report is accurate at the date of issue. Any site works, redistribution of material or engineering works carried out on the site after surveys or data collection activities by Queensland Health Scientific Services may invalidate information provided in this report.

6.0 REFERENCES

1. QHSS (2001). *Stage 2 Radiation Investigation Report No. 01PQ72. North Precinct, Casuarina Beach Development.* Queensland Health Scientific Services. Queensland Health. Brisbane. Australia.

R Kleinschmidt
Senior Health Physicist
MARPS, SPERA

12 February 2002



GENERAL NOTES / LEGEND

Date of survey: 05 February 2002
Survey Instrument: NaI(Tl) downhole tool

BHbx bo e holes, survey 02 Aug 2001

BHbx bore holes, survey 05 Feb 2002

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Job/Lab No: 01PQ227	Date: 07 Feb 2002
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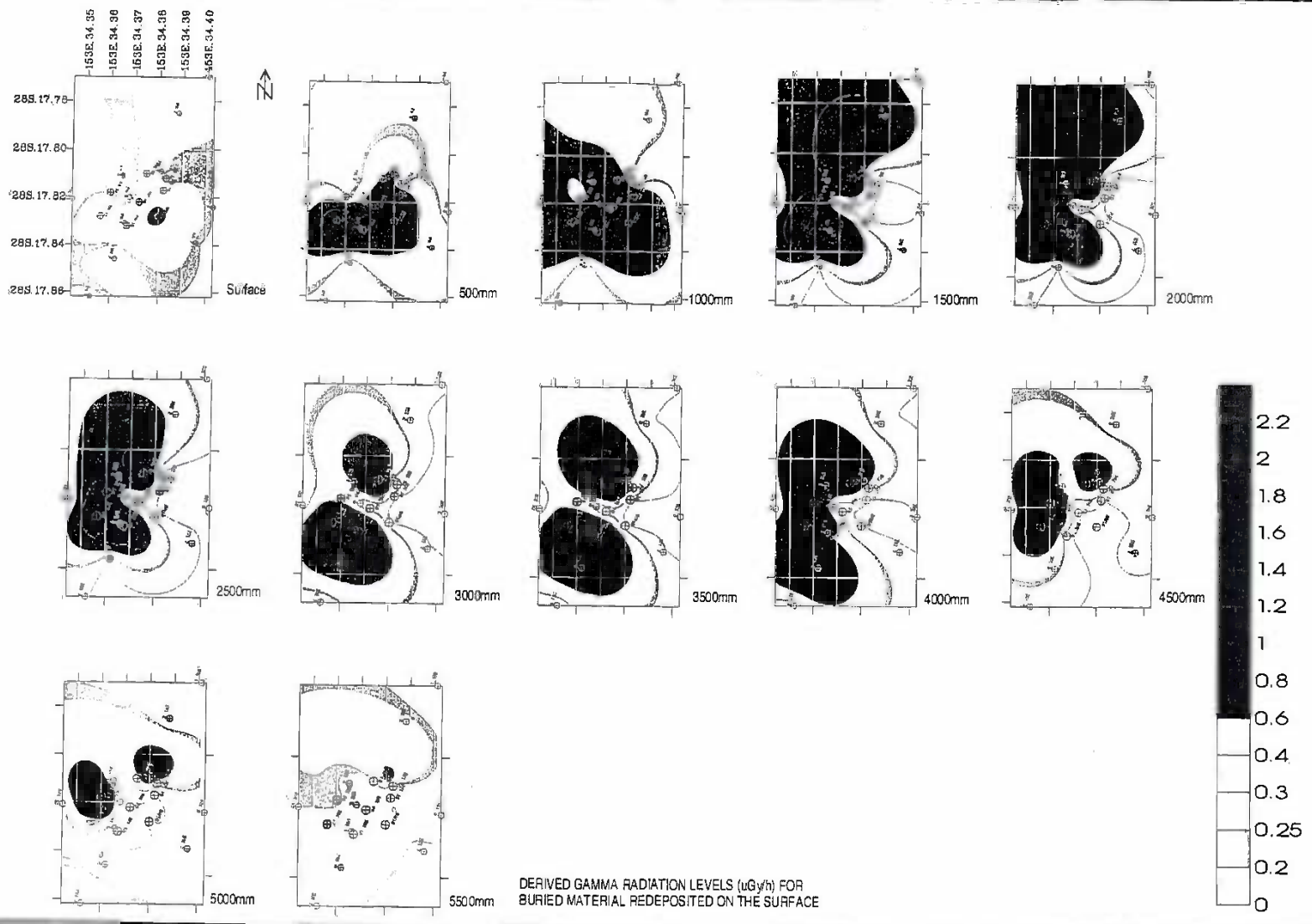
Project: CASUARINA BEACH NORTH PRECINCT	Title: SITE & BOREHOLE LOCATIONS
Client: Cardno MBK (Aust) Gold Coast	Drawing No.: Figure 1
	Rev: 1.2



DERIVED GAMMA RADIATION LEVELS (uGy/h) FOR BURIED MATERIAL REDEPOSITED ON THE SURFACE

GENERAL NOTES

All measurements are in µGy.h^{-1} unless otherwise indicated.

Survey conducted by: Allan Burton & Gordon Gee
Date of survey: 05 February 2002
Survey instrument: NaI(Tl) downhole tool

Drawn	Scale
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Job/Cad file	Date
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File	
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ABN: 66 329 169 412
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Project	Title
CASUARINA BEACH NORTH PRECINCT	DERIVED SURFACE GAMMA RADIATION LEVELS (uGy/h) FOR BURIED MATERIAL - PLAN VIEWS
Client	Drawing No. / Rev
Cardno MBK (Aust.) Gold Coast	Figure 4 — 1.1

7.0 DISCUSSION OF RESULTS

The detailed sub-surface investigation determined that radioactive material with a gamma radiation level of between 0.7 and 1.0 µGy/hr was located beneath the southern drainage swale, and lot N82. As illustrated on Figure 2, the extent and level of radioactive material varies at depth. On the basis that residences constructed in this area will require footing excavation, and almost certainly swimming pools, appropriate remediation strategies are required to minimise the potential exposure of radioactive material buried at depth.

Radiation levels up to 1.0 µGy/hr were recorded at depth and if brought to the surface could cause surface radiation levels slightly above he action level criteria for residential properties. It is considered that remediation to a depth of 2.5 metres will be adequate to ensure that any residual material remains undisturbed by any future residential development.

No lots outside of lot N82 displayed surface radiation levels above 0.3 µGy/hr, which is less than 50% of the action level criteria of 0.7 µGy/hr for residential areas. Radiation levels taken at the surface in measurement locations indicated that the slightly elevated levels recorded at 1 m above the surface were not likely to be caused by substantial material present at depth. Queensland Health has recommended that further hand augering and monitoring investigations be carried out in these locations to confirm this finding. However, it has been determined by the developer that it will excavate the affected material in these areas, and treat this material concurrently with the remediation process for lot N82. Site investigations will therefore be undertaken as part of this procedure.

Dark mineral stained sands identified in the Crown Road Reserve do not exceed any action clean up levels. However it is recommended that this material be incorporated in future remediation strategies for completeness. The developer will therefore also excavate this material and dilute it with clean sand, in an identical fashion to that proposed for Lot N82.

8.0 REMEDIATION STRATEGY

The remediation strategy developed for the contaminated areas would be required to reduce the risk of potential long term human exposure to contaminated soils to acceptable levels.

In order to achieve this, the following remediation strategy is recommended.

A residual radiation value of 0.35 µGy/hr is considered adequate for the affected areas which comprise future residential allotments. The proposed remediation strategy in this case is to excavate material to a depth of 2.5 m over the affected area, and vertically mix this material with uncontaminated sand found elsewhere on the site. The area on Lot 82 potentially affected by elevated radioactivity is approximately 3,500 m^2, although this will be confirmed by detailed site testing undertaken during the remediation process. The extent of material requiring treatment will be confirmed during the excavation process, and excavation will encompass all areas where radiation levels in excess of 0.7 µGy/hr are found in sub-surface deposits.

Appropriate environmental management measures will be implemented to mitigate potential migration by wind and water erosion and a Remediation Action Plan would be developed which would incorporate an Occupational Health and Safety plan specific to the handling of low level radioactive materials. Validation of the remediation works conducted would be carried out by recording surface radiation levels of the affected area and a report submitted to Council for sign off on the suitability of the prescribed areas for their future uses.

No specific remediation measures are proposed for the southern open space area which is affected by elevated radiation levels. The monitored levels are significantly less than the Guideline value of 2.5 µGy/hr adopted by the NSW Department of Health for open space areas. The swale area at the north will eventually be incorporated into a road to be built at this location, although it is proposed to reduce existing radiation levels by mixing in the interim duration.

It is considered that existing radiation levels within the open space areas comply with appropriate recommended levels, and pose no danger to humans or to the environment.

9.0 CONCLUSION

The information presented in this report shows that existing surface radiation levels within the Northern Precinct are compliant with NSW Government guidelines, and that no remedial action is specifically required. However, it has been identified that elevated radiation levels at depth below lot N82 could present problems to future home owners and residents of the area.

For this reason, it has been recommended that a limited remediation program be completed over lot N82 and other potentially affected areas within the site to remove any potential limitations on future residents of the area. This program will consist of excavation of material over an area of approximately 3,500 m^2 on this lot, and mixing of this material with clean sand available elsewhere on the site. The remediation will continue until maximum radiation levels of 0.35 µGy/hr are achieved within the affected area.

A detailed remediation report will be prepared and submitted to Council for final signoff following completion of the work.

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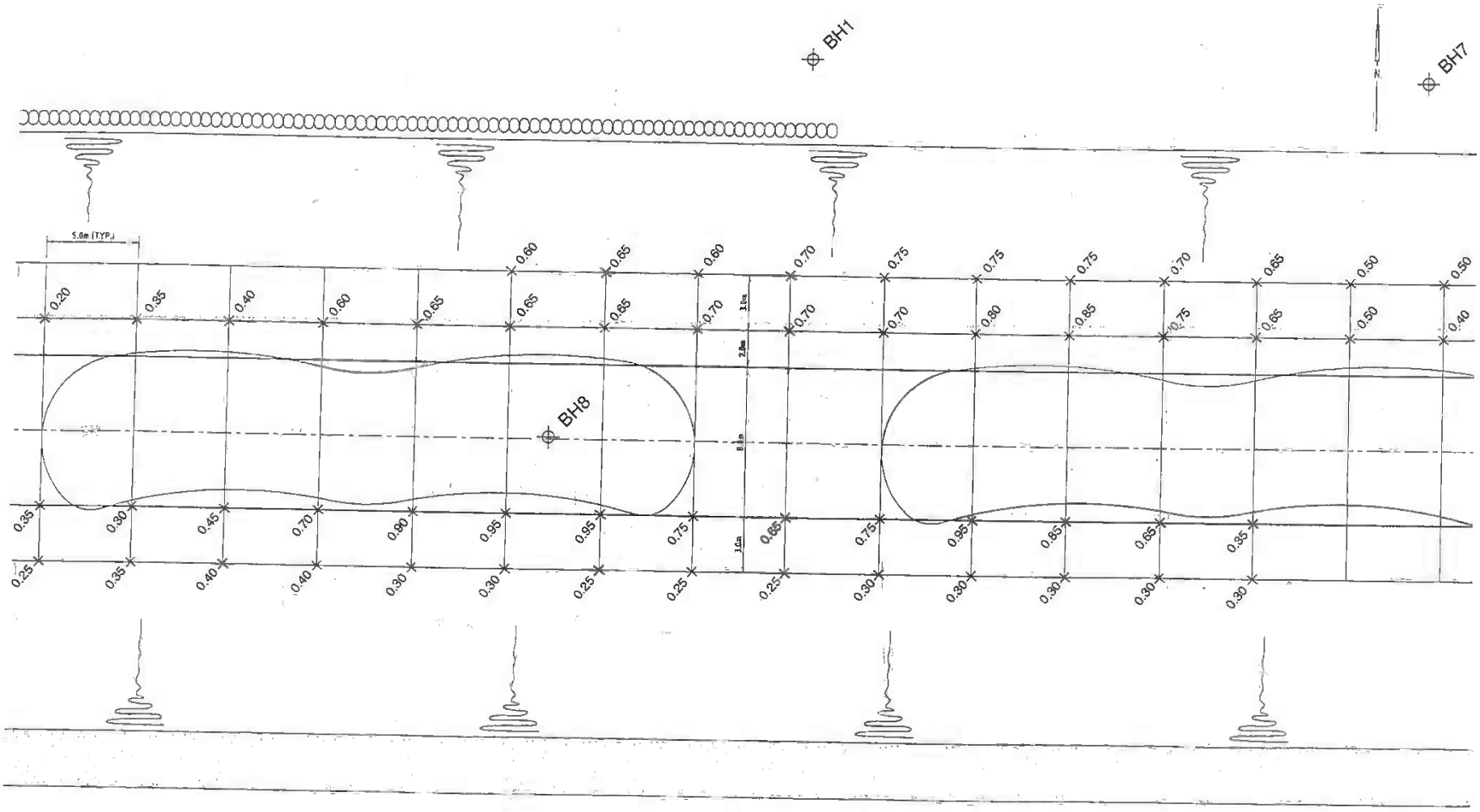
ATTACHMENT I

SITE LAYOUT/SAMPLE LOCATIONS



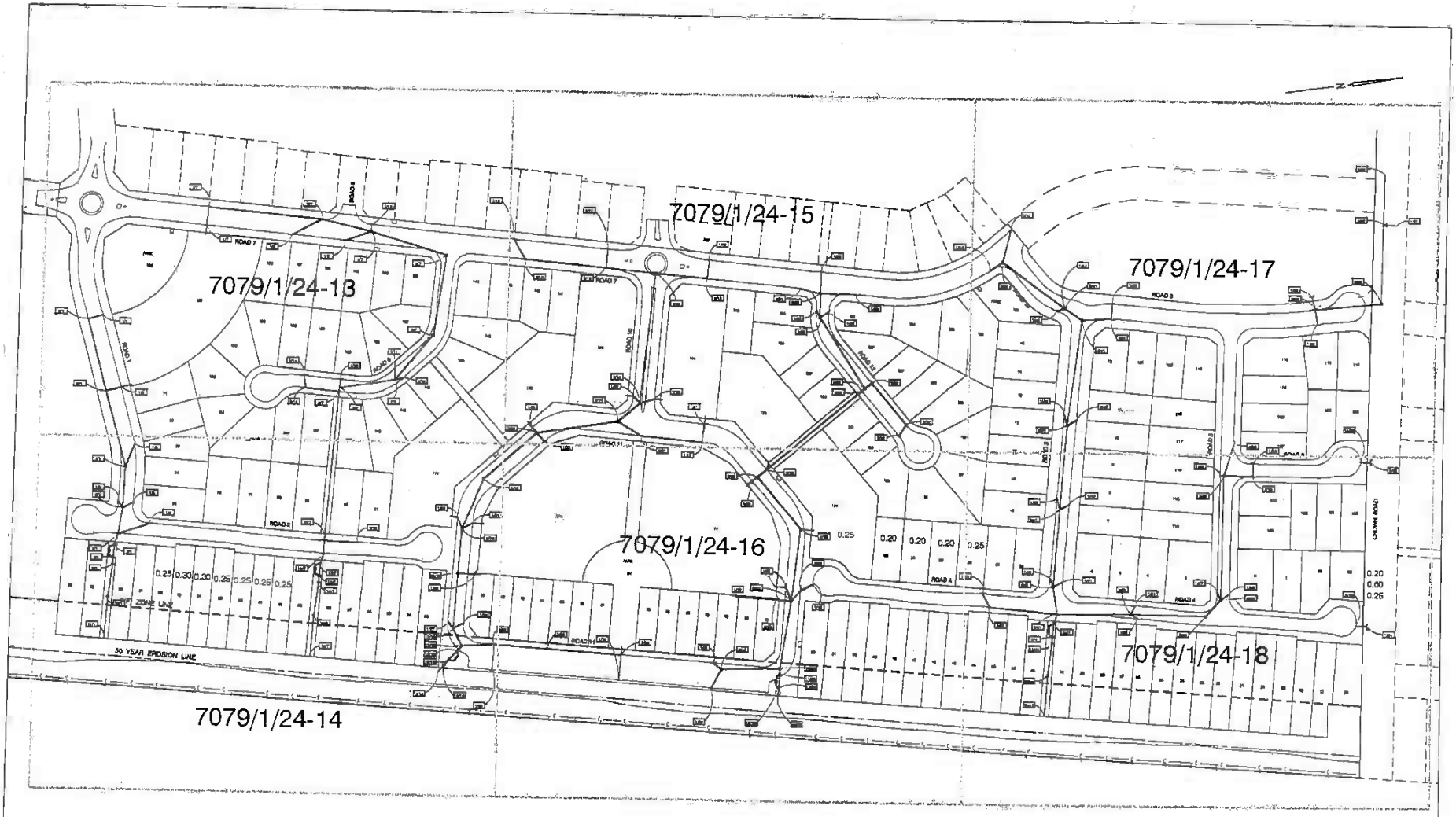
CONSOLIDATED PROPERTIES GROUP PTY LTD	
CASUARINA BEACH PROJECT NORTH PRECINCT	SCALE – N.T.S. DATE – 10th AUGUST 2001 JOB No. 7079/1-24

Cardno MBK

CAD FILE NAME: GA7079\01\24\7079124SK18.dwg

SK No.18 (13-08-01)

EAST-WEST SWALE RADIATION LEVELS



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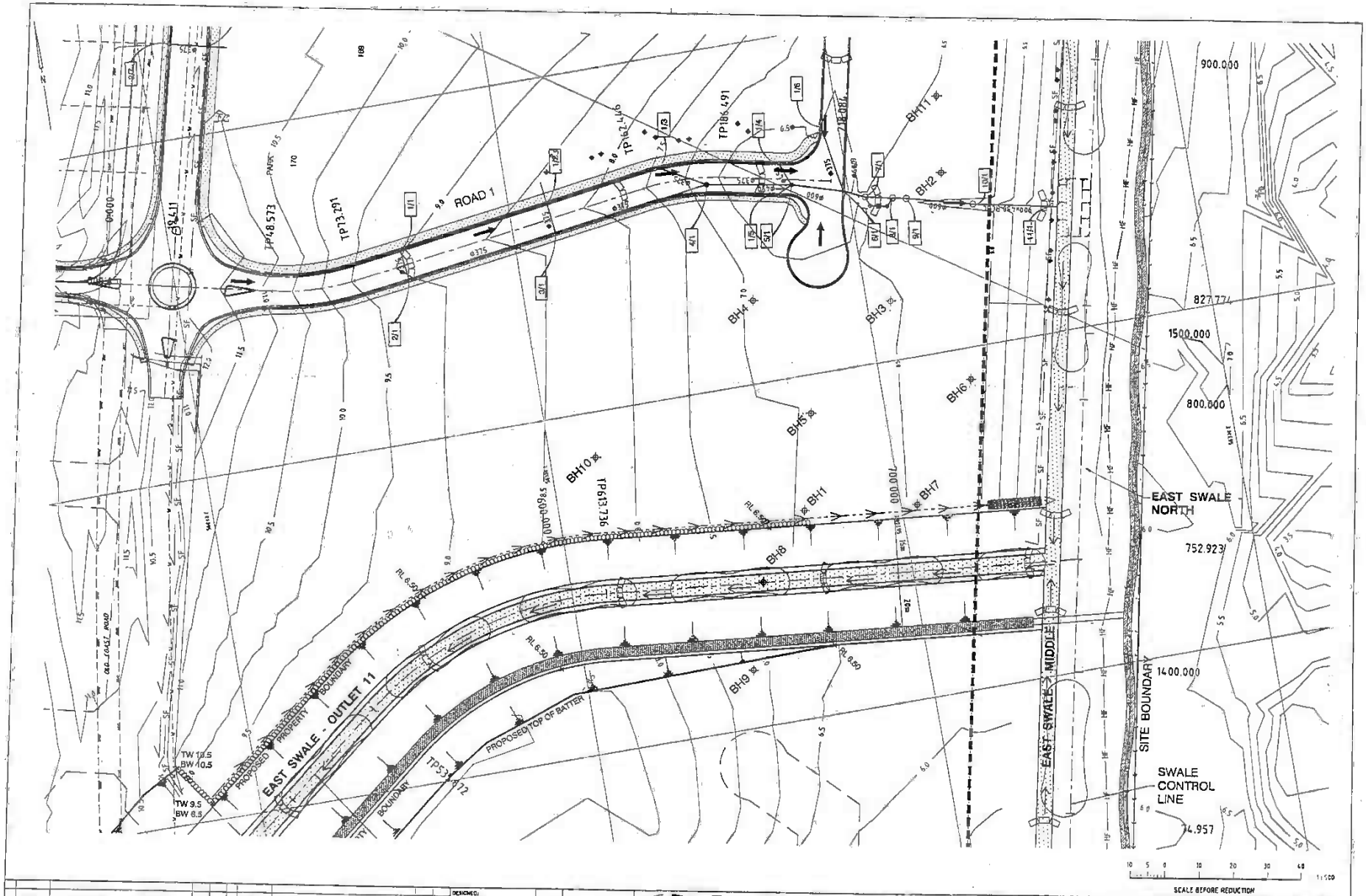
No.	DATE	REVISIONS	REC.	APPR.	GENERAL LAYOUT PLAN
A	17-01-91	REVISED TO COUNCIL			DATE: JANUARY 1991
					DRAWING No: 7079/1/24-12



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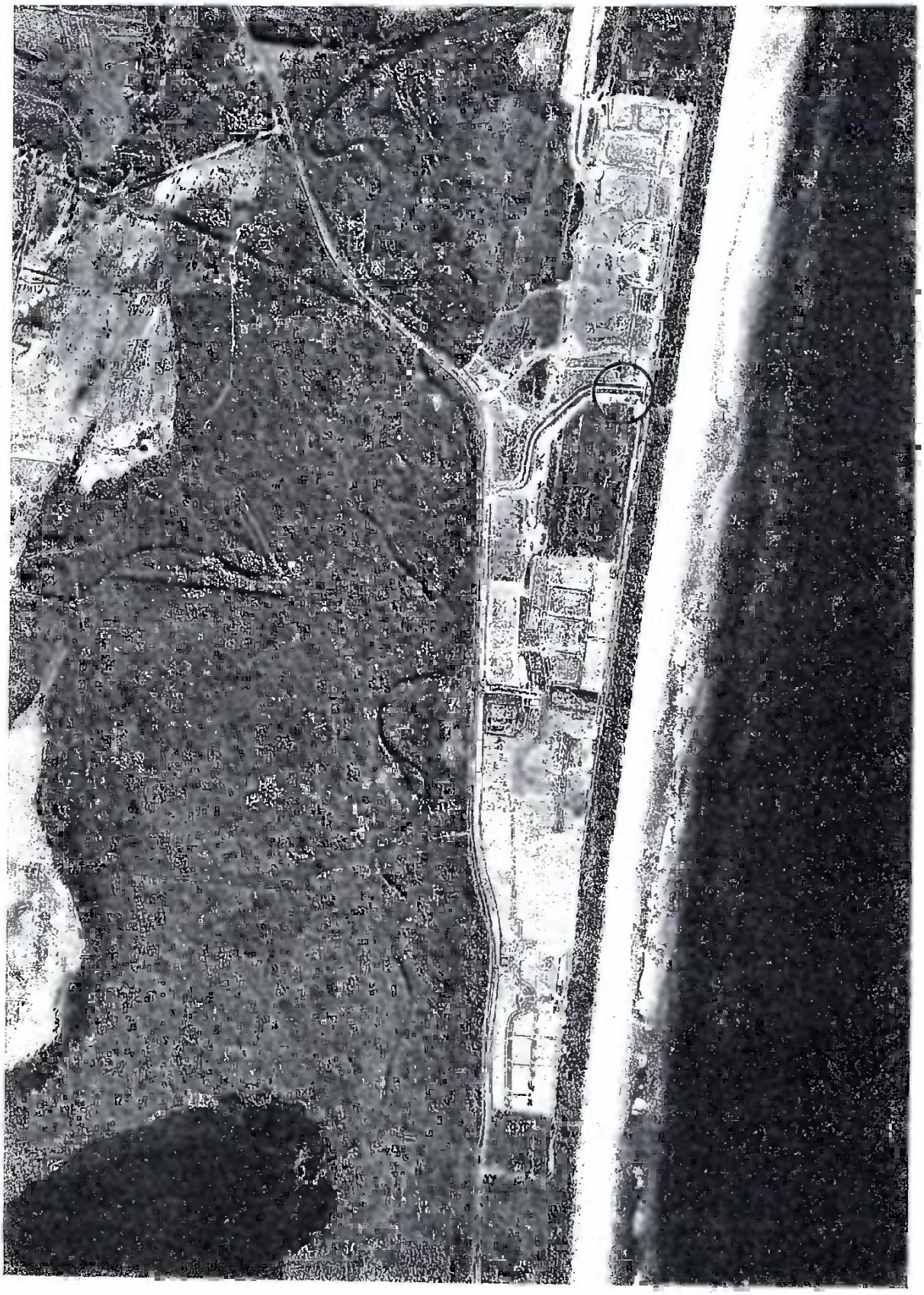
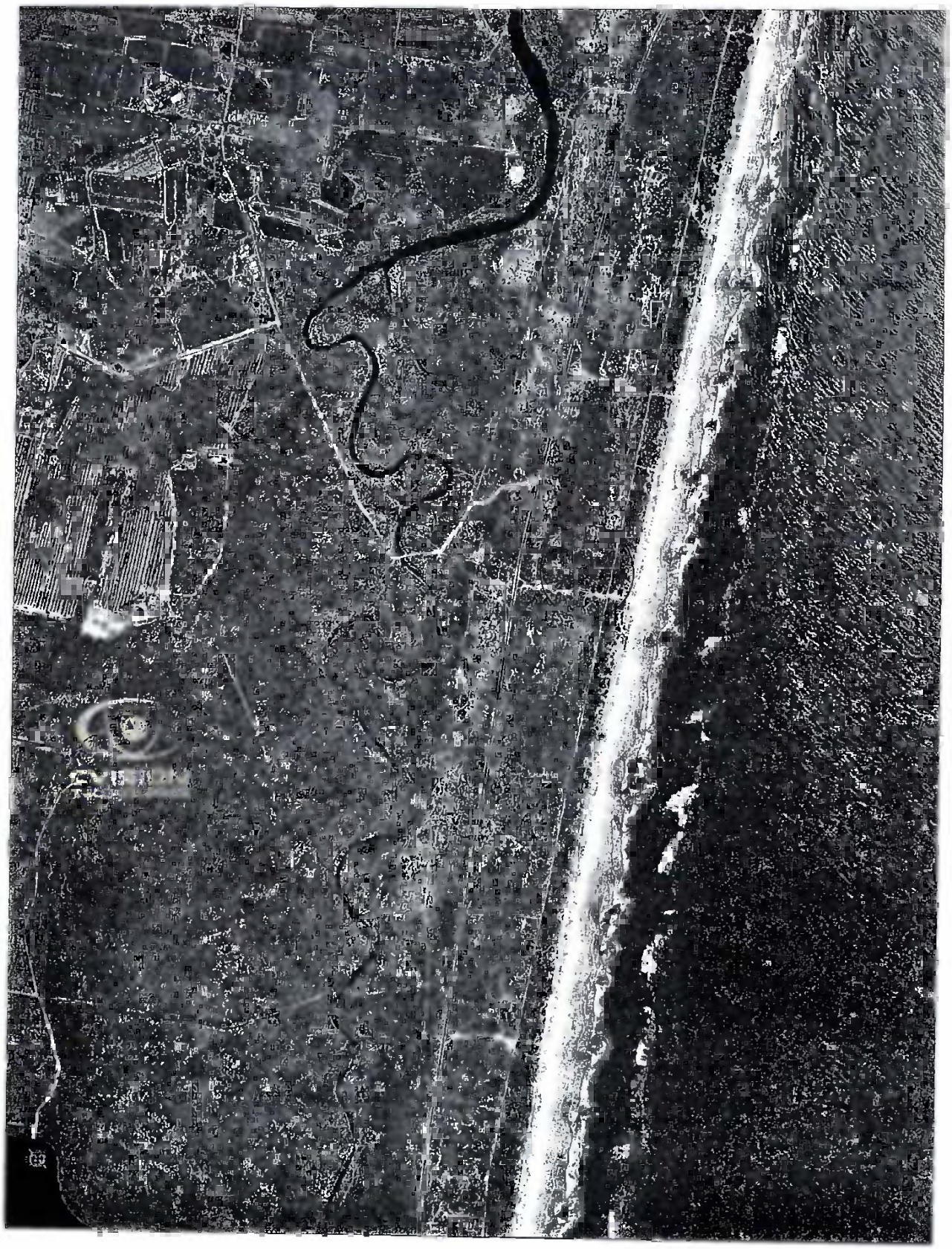
RECOMMENDED: PROJ. MAN.	APPROVED: PROJ. DIR.			DETAILED SITE INVESTIGATION	7079/1/24-FIG. 2
REF ATTACHED:				CASUARINA BEACH	
CAD FILE NAME:					

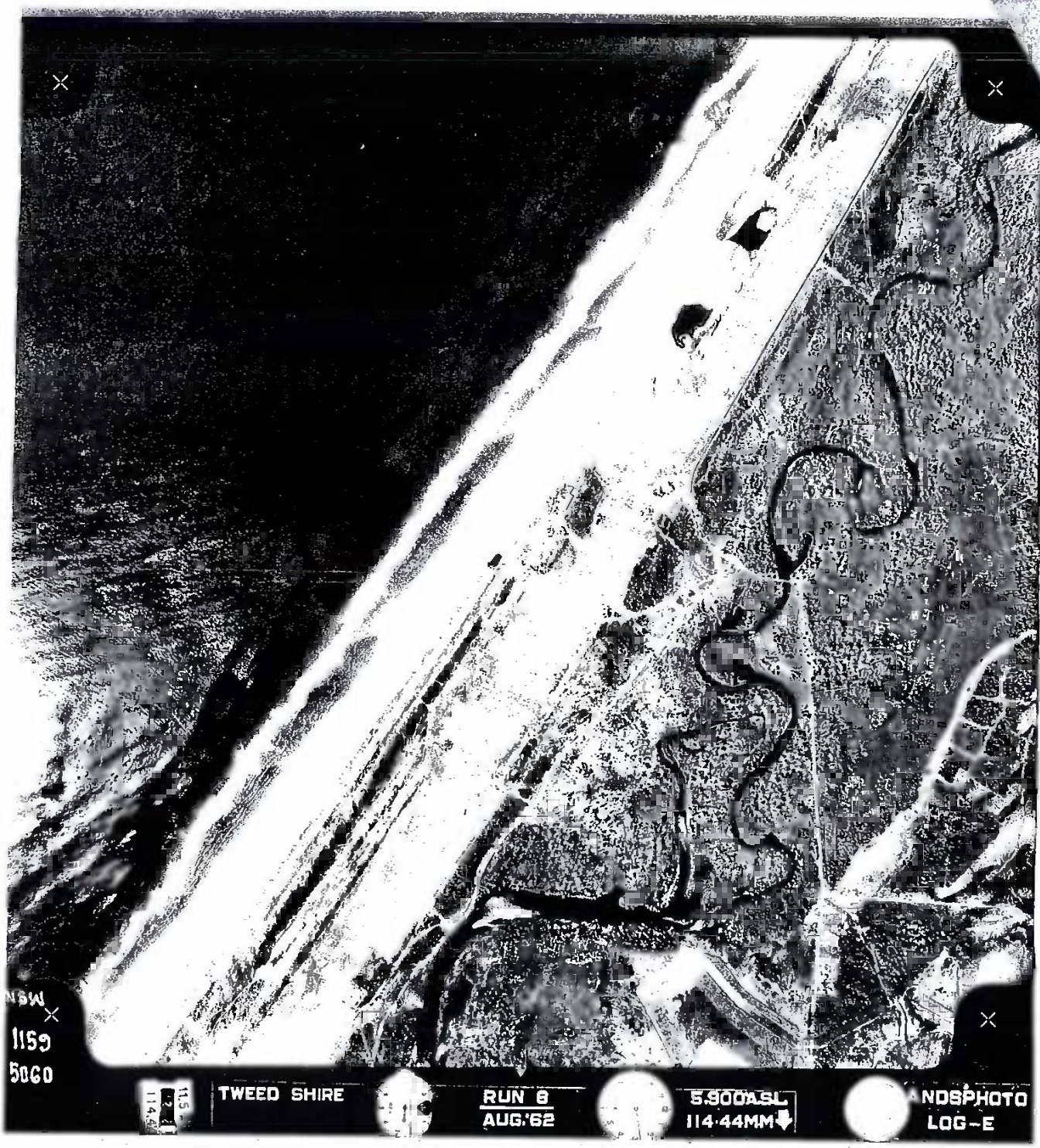
Cardno MBK

ATTACHMENT II

PAST AERIAL PHOTOGRAPHS







Cardno MBK

ATTACHMENT III

PRELIMINARY SITE INVESTIGATION

Cardno MBK

Engineering the Future

HUTCHINSON BUILDERS PTY LTD

PRELIMINARY SITE INVESTIGATION REPORT

CASUARINA BEACH NORTH PRECINCT

25 July 2001

REF: 7079/1-77

DETAILED SITE INVESTIGATION REPORT

NORTH PRECINCT, CASUARINA BEACH, NSW

TABLE OF CONTENTS

1.0 INTRODUCTION

As part of the development of the Casuarina Beach development and the associated "due diligence" requirements for the overall site management program, Hutchinson Builders, 31Staple Street, Seventeen Mile Rocks Qld 4073, has commissioned the services of Cardno MBK (Qld) Pty Ltd to:

- conduct a preliminary site investigation, to establish whether radioactive sand residues from former mineral sand mining activities exists on the site; and
- if required, establishing the extent of soil contamination, and possible environmental, health and safety impairment risks, with a view to establishing a suitable remediation/management strategy.

The above will be carried out in accordance with NSW Government Department of Health – Radiation Branch publication, "No. 12 Clean-Up and Disposal of Radioactive Residues from Commercial Operations Involving Mineral Sands".

This report covers:

- The results of the on-site inspection and preliminary in-situ analysis, (to identify, likely areas of contamination, and prepare a sampling and analysis protocol);
- The results of the laboratory analysis of the soil samples taken; and
- Recommendations for ongoing site management.

2.0 LOCATION AND SITE DESCRIPTION

2.1 Location

The area under investigation is located in the East Swale – Outlet 11, of the North Precinct, Casuarina Beach, NSW, 2487, which is a newly constructed urban development.

The Local Authority is the Tweed Shire Council and the Regulating Authority, with respect to radioactive material is the NSW Environmental Protection Authority – Radiation Control.

2.2 Site Description

The site under investigation is part of a major urban development.

A summary of the features of the site is presented in the detailed layout in Attachment 1.

3.0 SITE HISTORY

Based on interviews with former mineral sand mining operators and desktop searches, it was noted that the site has been subject to mineral sand mining activities in the past.

Mineral sand mining activities in the area were conducted between 1954 and 1976. When mining activities ceased the area was partially rehabilitated. Residential development activities commenced in 1999 and the Casuarina Beach development is in the final stages of completion.

4.0 SITE INSPECTION

A site inspection was conducted on July 12, 2001 by Mr Simon Groth, Environmental Scientist - Cardno MBK Gold Coast and Mr Ross Kleinschmidt, Senior Health Physicist – Queensland Health Scientific Services, to examine:

- the sampling and analysis requirements,
- local geology and topography, and
- and the possible remediation/management options (if required).

4.1 Topography and Vegetation

The topography in the local area consists of relatively flat land, interspersed with newly constructed stormwater swales and urban streets.

Vegetation in the area consists of Casuarina and Banksia species inhabiting the coastal dune area to the east and south of the area being investigating.

Residential lots and stormwater swales in the vicinity of the investigation area had recently been seeded with various native and introduced grasses.

4.2 Filling

Major civil earthworks were required to prepare the site for the current urban development. However no imported fill was required or received in order to achieve the current and final landform.

4.3 Geology

Reference to the Douglas Partners report on Preliminary Geotechnical Investigation, Kings Beach Development Bogangar, Tweed Coast, Northern NSW, February 1996, reports the eastern and central parts of the site are underlain by beach and dune sand, and the extreme western part is underlain by river gravels, alluvium, sand and clay. The report also confirms that sand mining (for rutile) has been undertaken in the area.

5.0 IN-SITU RADIATION SURVEY, SOIL SAMPLING AND ANALYSIS

Visual inspection confirmed black mineral staining in the base of the eastern swale being, outlet 11 in the north precinct, and extended along the swale for approximately 50 metres. The full extent of the black mineral sand could not be determined due to the mulching present on the swale embankments (Refer to Photographic Illustration 5.1). A small amount of mineral staining was also discovered on the adjacent lot to the north of the swale.

Photographic Illustration 5.1: Black mineral staining exposed in stormwater swale

The radiation survey was conducted using a calibrated Bicron Micro Sievert survey monitor to measure surface gamma radiation levels. Four transects were walked and gamma radiation surface levels were recorded at approximate 10 meter intervals. The surface radiation results are presented in Attachment II.

Photographic Illustration 5.2: Surface gamma radiation readings being taken.

5.1 Soil Sampling

During the preliminary site investigation, 2 soil samples were taken. Sample 1 was taken in the base of the swale (0mm – 200mm) and sample 2 was taken at the top of the swales northern embankment (50mm – 200mm) where visible staining was encountered and radiation levels were elevated. Samples were taken for analysis to the Queensland Health Scientific Services laboratory to determine uranium and thorium radioactivity concentrations and the results are presented in Table 6.2. Sampling locations are presented in Attachment I.

6.0 ANALYTICAL RESULTS

In-Situ surface level radioactivity results are summarised in Table 6.1, and show the ranges of levels encountered in four transects walked. Transects are illustrated in Attachment I.

Table 6.1: In-Situ Surface Level Radioactivity Results

Transect Number	Surface Radioactivity Range (uGy/h)
1 – Eastern Swale	0.1 – 1.5
2 – North/South	0.1 – 0.7
3 – East/West	0.1 – 0.5
4 – North/North East	0.1 – 0.3

Uranium and thorium activity concentrations were determined in samples taken from visibly stained areas and are summarised in Table 6.2. These results should be considered as preliminary data only (Refer to Queensland Health Scientist Services Report in Attachment II).

Table 6.2: Uranium and Thorium Activity Concentrations in Soil Samples

Sample Identification	Description	Uranium-238 Activity (Bq/kg)	Thorium-232 Activity (Bq/kg)
Sample 1	0mm-200mm	900+-100	2400+-200
Sample 2	50mm-200mm	1000+-100	2500+-200

7.0 DISCUSSION

The black mineral sand observed in the stormwater infiltration basin is associated with naturally occurring radioactive materials and based upon the site history and the localised nature of the material, suggests that the area under investigation may have been used as a tailings dam generated from the former mineral sands processing activities in the area.

Maximum surface gamma radiation levels of 1.5 microgray per hour in the basin of the stormwater swale and levels up to 0.7 microgray per hour (uGy.$^{h-}$1) along the transects walked on the northern adjacent lot of the swale, were recorded during the preliminary investigation. Natural background surface gamma radiation levels of 0.1 microgray per hour can be considered normal for the area.

Levels detected on the adjacent northern lot may be associated with the possible mixing or dispersion of material similar to that encountered in the swale or the continuation of the concentrated deposit buried at depth below the surface.

Laboratory test on the samples gathered confirm the black mineral as being naturally occurring radioactive material associated with mineral sand mining waste products such as ilmenite and monazite.

The NSW Department of Health - Radiation Branch has developed action level thresholds for the clean up and disposal of radioactive residues from commercial operations involving mineral sands, and are presented below.

1. Action Level Criteria

1.1 For dwellings, schools (including playground), businesses, factories, etc. where occupancies by the same individuals occur regularly on a day by day basis, the remedial action level should be 0.7 µGy h^{-1} (or 70 µR h^{-1}) for all points at 1 metre above the area of concern on the property.

1.2 For other areas, where occupancies are for a few hours per week by the same individuals or by differing individuals and for garden areas, the remedial action level should be 1.0 µGy h^{-1} (100 µR h^{-1}) for all points at 1 metre above the lowest surface of the area.

1.3 For roads, paths, and other areas with intermittent occupancy, the remedial action level should be 2.5 µGy h^{-1} (250 µR h^{-1}) for all points at 1 metre above the surface of the areas.

1.4 All values quoted above should include a value for normal natural background of 0.1 µGy h^{-1} (10 µR h^{-1}).

8.0 CONCLUSIONS

Surface radiation levels in the stormwater swale do not exceed the above stated Action Level Criteria, 1.3, of 2.5 uGy.h^{-1} for roads, paths, and other areas with intermittent occupancy, which is considered to be the applicable criteria for an area which is a dedicated stormwater reserve that will have only intermittent occupancy. As the mineral sand material is exposed to the environment and there is the potential for wind and water erosion to occur allowing the material to migrate to other areas, a management strategy needs to be developed to mitigate any such occurrence.

Surface gamma radiation levels in the adjacent northern lot, which is a proposed residential area, is less than but approaching Action Level Criteria 1.1, For dwellings, schools (including playground), businesses, factories, etc. where occupancies by the same individuals occur regularly on a day by day basis.

It is considered that there may be the potential for similar radioactive material as discovered in the stormwater swale to be buried under the adjacent northern lot, which is a proposed future residential area. This being the case, there is the potential for this material to be disturbed, redistributed and/or removed off site during the excavation of footings and swimming pools etc. Exposing this material has the potential of exceeding the relevant Action Level Criteria for the site or disposal area.

9.0 RECOMMENDATIONS

Based on the preliminary site investigation results obtained and the proposed future land uses of the areas investigated, it is recommended that the following take place:

- The Environmental Protection Authority - Radiation Control Branch and the Tweed Shire Council be notified of the investigation findings;
- A Detailed Site Investigation be conducted to establish the vertical and lateral extent of the contaminated areas.
- The preparation of a site remediation and management plan for the subject area.

Cardno MBK

ATTACHMENT IV
QUEENSLAND HEALTH STAGE II
RADIATION INVESTIGATION REPORT

Enquiries: Ross Kleinschmidt
Telephone: 07 3274 9124
Facsimile: 07 3274 9123

Requested by: Simon Groth
Cardno MBK (Qld) Pty Ltd
Commercial Centre, Isle of Capri
GOLD COAST Q 4217

Reference: Casurina Beach Development
STAGE 2 REPORT

DRAFT STAGE 2 RADIATION INVESTIGATION REPORT No. 01PQ72

North Precinct, Casurina Beach Development
TWEED SHIRE NSW

Date Request Received: 30 July 2001

Report Description: Stage 2 Radiological Investigation, North Precinct Casurina Beach Development, Kingscliff, NSW.

1.0 SCOPE OF WORK

A Stage 2 radiological investigation of the North Precinct, Casurina Beach development was conducted as recommended in the Stage 1 preliminary report (QHSS 2001).

A radiation exposure pathway analysis has been developed using experimental data collected by surface gamma radiation measurements and logging a number of bore holes in designated subject areas. The scope of the report is limited to those areas identified by Cardno MBK (Qld) as to be included in the investigation.

The locations of the subject areas are shown in Figure 1, a generalised plan of the development area provided by Cardno MBK (Qld).

Queensland Health Scientific Services was commissioned by Cardno MBK (Qld) to perform the Stage 2 radiological investigation for inclusion in a report to the site developer, the Tweed Shire Council and the NSW Environmental Protection Agency.

2.0 ASSESSMENT STRATEGY

2.1 Exposure Pathways

A number of radiation exposure pathways may be considered in assessing the impact of a mineral sand deposit containing enhance levels of radioactive materials. The pathways include external gamma irradiation, inhalation of particulates and the radioactive gas radon, and ingestion of the material. The physical and chemical properties of the mineral sand materials present on the site do not promote significant exposure contributions from ingestion and inhalation of particulates in a residential / suburban land use situation. It is also unlikely that a significant inhalation exposure would be derived from radon due to local weather conditions and prevailing sub tropical construction practices, i.e. open plan, well ventilated structures.

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2.2 Subject Areas

a. Area 1

The first subject area includes the site described in the Stage1 report. Mr Ross Kleinschmidt and Allan Burton, Queensland Health Scientific Services and a representative of Cardno MBK (Qld) performed the on site component of the investigation on 02 and 03 August 2001.

Description: Area 1 (Figure 1a) including Lots N67 to N70 as identified in Stage 1 report subject area.
Assessment Method: Surface gamma survey plus downhole logging to water table.

b. Area 2

A Subsequent surface gamma radiation survey was requested on 10 August 2001. This survey was conducted by Mr Allan Burton, Queensland Health Scientific Services and representatives of Cardno MBK (Qld)

Description: Area 2 (Figure 1a) including Lots N59 to N66.
Assessment Method: Surface gamma survey.

c. Area 3

A Subsequent surface gamma radiation survey was requested on 10 August 2001. This survey was conducted by Mr Allan Burton, Queensland Health Scientific Services and representatives of Cardno MBK (Qld)

Description: Area 3 (Figure 1a).
Assessment Method: Surface gamma survey.

d. Area 4

A Subsequent surface gamma radiation survey was requested on 10 August 2001. This survey was conducted by Mr Allan Burton, Queensland Health Scientific Services and representatives of Cardno MBK (Qld)

Description: Area 4 (Figure 1b) including sections of Lots N19 to N25, N131, N132 and N133.
Assessment Method: Surface gamma survey.

e. Area 5

A Subsequent surface gamma radiation survey was requested on 10 August 2001. This survey was conducted by Mr Allan Burton, Queensland Health Scientific Services and representatives of Cardno MBK (Qld)

Description: Area 5 (Figure 1b) including Lots N3 to N7 and Lot 114.
Assessment Method: Surface gamma survey.

f. Area 6

A Subsequent surface gamma radiation survey was requested on 10 August 2001. This survey was conducted by Mr Allan Burton, Queensland Health Scientific Services and representatives of Cardno MBK (Qld)

Description: Area 6 (Figure 1b).
Assessment Method: Surface gamma survey.

2.3 External Gamma Radiation survey

A Bicron Micro Sievert (serial number B251S) survey monitor was used to measure surface gamma radiation levels. The instrument is calibrated by Scientific Services, traceable to the primary Australian Standard, specifically for environmental measurements in Micro Gray per hour.

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All site radiation level measurements were performed one metre above the ground surface. Using this measurement geometry and with typical soil densities, approximately 90% of the measured exposure rate originates from the top 200mm of material over an 8m radii (NCRP 1998). Soil moisture corrections can be considered as negligible under the weather conditions experienced during the survey, and were not applied to the results. A natural background surface gamma radiation level of 0.1μGy.h^{-1} can be considered as normal for the area.

Surface gamma radiation surveys over Areas 2 through 6 were directed by Cardno MBK (Qld) on findings of their own surface gamma radiation screening surveys.

2.4 Downhole Logging

Downhole logging techniques allow for in-situ measurement of gamma radiation emitting materials. Results from the field measurements can be calibrated against samples using high resolution gamma ray spectrometry to establish possible gamma exposure rates associated with buried material.

Bore holes were established to a depth of approximately 6m (or water table) and cased with 90mm PVC piping. The logging tool was then lowered in the bore hole and results logged every 0.5m. Several laboratory samples were collected from known depths for system calibration.

2.5 Assessment Method Limitations

The surface gamma radiation survey technique is suitable only for measurement of material present in the top 200mm - 300mm of soil. Material below this depth shows no appreciable surface exposure rate.

In-situ downhole logging, sampling and subsequent laboratory analysis or the use of open inspection trenches and gamma survey can be considered the only suitable techniques for establishing the presence and extent of buried, radiologically enhanced material.

Visual inspection of soil/sand colour should not be considered as an alternative to radioactivity measurement due to the possibility of contaminants other than the black mineral ilmenite being present (e.g. monazite, a pale green / yellow mineralisation).

3.0 RESULTS

3.1 Area 1

Results of the downhole logging data are provided in Figure 2. Figure 2a shows gross activity profiles for each bore hole to a depth limited by the water table. Figure 2b shows isoactivity contours for 0.5m depth slices to 4m. Figure 2c shows the material buried at depth that, if distributed on the surface, would give rise to surface gamma radiation activities greater than 0.2μGy.h^{-1}, 0.35μGy.h^{-1}, 0.7μGy.h^{-1} and 1.0μGy.h^{-1} respectively.

It is obvious that large quantities of material are present at depth and that the extent of the bulk material has not been fully mapped. Surface gamma radiation surveys have not detected the presence of this buried material.

3.2 Area 2

Surface gamma radiation levels for Area 2 are shown in Figure 3. Maximum surface gamma radiation levels of 0.3μGy.h^{-1} per hour were recorded. These elevated levels may be associated with either the mixing and dispersion of more heavily contaminated material or a continuation of the concentrated deposit, buried at some depth below the surface. Depth / activity profile data were not requested for this area.

3.3 Area 3.

Surface gamma radiation levels for Area 3 are shown in Figure 3. A Maximum surface gamma radiation level of 0.2μGy.h^{-1} per hour was recorded in the eastern boundary of Area 3, the majority of the area being less than or equal to 0.1μGy.h^{-1}. The elevated levels may be associated with either the mixing and dispersion of more heavily contaminated material or a continuation of the concentrated deposit, buried at some depth below the surface. Depth / activity profile data were not requested for this area.

3.4 Area 4 & Area 5

Surface gamma radiation levels for Area 4 and Area 5 are shown in Figure 4. A Maximum surface gamma radiation level of 0.25μGy.h^{-1} per hour was recorded in Area 4 and Area 5. The elevated levels may be associated with either the mixing and dispersion of more heavily contaminated material or a concentrated deposit, buried at some depth below the surface. Depth / activity profile data were not requested for this area.

3.5 Area 6

Surface gamma radiation levels for Area 6 are shown in Figure 4. A Maximum surface gamma radiation level of 0.6μGy.h^{-1} per hour was recorded in a storm water drainage depression (proposed road area in future development). The elevated levels may be associated with either the mixing and dispersion of more heavily contaminated material or a concentrated deposit, buried at some depth below the surface. Depth / activity profile data were not requested for this area, however, visible staining with black mineral is evident.

4.0 CONCLUSIONS

The logging of bore holes in Area 1 confirms the presence of radiologically enhanced mineral sand material at depths to at least the water table (approx. 6m).

The surface gamma radiation levels previously recorded for the area (QHSS 2001) do not correlate with activity concentrations buried at depth, and therefore cannot be used as an indicator of buried, radiologically enhanced material.

The surface gamma radiation levels in the remaining survey areas, Areas 2 through 6, indicate the presence of radiologically enhanced materials. There is the potential for radiologically enhanced mineral to be buried in these areas, or other areas of the development previously surveyed by Cardno MBK (Qld).

5.0 DISCUSSION

This Stage 2 Report has established and recorded the extent of radiologically enhanced mineral sand residues in Area 1 (Figure 3) of the North Precinct, Casurina Beach Development.

The scope of this report does not allow for a blanket characterisation of the extent of buried materials that may be present in the remainder of the development. It is recommended that an extensive subsurface investigation program be instigated should full characterisation of the site be required by the relevant authorities.

No surface gamma radiation levels in the development residential subdivision area were in excess of the Action Limit (NSWEPA 1984) of 0.7μGy.h^{-1} for residential areas (see section 5.1 for further comment).

5.1 Remediation

The application of remedial action to sites contaminated with radioactive materials should be conducted with the view of applying a best practice outcome. The Action Levels (NSWEPA 1984) previously described in the Stage 1 Report (QHSS 2001) relate to intervention practices associated with residues from mineral sand processing that were developed over one and a half decades ago. A review of more recently developed Queensland guidelines (Radiation Health 1998 & QldEPA 2001) for similar scenarios, suggests more stringent remediation levels may be more suitably applied to the site. In determining appropriate levels, it must be considered that a significant change in land use has occurred for the area, providing the opportunity for remediation to a more acceptable level in line with achieving radiation exposures as low as reasonably achievable (ALARA).

A remediation surface gamma radiation level of 0.35μGy.h^{-1} (including background of 0.1μGy.h^{-1}) will restrict the additional effective radiation dose, via the external exposure pathway, using residential occupancy (Appendix A) to less than 1mSv per annum. This value, 1mSv per annum, is the internationally accepted effective radiation dose that may be received from a radiation practice by a member of the public over one year. While this limit is normally applied to dose received from a radiation practice, it can be argued that under the circumstances of this situation, applying this criteria is a best practice approach to any remediation plan. It is recommended that the derived remediation limit of 0.35μGy.h^{-1} (including

background of 0.1μGy.h^{-1}) should be applied to the entire development, including the swale areas.

Development of an on site disposal repository would provide a level of control of the radiologically enhanced materials. The excavated material may be placed in a purpose built containment, engineered to reduce erosion and covered with 1m to 2m of clean fill. Implementation of a management plan to restrict land use and future development would be required for the containment area. Use of the material as bedding for future roadworks in the development may also be considered as an alternative pending assessment and relevant authority approval.

In the event that radiologically enhanced material is removed off site, including transport on public roads, relevant authorities should be contacted regarding transport and disposal regulatory requirements.

An occupational health and safety plan should be developed for any remediation activities implemented for the site. Control of dust and external radiation exposure should be considered in conjunction with exposure monitoring of workers.

5.2 Management

Redistribution of buried material by way of construction excavation may increase surface gamma radiation levels to unacceptable levels. A management system is required to ensure that radiologically enhanced materials exposed during the life of the development are monitored and disposed of in an appropriate manner. Systems have been employed by the Gold Coast City Council in past years to manage similar deposits of mineral sand tails and may be considered as a model for management of this site.

6.0 LIMITATIONS OF REPORT

Scientific Services has prepared this report for use by Cardno MBK (Qld) in accordance with generally accepted consulting practice. It may not contain sufficient information for the purposes of other parties or other uses.

To the best of our knowledge the information contained in this report is accurate at the date of issue. Any site works, redistribution of material or engineering works carried out on the site after surveys or data collection activities by Queensland Health Scientific Services may invalidate information provided in this report.

7.0 REFERENCES

1. ICRU (1994). *Gamma-ray spectrometry in the environment.* ICRU Report 53. International Commission on Radiation Units. USA

2. NCRP (1998). *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies.* Report No. 129. National Council on Radiation Protection and Measurements. Bethesda. USA

3. NSWEPA (1984). *Clean-up and disposal of radioactive residues from commercial operations involving mineral sands.* Radiation Safety Information Series No. 12. New South Wales Environmental Protection Agency. Sydney. Australia.

4. QHSS (2001). *Stage 1 Radiation Screening Report No. 01PQ56. EAST SWALE - OUTLET 11, North Precinct, Casurina Beach Development.* Queensland Health Scientific Services. Queensland Health. Brisbane. Australia.

5. QldEPA (2001). *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland.* Queensland Environmental Protection Agency. Brisbane. Australia

6. Radiation Health (1998). *Policy on Land Affected by Radioactive Materials due to Past Practices. Queensland Department of Health*. Brisbane. Australia

7. UNSCEAR (1993). *Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 1933 Report to the General Assembly, with Scientific Annexes.* United Nations, New York. USA.

R Kleinschmidt
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16 August 2001

APPENDIX A

Data used in establishing a remediation action level for the Casurina Beach Development.

Residential / Suburban Land Use

Parameter	Data		Reference
Dose conversion factor for terrestrial gamma radiation (mean for adults & children, $Th232_{series}$ + $U238_{series}$ in a 1:1 ratio)	0.75 Sv / Gy	DC	UNSCEAR 1993
Total hours in a day	24 hours	H_d	
Total days in a year	300 days	H_y	
Total days in a year - outside dwelling (40% total days in a year, suburban)	120 days	$H1_{out}$	NCRP Report No. 129
Total days in a year - inside dwelling (60% total days in a year, suburban)	180 days	$H1_{in}$	NCRP Report No. 129
Shielding factor, dwelling (mean for $Ra226_{series}$ + $Th232_{series}$ in a 1:1 ratio)	0.3	SF	NCRP Report No. 129
Proposed remediation action level (in addition to 0.1μGy.h^{-1} for area natural background level)	0.25μGy.h^{-1}	AL_{Rem}	This report

CALCULATION OF ADDITIONAL ANNUAL DOSE RECEIVED BY A MEMBER OF THE PUBLIC USING A PROPOSED REMEDIATION ACTION LEVEL OF 0.25μGy.h^{-1}

Annual dose - outside dwelling (D_{out}) $= DC \times AL_{Rem} \times H_d \times H1_{out}$
$=$ **540μSv**

Annual dose - inside dwelling (D_{in}) $= DC \times SF \times AL_{Rem} \times H_d \times H1_{out}$
$=$ **243μSv**

Total additional dose $= D_{out} + D_{in}$
$=$ **783μSv**

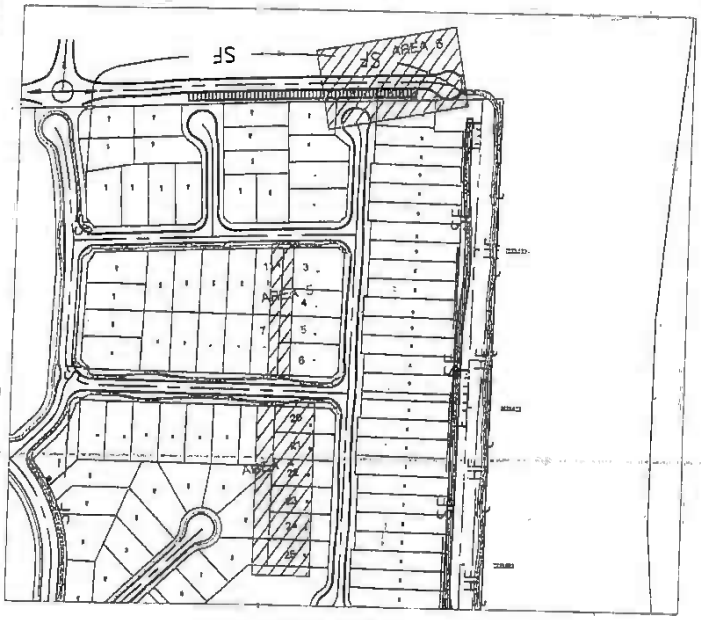

Figure 1b:
Areas 4,5 & 6

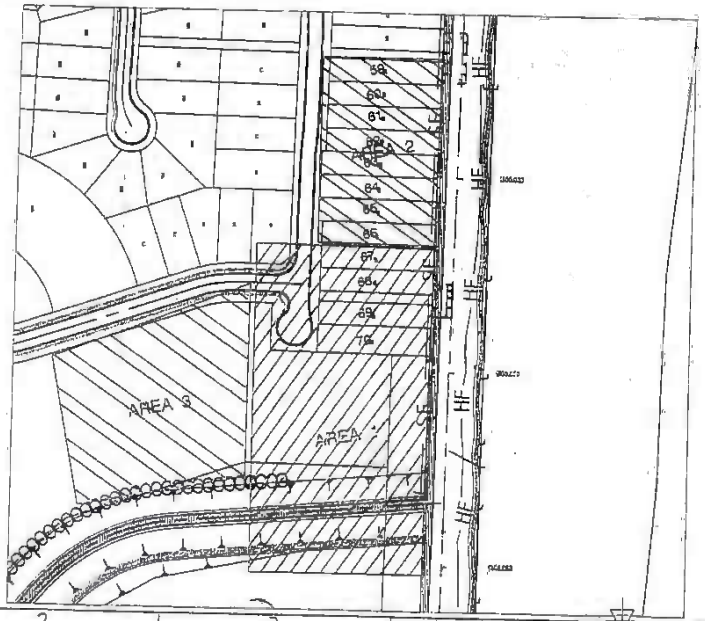

Figure 1a:
Areas 1,2 & 3

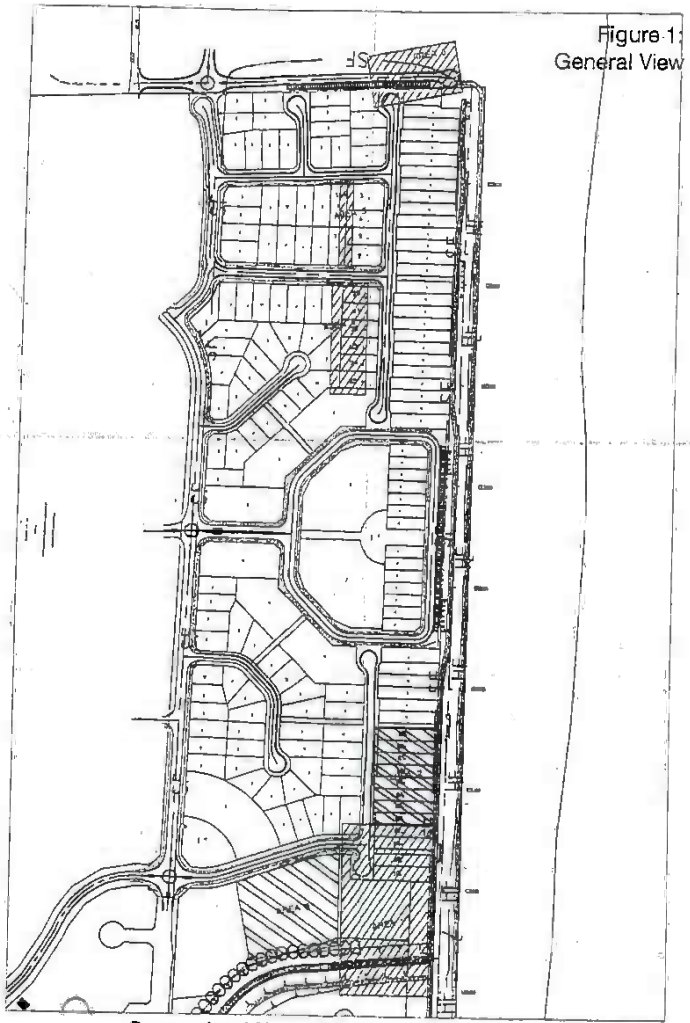

Figure 1:
General View

RevNo	Revision note	Date	Signature	Checked

Queensland Health Scientific Services - Health Physics Group

Itemref	Quantity	Title/Name, designation, material, dimension etc			Article No./Reference
Designed by rk		Checked by rk	Approved by – date rk – 17/08/01	File name 01PQ72_f1	Date 16/08/01	Scale n/a

Casurina Beach

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Figure 2b

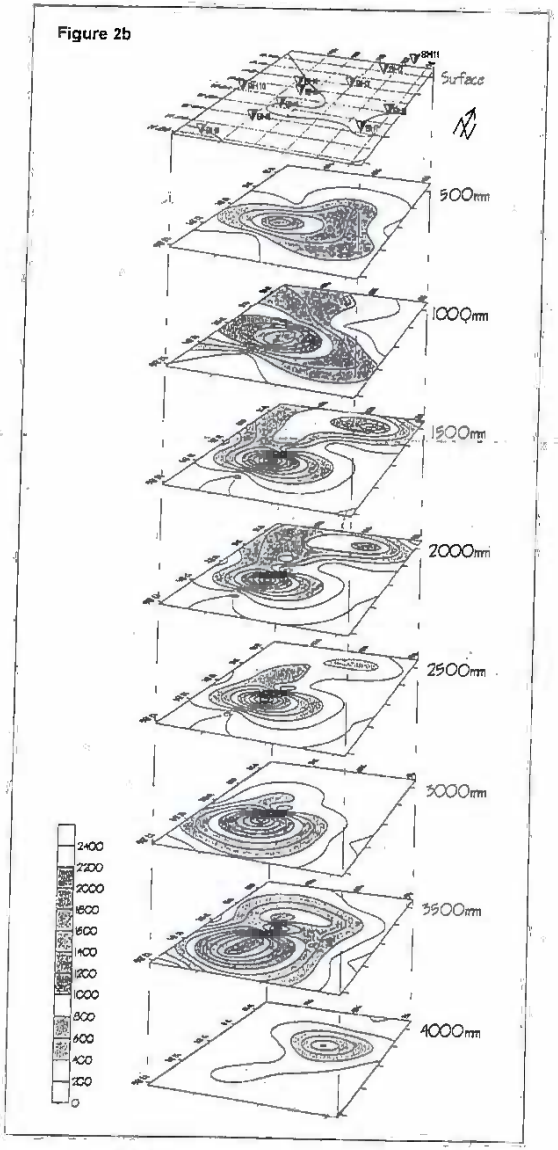
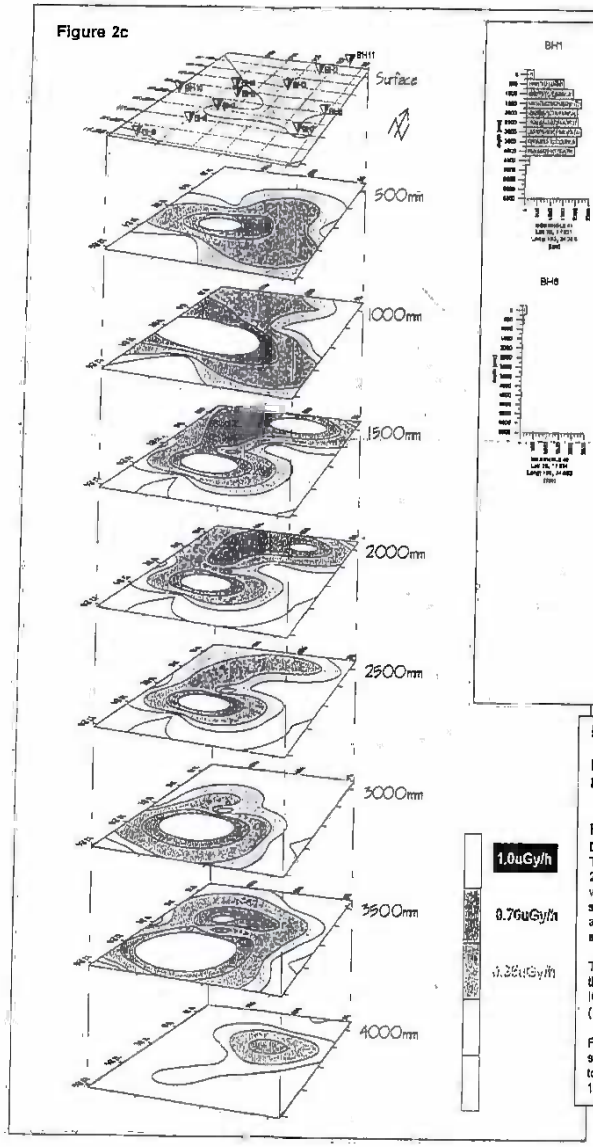


Figure 2c



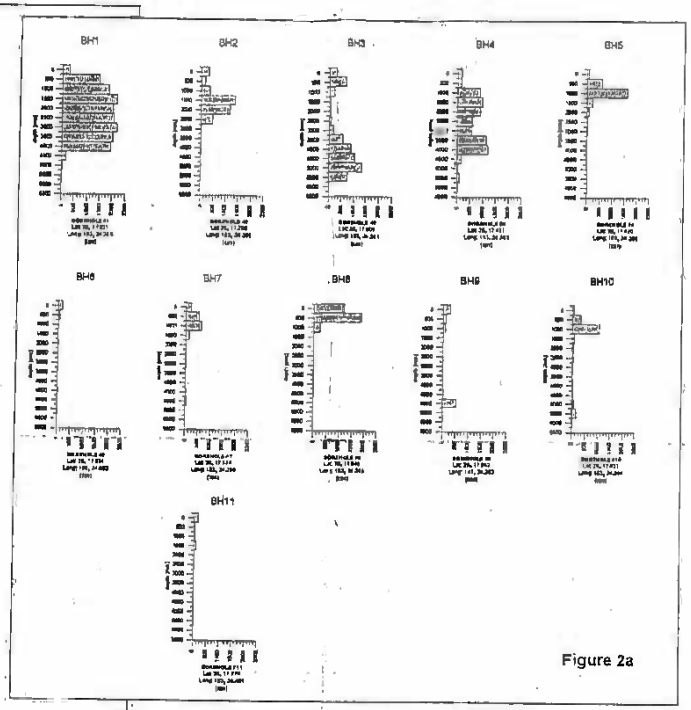


Figure 2a

INTERPRETATION OF DATA

Figure 2b
RAW DATA: DEPTH vs ACTIVITY

Figure 2c
DERIVED SURFACE EXPOSURE RATE

The raw logging data has been converted to a combined uranium 238 + thorium 232 activity concentration by comparing log count rate with specific activity determined by high resolution gamma spectrometry. Based on the gamma spectrometry results, it is assumed that there is a 1:2.5 U/Th activity ratio for all material surveyed.

The combined uranium 238 + thorium 232 activity concentration is then converted to surface exposure rate based on data provided by ICRU Report 53, *Gamma-Ray Spectrometry in the Environment* (1994).

Figure 2c shows the extent of buried material that, if brought to the surface and distributed to a depth of approx. 200mm, would give rise to surface gamma radiation levels of between 0.20uGy/h (green) and 1.0uGy/h (yellow).

FIGURE 2: Area 1 downhole logging results
Queensland Health Scientific Services

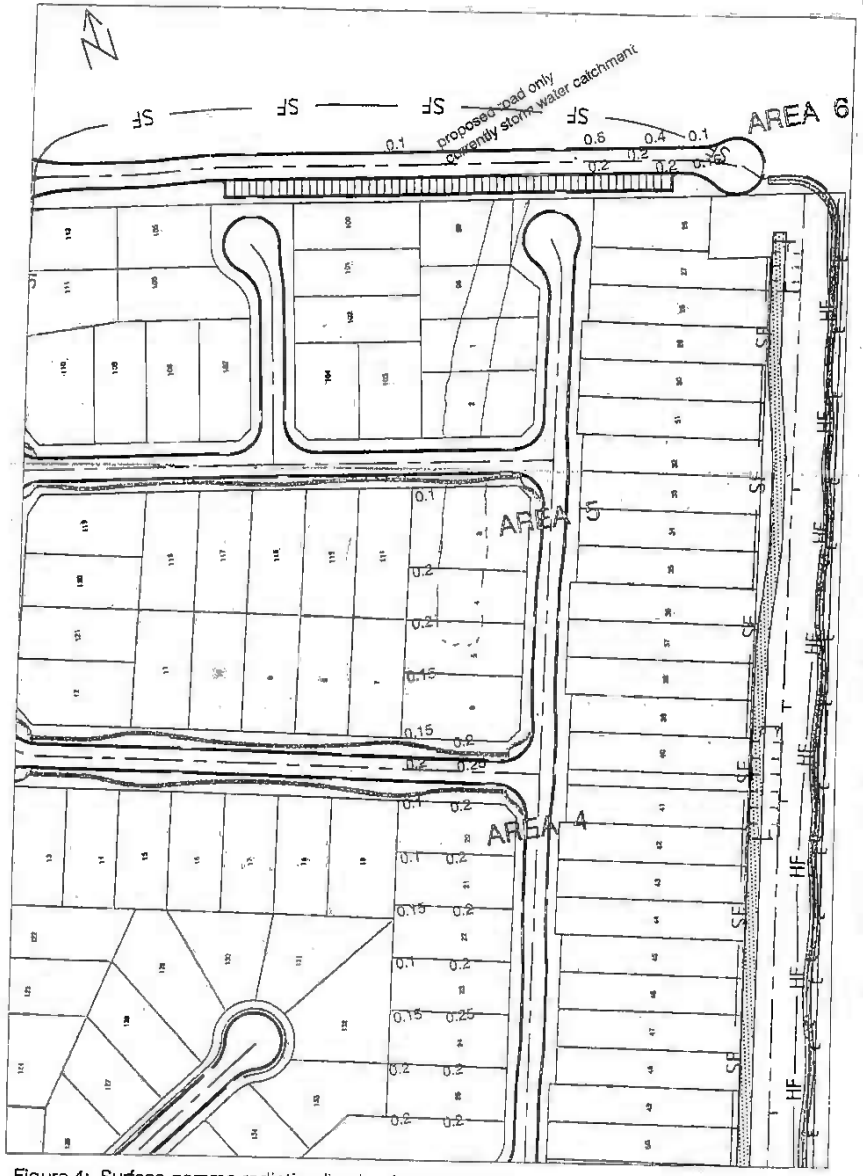


Figure 4: Surface gamma radiation levels, Areas 4, 5 & 6

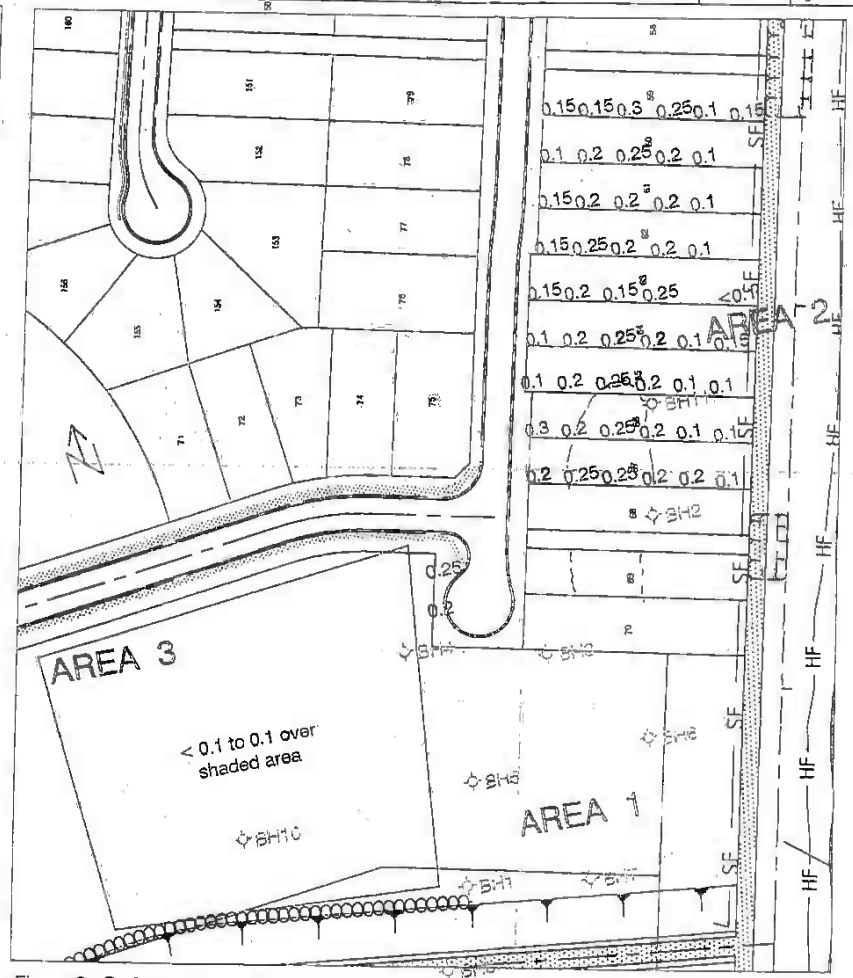


Figure 3: Surface gamma radiation levels, Areas 2 & 3 + bore hole locations

NOTES: All measurements are in uGy/h unless otherwise stated

RevNo	Revision note	Date	Signature	Checked

Queensland Health Scientific Services - Health Physics Group

Itemref	Quantity	Title/Name, designation, material, dimension etc			Article No./Reference
Designed by rk		Checked by rk	Approved by - date rk - 17/08/01	File name 01PQ72_f3&4	Date 17/08/01	Scale n/a

Casurina Beach

01PQ72 Figures 3 and 4

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APPENDIX F

ACID SULFATE SOILS MANAGEMENT PLAN

CASUARINA BEACH DEVELOPMENT
TOWN CENTRE ACID SULFATE SOIL MANAGEMENT PLAN

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

The aim of this Acid Sulfate Soils Management Plan is to provide design, management, monitoring, and remedial action measures to minimise the potential impact on the environment caused by the possible disturbance of acid sulfate soils as a result of construction activity associated with the Town Centre Stage 2 of the Casuarina Beach Development.

1.2 Description of Project

The Casuarina Beach development will be a staged residential precinct which will ultimately accommodate a population of about 5,600. The development area, which is located on the northern New South Wales coast south of Kingscliff, is bounded to the west by Cudgen Creek and to the east by the Pacific Ocean.

Stage 1 of the development involved the construction of a new coast road to the west of the previous alignment, and the formation of 7 management lots. Following stages are involved with the urban development of each or several of these management lots.

Following stages have been involved with the construction of residential development throughout the site. The Town Centre area will be the commercial hub for the Casuarina precinct, as well as providing medium and low density housing for residents and tourists. The work to be carried out on the site includes the construction of Casuarina Way between the Casuarina Central and Northern Precincts, as well as clearing of vegetation and significant earthworks reshaping of the site. The site will eventually be developed as an urban community, involving the provision of all relevant urban infrastructure such as roads, water supply, sewerage, power and telecommunications.

1.3 Description of Existing Environment

1.3.1 Existing Ground Levels

The site is presently dominated by a ridge with a maximum level of between 10 and 12 m AHD, which runs from south to north through the central section of the site. This ridge is a remnant of the construction of the new Coast Road in the first stage of Casuarina. On the western side of the ridge, substantial earthworks took place in 1999 as part of this construction. The ground levels in this part of the site vary from about 10 m AHD adjacent to the ridge, to about 3 m AHD on the eastern edge of the road.

On the eastern side of the ridge, the site remains unchanged in level from its pre-existing condition. From the east to the west, levels fall from 10 m AHD on the line of the beach dunes to a depression with a level of about 6 m AHD, before rising again to meet the ridge level of 12 m AHD.

1.3.2 Soils

The site comprises dunal sands and beach ridges, extending from the beach dune to beyond the alignment of the Coast Road. Quartzose sand is identified in surface deposits. Previous studies by Douglas Partners determined the underlying soils to be generally clean beach and dunal sands.

On the elevated land containing the beach ridges, underlying soils comprise loose sands up to 0.5 m in depth, becoming medium dense below 0.5 to 1.0 m depth. Dense and very dense sands occur below 8 m to 11 m depth. Some minor traces of silt layers, and silty sand, are interbedded with the clean sands at depth.

1.3.3 Surface Water

There is no permanent surface water within the Town Centre development area.

1.3.4 Ground Water

A groundwater ridge exists under the high part of the site, generally coincident with the location of the old coast road. Previous investigations have determined that the water table has a consistent level of slightly above 1 m AHD in this area. A positive hydraulic gradient therefore exists for groundwater discharges to both Cudgen Creek and the Pacific Ocean.

1.4 Previous Investigations

A number of previous acid sulfate soils investigations have been completed in relation to the Kings Beach development area. These are reported upon in detail in the Acid Sulfate Soil Management Plan prepared by Cardno MBK for Stage 1 of this project, and submitted to Tweed Shire Council in August, 1999.

In general, these previous investigations have determined that the majority of the site to be developed, including all of the area covered by the Town Centre Stage 2, is unlikely to have any ASS or PASS constraints. For example, testing by Douglas Partners included a terrain evaluation which identified the following two terrain units within the study area:

- Terrain Unit QS_1. This area generally corresponds to the area above RL 5 m AHD located along the more elevated central and eastern portions of the site and the previously mined area.

- Terrain Unit QS_2. This area lies to the west of terrain unit QS_1 and generally corresponds to the low lying area below RL 5 m AHD along the western part of the site adjacent to Cudgen Creek.

The Town Centre site is mostly (more than 90%) contained within the QS_1 unit. Boreholes DP5, BH2, BH4, AS-A and AS-L are located within, or adjacent to the proposed development area. Previous testing carried out on soil or water quality samples from each of these holes indicated generally low acid potential.

No acid sulfate soils were disturbed in this area during the construction of the Coast Road.

2. PROPOSED WORKS

In relation to ASS and PASS, it is considered that there are only two mechanisms whereby potential disturbance could occur. These are:

- Preliminary earthworks movements, involved with reshaping of the land profile
- Excavation associated with construction of sewers and other buried infrastructure

On the basis that the water table level over the Town Centre site is generally at or below 1.0 m AHD, there are no planned works which could affect groundwater conditions. Mobilisation of acid as a consequence of exposure of PASS materials by lowered water levels will therefore not be a problem. The changes in surface level will not be significant in relation to the water table.

No changes in ground level are proposed for the western part of the site. The construction of Casuarina Way in this area will take place at levels that are not significantly different to existing ground levels. This is illustrated on the attached plans which show the developed land form. Excavation of high points, and filling of low points, is proposed on the eastern part of the site, to produce a more consistent land form than currently exists.

While these earthworks will be significant, no material will be disturbed below a level of at least 6 m AHD. This excavation will also take place on that part of the site which is free of acid sulfate soils. Consequently, it is not expected that there will be any disturbance of ASS or PASS material during the bulk earthworks phase of the project.

Infrastructure installation may involve limited disturbance of deeper soils. Consequently, and on the basis of the previous ASS testing completed by Douglas Partners and Sinclair Knight Merz, it is recommended that all earthworks to be carried out below 6.0 m AHD in the area west of Casuarina Way be classed as having ASS potential, and be tested and treated accordingly.

3. CONSTRUCTION ACTIVITIES

3.1 Responsibility of Contractor

The Contractor(s) for civil works on the site shall conduct operations in accordance with this document. Prior to the commencement of works, the Contractor shall provide the following information to the consultant:

- Contractor's environmental policy,
- Names and responsibilities of supervisory staff involved with the implementation of the acid sulfate management plan.
- Schedule of site inspections (and personnel responsible) to identify environmental problems, and maintenance actions to remedy any environmental problems identified.
- An Incidents and Events Register, in which all environmental problems identified during inspections and monitoring, and complaints received are recorded and acted upon.
- Environmental training plan and Training Record Plan for all personnel involved in development of the site.

Emphasis shall be placed upon the timely resolution of any complaints received in relation to development of the site and the development and implementation of corrective actions in response to non-conformities to the Management Plan (identified by the monitoring process).

The Performance Objective regarding complaint resolution is for the issue causing each complaint to be resolved in such a manner that there is no further complaint for the same reason.

The Contractor is to maintain an "Incidents and Events Register" which lists the date of the incident or complaint and the type of incident or complaint. For each incident, an incident/ complaint log is to be completed nominating:

- Date of incident,
- Nature of incident and associated information,
- Location of incident,
- Name of person or body which reported incident,
- Employee who received notice of incident,
- Project Manager's review and comment,
- Recommended action to resolve incident,
- List of organisations to be contacted with regard to incident,
- Outcome of actions undertaken subsequent to incident being recorded, and
- Date of resolution of incident.

Each incident is to be assigned a number to be entered on the master Incident and Event Register. Further, Tweed Shire Council and the Environment Protection Agency are to be notified and directions with regard to corrective action sought for incidents which have the potential to cause environmental harm.

3.2 Notification to Council

Prior to the commencement of works, Council shall be notified in writing of the Consultant and contact officer nominated to be responsible for Acid Sulfate Soil Management as defined by this management plan.

3.3 Acid Sulfate Management Plan

POLICY: To minimise the impact of disturbance of acidic and potential acidic soils upon surface and ground water quality.

PERFORMANCE OBJECTIVES: To avoid detrimental impact on the water quality and aquatic environment of the Cudgen Creek and the Pacific Ocean, as a result of the discharge of acidic waters from the site.

To comply with relevant legislation and to manage acid sulfate soils in accordance with the Environment Protection Agency publication *Assessing and Managing Acid Sulfate Soils, Guidelines for Land Management in NSW Coastal Areas* (June 1995) and the NSW Department of Urban Affairs and Planning publication *Acid Sulfate Soils Guidelines* (November 1997).

To avoid detrimental impact on the groundwater resource of the region.

CONTROL MEASURES: The Contractor and his site representatives shall be trained in the recognition of possible acid sulfate soils.

All soil excavations below 6.0 m AHD in the area west of Casuarina Way shall be considered to potentially contain PASS, and should be handled accordingly, including appropriate site testing. If PASS is detected, limiting rates should be determined from laboratory analysis if soil is to be exposed for more than 12 hours. If exposure will be for less than 12 hours, the Contractor shall liaise with the consultant in relation to determining an amount of lime to be added.

Sampling, storage and testing of samples shall be completed in accordance with Part 4 (Laboratory Methods) of the ASSMAC Manual, 1998. Laboratory testing shall use the POCAS (Peroxide Oxidation Combined Acidity & Sulfate) method. Field testing shall be via the field peroxide pH test.

ASS and PASS material shall be neutralised if necessary by the addition of fine agricultural lime well mixed through the soil. Lime addition rate shall be determined from test results carried out at regular frequency eg. 1 test per 500 m^3 with a factor of safety for inefficiencies. Mixing may be carried out by spreading in thin layers and use of agricultural spreader and disc plough or similar. Lime storage, application and mixing shall be carried out in accordance with Part 2 (Management) of the ASSMAC Manual, 1998.

A supply of agricultural lime ($CaCO_3$) shall be available at all times for treatment of acid sulfate soils. The supply shall be stored in a covered and bunded area to prevent accidental release to waters.

A similar quantity of hydrated lime shall also be available at all times for treatment of acidic waters. Storage requirements for hydrated lime shall be identical to that specified above for agricultural lime.

In the event that ASS conditions are present at any specific location, runoff controls will be implemented, with neutralisation of acid generating material by the addition of lime. Opened ground shall be isolated from upstream catchments, by the construction of earth bunds around the upstream side of the excavation. A detention basin shall be formed immediately downstream of the excavation, to capture runoff from the site. The basin shall be sized to completely hold 50 mm of runoff from the excavated area. Impounded water shall be tested and treated with lime to bring the pH to a minimum of 6.5 if necessary. Testing and neutralisation of water stored on the site prior to release shall be carried out in accordance with Part 2 (Management) of the ASSMAC Manual, 1998.

Lime stabilised water may be released when this pH criterion is satisfied, provided that there is no floating matter and no visible oil or grease in the discharged water. A precautionary approach is to be used with the storage and addition of hydrated lime, since it has an inherently high pH and can cause extreme alkaline conditions if overdosing occurs.

If required, a permanent storage site for ASS and PASS spoil material excavated from the site, and deemed to be unsuitable for reuse, shall be designated by the Consultant. This site shall provide for detention of potential acid sulfate material in anoxic conditions below the water table with minimum final cover of 3 m water depth or 1 m of sand or other non acid generating fill. The site must be approved by Tweed Shire Council.

The disposal location should be excavated and a survey carried out to enable accurate records to be provided to Tweed Shire Council and the Environment Protection Agency. Council shall be consulted with respect to suitable locations for disposal and called to inspect any disposal area during its use and prior to its capping.

It is noted in this regard that studies completed to date indicate that all excavated material will be reusable in embankment and filling activities, and that it is therefore unlikely that a permanent storage site will be required.

All acidic soils used for filling purposes shall be treated with agricultural lime at the appropriate rate determined from soil testing.

Regardless of whether acid sulfate material is encountered on the site, all water to be discharged shall be tested to ensure that the pH of any discharged water is between 6.5 and 8.5.

Where stockpiling is necessary, the following will occur:

- Any ASS to be treated immediately with lime,
- Stockpiles to be located in areas which will minimise environmental impact,
- Design of stockpiles to minimise the surface area exposed to oxidation, the amount of infiltration, and will include diversion banks to isolate stockpiles from runoff.
- An apron of limestone will be placed beneath stockpiles.

VERIFICATION: Soil material which has been treated with lime shall be sampled at a rate of 1 test per 1,000 m^3, to determine the adequacy of the liming rate and the mixing process. Appropriate remedial action shall be implemented if acidic potential still remains.

MONITORING: Regular monitoring and laboratory testing of water quality will be undertaken. Such monitoring shall include the testing of surface water in Cudgen Creek and groundwater in a number of boreholes, as outlined in the Water Quality Monitoring Program.

Monitoring will be undertaken on a monthly basis prior to and during the construction phase, and on a three monthly basis for 12 months following completion of the works.

In addition, regular on-site monitoring of water quality will be required during the construction phase. Such monitoring shall include:

- Daily measurements of any discharge from known ASS or PASS sites, recording pH and NFR. This shall also apply to any excavation below RL 5.0 m AHD, whether ASS is recognised or not.

The Contractor shall maintain records of any fauna kills in adjacent waterways and leachate staining.

Water pumped into any temporary basins shall be tested for pH and treated if necessary prior to discharge.

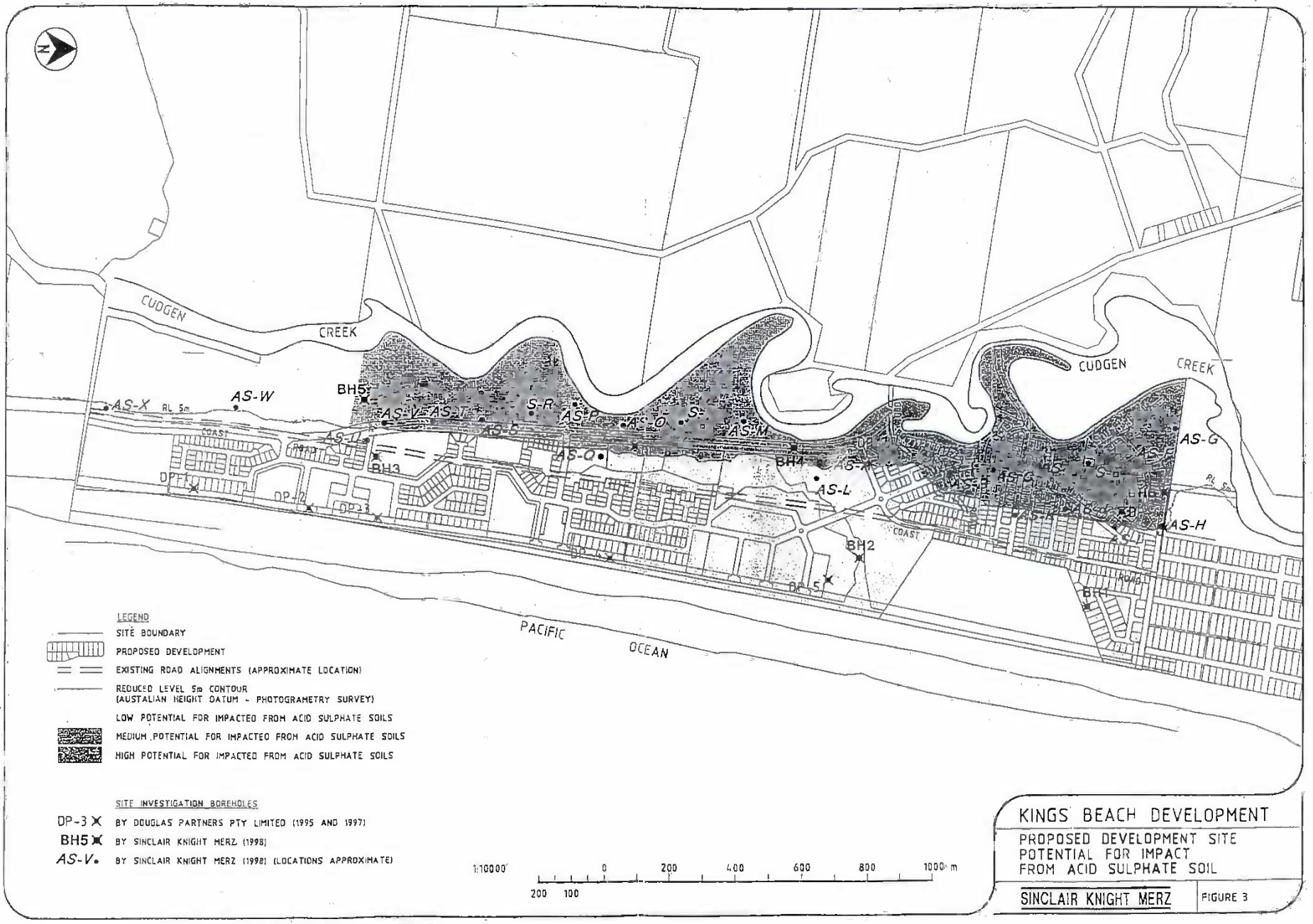
REPORTING: Monthly reports by the Consultant (copy to Contractor) on the monitoring during construction, and of all corrective action taken to maintain the performance requirement. Copies to Environment Protection Agency and Tweed Shire Council.

CORRECTIVE ACTION: Water shall not be discharged from the site if the water quality is assessed as not being suitable for discharge. In general, this will require pH to be at least 6.5, and the average suspended solids concentration to be less than 50 mg/L.

Remedial measures shall be applied when the following water quality indicator levels are exceeded:

pH	between 6.5 and 8.5.
Fe (iron) total	< 500 µg/L
Total Dissolved Solids	<1,500 mg/L
Aluminium Al (total)	<5 µg/L (pH <6.5)
	<100 µg/L (pH >6.5)

Corrective action shall be undertaken by the Contractor to the satisfaction of the Consultant, and may include dosing with chemicals and extended holding times in detention basins. Dosing rates for materials such as lime (for pH stabilisation) and polyelectrolyte coagulants (for precipitation of suspended solids) shall be in accordance with monitored results.



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APPENDIX G

EARTHWORKS MANAGEMENT PLAN

Cardno
Shaping the Future

EARTHWORKS MANAGEMENT PLAN

Casuarina Town Centre

December 2007
Job No. 7079/4- 5

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Document Control

Version	Date	Author		Reviewer	
		Name	Initials	Name	Initials
1	18 December 2007	S Walter		A Cunningham	

CASUARINA TOWN CENTRE

CASUARINA BEACH

EARTHWORKS MANAGEMENT PLAN

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 PURPOSE

This Earthworks Management Plan (EMP) has been prepared on behalf of Kings Beach No 2 Pty Ltd, for the development of the Casuarina Beach Town Centre. The aim of this management plan is to define the scope of Earthworks involved in the construction of the development and how it will be implemented. The plan also provides detailed information on earthworks programming, procedures and guidelines during the course of earthworks construction in order to minimize the impact of the project on the physical and social environment. In particular the earthworks management plan provides monitoring and remedial measures to ensure corrective actions are implemented if problems occur.

The Earthworks Management Plan (EMP) is in accordance with Australian Standards AS 3798 'Guidelines on earthworks for commercial and residential developments' and good engineering and environmental practice.

1.2 DESCRIPTION OF PROJECT

Casuarina Beach – Casuarina Town Centre is a proposed development located 3 km south of Kingscliff. The site is bound by Tweed Coast Road to the west, the Pacific Ocean to the east, Casuarina Beach – Central Precinct to the south and Casuarina Beach – Northern Precinct to the north. The subject land is described as Lot 223 on DP1048494 and contains a total area of 19 hectares. The location of the land is shown on the attached figures.

Construction of the landform to final profiles will involve cut and fill operations. Imported fill will be required as it is intended that the required fill material will be brought to the site by road transport.

The proposed works to be carried out on the site include:

- Clearing of vegetation.
- Carrying out the bulk earthworks to reflect the desired ultimate development landform.
- Filling the existing drainage swale through the site and replacing it with an underground pipe drainage system.
- Construction of Casuarina Way roadway through the site.
- Provide all infrastructure required throughout the site (roadways, drainage, water quality controls, water supply, sewerage, electricity and communications)

The proposed earthworks will result in the site generally grading from the eastern boundary towards Tweed Coast Road on the western boundary of the site.

1.3 DESCRIPTION OF EXISTING SITE

The site is partially cleared in the north western area with grass cover the major vegetation cover. The south eastern portion of the site is uncleared and contains regrowth vegetation after sand mining activities in the past. The eastern portion of the site has remained essentially in the same condition as it was when sand mining ended in the early 70's.

A ridge runs north-south through the centre of the site (RL 12.0) along the proposed alignment of Casuarina Way extension. The site grades gently from the ridge down towards the existing infiltration areas on the eastern boundary (RL 6.0). The western part of the site grades slightly steeper towards Tweed Coast Road (RL 3.0). A 7m high batter forms the south western portion of the site between the ridge and the playing field area.

An existing swale drain commencing at the north east of the site runs through the site and conveys the stormwater runoff from a large portion of the Casuarina Beach development. The swale links the infiltration areas/swales along the eastern boundary of the Casuarina Development to Cudgen creek on the western side of Tweed Coast road. Due to the grading requirements, the swale is up to 5m deep in some locations through the site.

2.0 EARTHWORKS MANAGEMENT

2.1 PROGRAMMING

The initial program of works to develop the site is generally proposed as follow:

Phase	Item
1.	Clearing, grubbing and mulching of vegetation to a temporary stockpile for reuse /landscaping
2.	Bulk Earthworks of site.
3.	Topsoil and seed allotments and disturbed areas.

Upon completion of any bulk earthworks, the disturbed area is to be revegetated promptly using the mulched stockpile and seeding.

2.2 STRIPPING AND CLEARING

The site will be stripped and cleared in one operation (to the minimum extent required for the work) and revegetated promptly. The intention of this is to minimise any effect of erosion.

The first stage of stripping and clearing will be carried out in the more densely vegetated area in the north-eastern area of the site. This area will be cleared and stripped to enable temporary stockpiling in this section of the site, and to facilitate the initial phases of the development as outlined in Section 2.1.

The remaining area of the site will be cleared as required for the earthworks to commence.

2.3 EARTHWORKS ON LEADS

Earthworks on leads will involve the removal and placement of approximately 15,000 m^3 of clean material.

The earthworks shall be a cut / fill operation (refer Figure DA25) whereby the source of fill material shall be the ridge running through the centre of the site. Additional fill, if required, will be imported to the site and sourced locally. This additional fill material may be obtained from the undeveloped Northwest Precinct of Casuarina north of Dianella Drive. Fill shall be placed on the eastern and western sides of the site to establish the final surface profile (refer Figure DA24).

All works shall be carried out in accordance with plans and specifications approved by Tweed Shire Council and with any other management plan applicable to the said works.

2.4 PERSONS RESPONSIBLE:-

The Developer and nominated earthworks contractor.

3.0 EARTHWORKS STANDARDS

3.1 CONTROL

Fencing is to be installed prior to the earthworks commencing in order to define the limits of work, thus restricting construction plant to within the site and for public safety. Earthworks construction will minimise dust emissions off site by reducing earthworks construction activity during situations of high wind and ensuring an onsite water cart is available at all times. When dust problems arise, exposed areas to be dampened and all loaded trucks to be covered.

Erosion and sediment issues that may be caused by the earthworks on the site are to be controlled by implementing the measures and devices shown on Cardno Figure No. DA27 – Erosion and Sediment Control Plan, together with minimising the area of disturbance and by the progressive re-vegetation of the site.

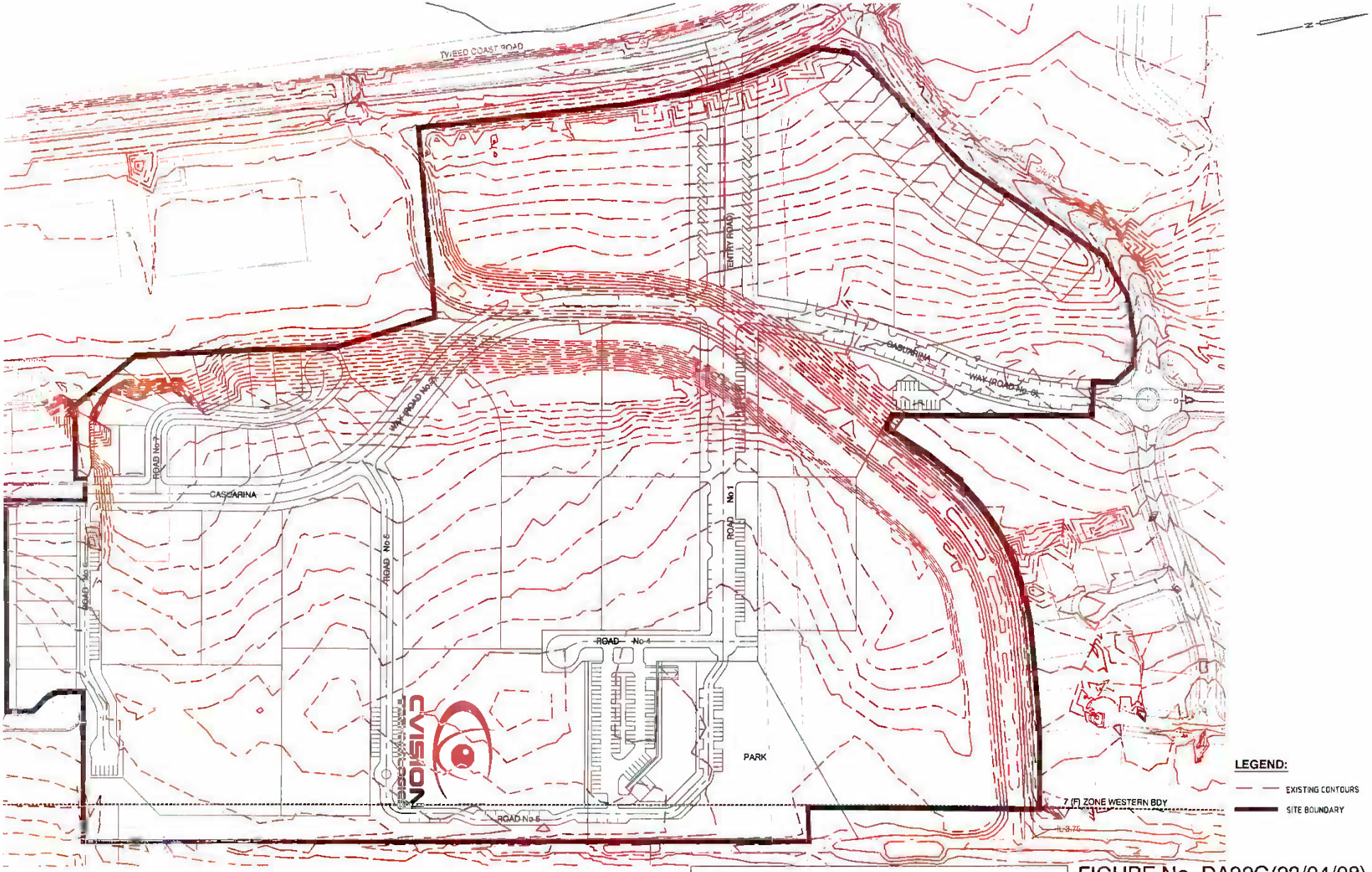
3.2 RESPONSIBILITY

The Developer and nominated earthworks contractor will be responsible for the operation and completion of earthworks on site. Cardno is to obtain Council approvals and provide supervision during construction and certification on completion.

3.3 PERFORMANCE

On completion, the earthworks will result in the site being reshaped to enable roads, parks and buildings to be constructed to Council requirements and above the design flood levels, and to facilitate the efficient installation of the Stormwater drainage and sewerage networks.

FIGURES



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Cardno (Qld) Pty Ltd ABN 051 074 992
Commercial Centre, cnr of Capel
Gold Coast City, Queensland 4217
Email: gcc@cardno.com.au

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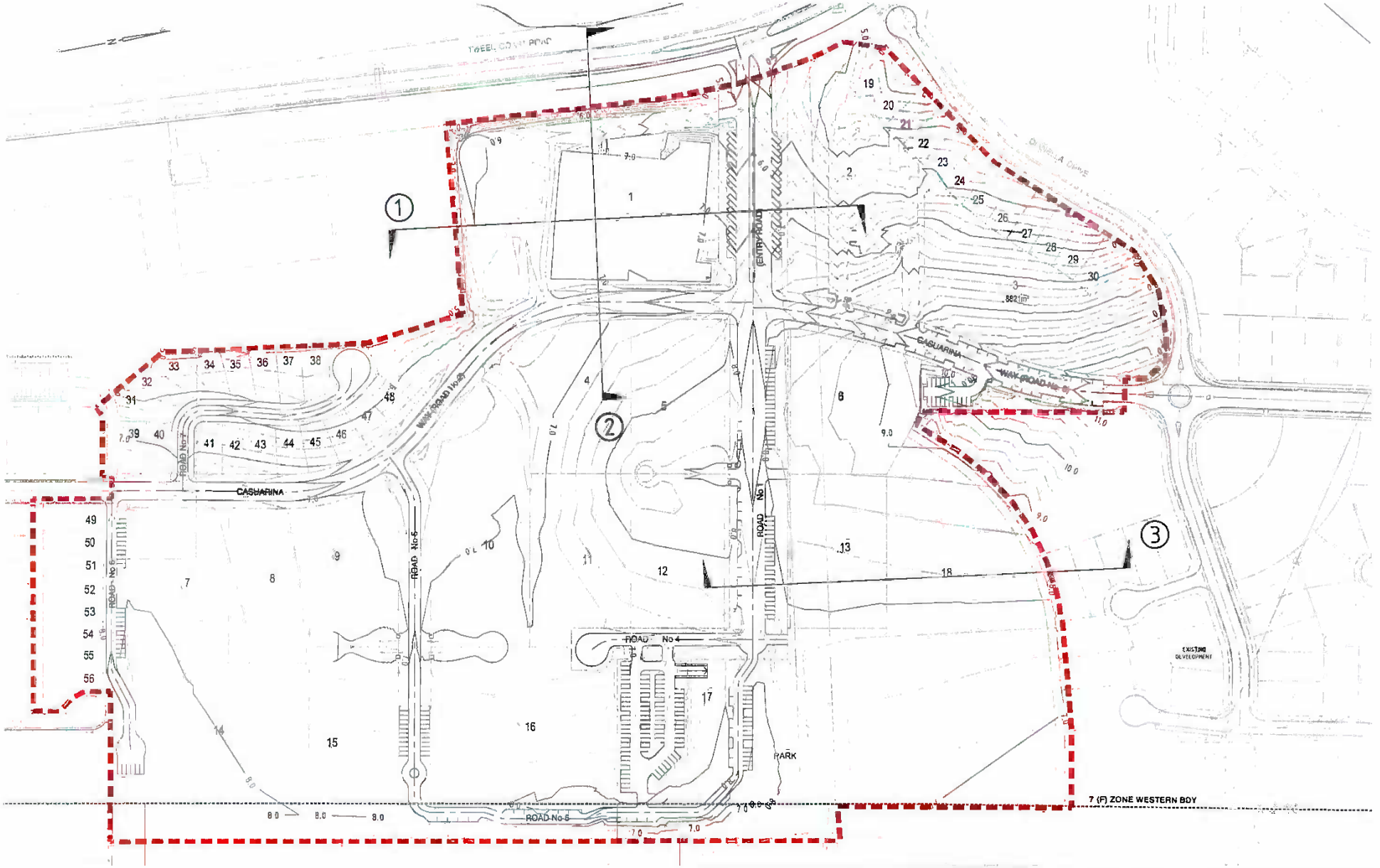
CASUARINA BEACH	SCALE :- 1:2000 A1
TOWN CENTRE	DATE :- 10 JULY, 2007 REV G
DA SUBMISSION	DRAWING No 7079/4/1-FIG DA22

FIGURE No. DA22G(23/04/08)
EXISTING CONTOURS PLAN



NOTE.
REFER FIGURE QA26 FOR SITE CROSS SECTIONS

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Commercial Centre, Isle of Capri
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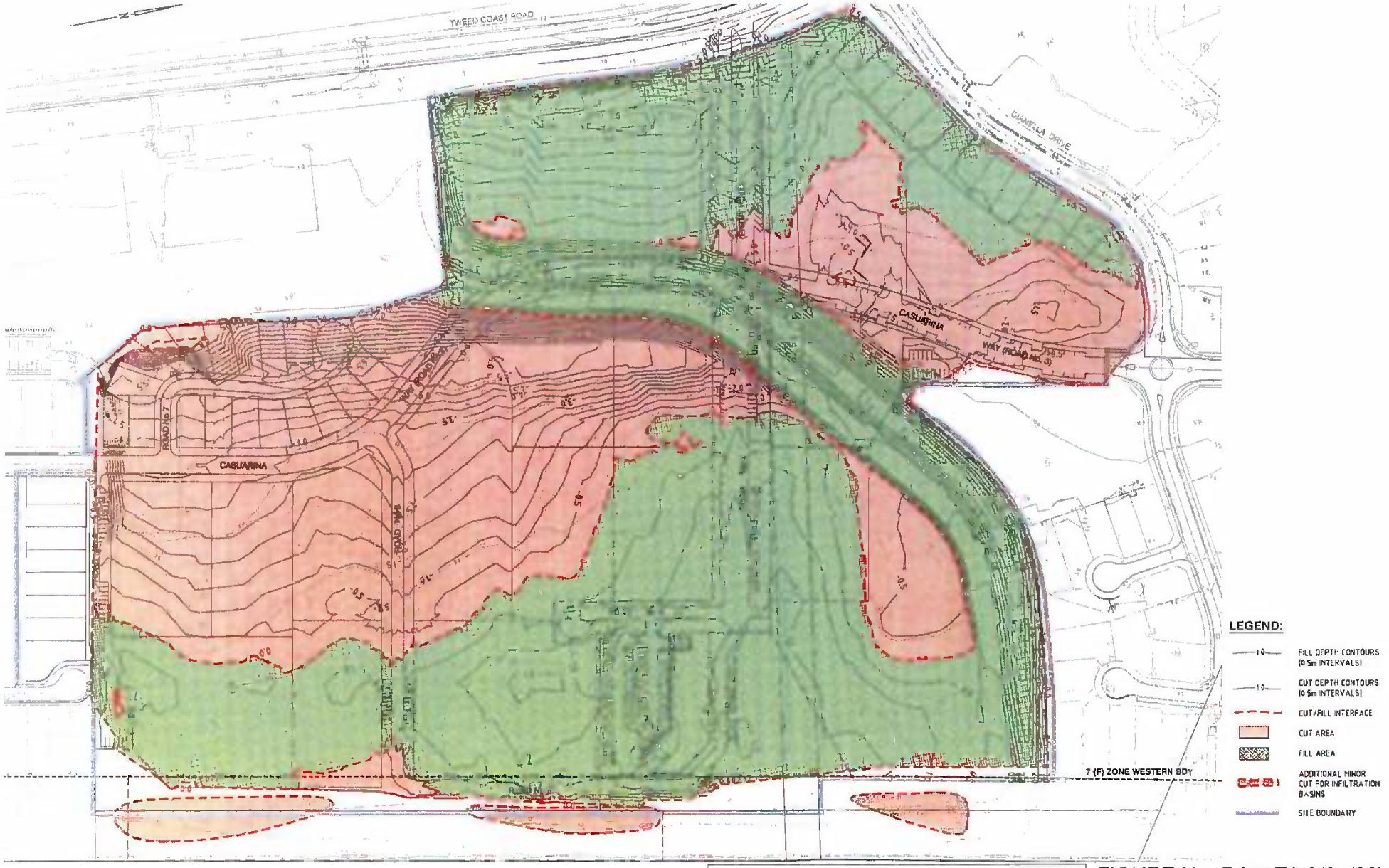
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- AS SHOWN A1 DATE :- 10 JULY, 2007 REV G DRAWING No 7079/2/1-FIG DA24

FIGURE No. DA24G(28/04/08)
FINISHED SURFACE CONTOURS



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Commercial Centre, 164 Gt Coast
Gold Coast City, Queensland 4217
Email: gcc@cardno.com.au

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KINGS BEACH (No. 2) PTY LTD

CASUARINA BEACH
TOWN CENTRE
DA SUBMISSION

SCALE :- 1:2000	A1
DATE :- 10 JULY, 2007	REV. E
DRAWING No.	7079/4/1-FIG DA25

FIGURE No. DA25E(23/04/08)

CUT / FILL DEPTHS
LAYOUT PLAN

SEDIMENT BASIN SIZES

BASIN NUMBER	MINIMUM BASIN SIZE (m)
SB1A	14 x 42 x 0.6
SB1B	14 x 42 x 0.6
SB2	6 x 17 x 0.6
SB3	8 x 24 x 0.6

NOTES:

1. EROSION AND SEDIMENT CONTROL MEASURES TO BE INSTALLED AND MODIFIED TO SUIT THE LANDFORM AT THE TIME.
2. IT IS EXPECTED THAT RUNOFF WITHIN SEDIMENT BASINS WILL INFILTRATE THROUGH THE SAND FILTER MEDIA.
3. SEDIMENT BASIN SB1A TO BE RELOCATED TO POSITION OF BASIN SB1B AS GRADING OF CATCHMENT VARIES DURING BULK EARTHWORKS
4. TSC's DEVELOPMENT DESIGN SPECIFICATION D7 ANNEXURE A - "CODE OF PRACTICE FOR SOIL AND WATER MANAGEMENT ON CONSTRUCTION WORKS," SECTION D7.A7 SEDIMENT CONTROL CONDITION 7.2 STATES. "SEDIMENT BASIN(S) MUST BE CONSTRUCTED WHERE THE AREA TO BE DEVELOPED EXCEEDS 1 HECTARE WHERE IT IS LESS THEN 1 HECTARE, OTHER SEDIMENT CONTROL DEVICES MAY BE ACCEPTED." THEREFORE FOR CATCHMENT AREAS OF GENERALLY 1 HECTARE OR LESS EROSION CONTROL DEVICES OTHER THAN SEDIMENTATION BASINS HAVE BEEN UTILISED.

LEGEND:

- SB3 — TEMPORARY SEDIMENT BASIN
- SEDIMENT BASIN DISCHARGE ARRANGEMENT (REFER CARDNO STD DRG S5/6-20)
- 5 — EXISTING CONTOURS
- SF — SEDIMENT FILTER FENCE (REFER TSC STD DRG STD.501 REV B)
- PB — PERIMETER BUND (REFER CARDNO STD DRG S5/6-20)
- CD — CATCH DRAIN (REFER CARDNO STD DRG S5/6-20)
- STABILISED SITE ACCESS (REFER CARDNO STD DRG S5/6-20)
- E 0.51 ha — PRELIMINARY BULK EARTHWORKS CATCHMENT AREA
- SITE BOUNDARY

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CASUARINA BEACH	SCALE :- 1:1000 A3
TOWN CENTRE	DATE :- 10 JULY, 2003 REV. G
DA SUBMISSION	DRAWING No 7079/4/1-FIG DA27

FIGURE No.DA27G(23/04/08)

EROSION & SEDIMENT CONTROL LAYOUT PLAN

APPENDIX H

DA DRAWINGS

KINGS BEACH (No. 2) PTY LTD
CASUARINA BEACH
TOWN CENTRE

APPLICATION FOR DEVELOPMENT APPROVAL
DRAWINGS REFERENCED IN ENGINEERING STATEMENT, JANUARY,2008

PROPERTY DESCRIPTION
LOT 223 ON LOT 1048494

Job No. - 7079/04/01
Date - JAN.2008

LOCALITY PLAN
NOT TO SCALE

DEVELOPMENT APPLICATION FIGURES LIST

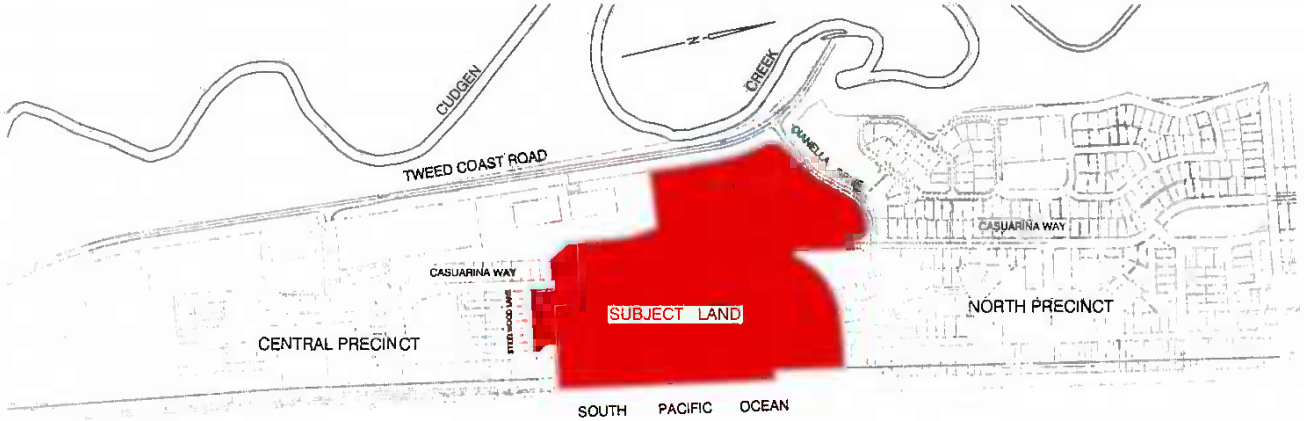
Fig No.	Description
FIGURE No. DA20	LOCALITY PLAN, SITE PLAN AND SCHEDULE OF DRAWINGS
FIGURE No. DA21	SUBJECT LAND AND AIR PHOTO 2005
FIGURE No. DA22	EXISTING CONTOURS PLAN
FIGURE No. DA23	ROAD LAYOUT PLAN
FIGURE No. DA24	FINISHED SURFACE CONTOURS
FIGURE No. DA25	CUT / FILL DEPTHS LAYOUT PLAN
FIGURE No. DA26	SITE CROSS SECTIONS
FIGURE No. DA27	EROSION AND SEDIMENT CONTROL LAYOUT PLAN
FIGURE No. DA28	ROAD No 1 LONGITUDINAL SECTION
FIGURE No. DA29	CASUARINA WAY (ROAD No.2) LONGITUDINAL SECTION
FIGURE No. DA30	ROAD No 3 (CASUARINA WAY) AND ROAD No 4 LONGITUDINAL SECTIONS
FIGURE No. DA31	ROAD No 5 LONGITUDINAL SECTION
FIGURE No. DA32	ROAD No 8 LONGITUDINAL SECTION
FIGURE No. DA33	ROAD No [illegible] LONGITUDINAL SECTION
FIGURE No. DA34	TYPICAL CROSS SECTION - SHEET 1
FIGURE No. DA35	TYPICAL CROSS SECTION - SHEET 2
FIGURE No. DA36	CATCHMENT AREAS AND DRAINAGE PATHS
FIGURE No. DA37	SEWER RETICULATION LAYOUT PLAN
FIGURE No. DA38	WATER RETICULATION LAYOUT PLAN
FIGURE No. DA39	SUBDIVISION LAYOUT PLAN
FIGURE No. DA40	DEDICATION AND EASEMENT PLAN
FIGURE No. DA41	STAGING PLAN

CARDNO STANDARD DRAWING LIST

Drg No.	Description
S5/8-20	SEDIMENT AND EROSION CONTROL DETAILS

TWEED SHIRE COUNCIL STANDARD DRAWINGS LIST

Drg No.	Description
S.D. 501	SEDIMENT CONTROL DEVICES SEDIMENT FENCE ENTRY/EXIT SEDIMENT TRAP
S.D. 502	SEDIMENT CONTROL DEVICES KERB AND FIELD INLETS, CHECK DAMS & STRAW BALE BANK



SITE PLAN
NOT TO SCALE

Cardno (Qld) Pty Ltd ABN: 001 074 992
Commercial Centre, Isle of Capri
Gold Coast City, Queensland 4217
Email: gce@cardno.com.au

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FIGURE No.DA20G(28/04/08)

LOCALITY PLAN, SITE PLAN AND SCHEDULE OF DRAWINGS

Cardno (Qld) Pty Ltd ACN. 051 074 992
Commercial Centre, Isle of Capri
Gold Coast City, Queensland 4217
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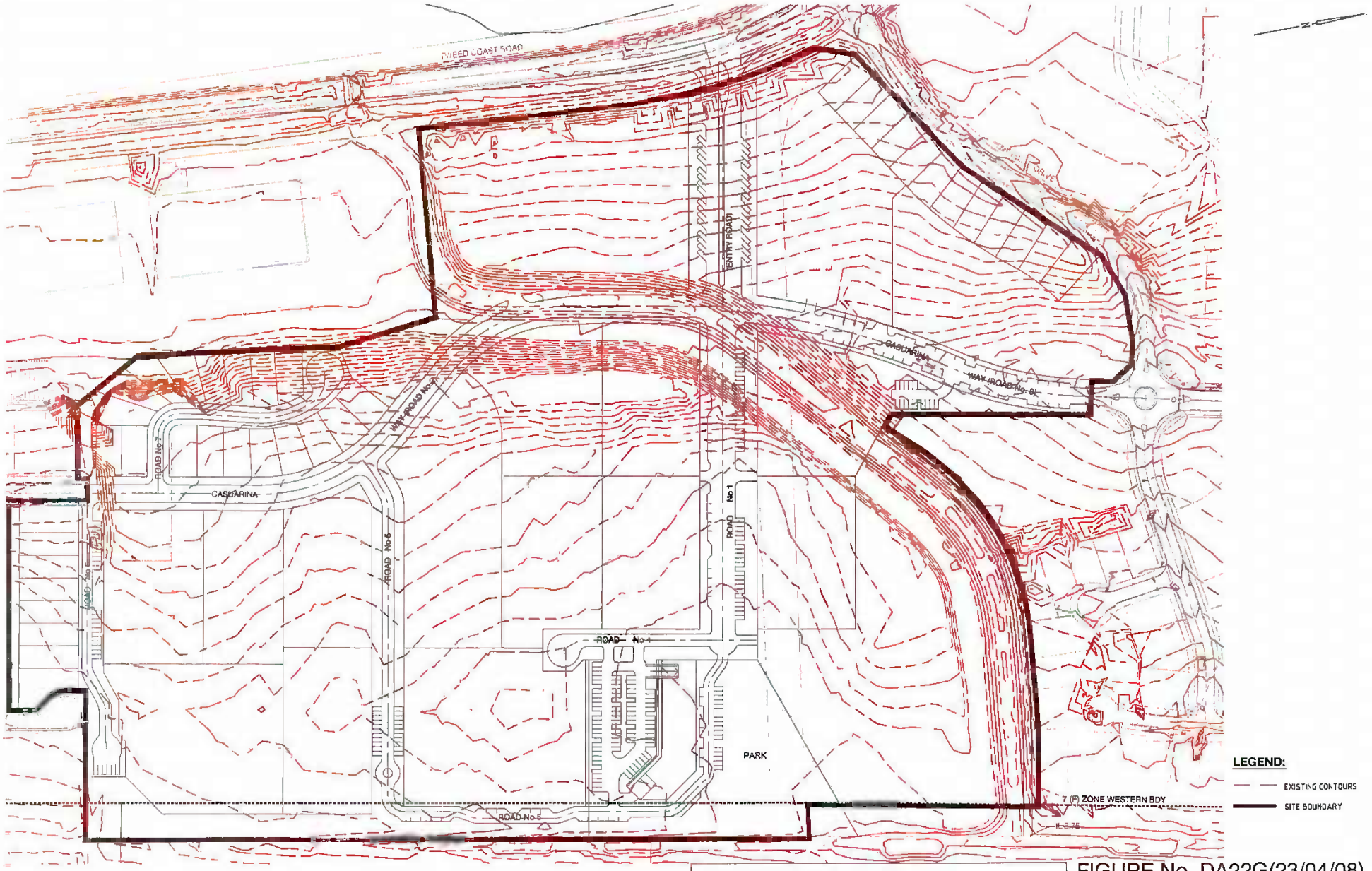
KINGS BEACH (No. 2) PTY LTD		
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- NOT TO SCALE	A1
	DATE :- 10 JULY, 2007	REV E
	DRAWING No.	7079/4/1-FIG DA21

FIGURE No.DA21E(28/04/08)

SUBJECT LAND
AIR PHOTO 2005

IMAGE FILE NAME : I:\7079\01\Casuarina Beach\7794\Reports\casuarina01.jpg
G:\7079\01\061011\DA Approval\7979804\01-figure-school.dwg

CAD FILE NAME : G:\7079\01\101\DA Approval\7079404\DA21E.dwg



20 10 0 20 40 60 80

SCALE BEFORE REDUCTION

1:2000

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CAD FILE NAME: G:\7079\PLOT\DA Approval\7079DA22G.dwg

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:2000 A1 DATE :- 18 JULY, 2007 REV 0 DRAWING No. 7079/4/1-FIG DA22

FIGURE No. DA22G(23/04/08)
EXISTING CONTOURS PLAN

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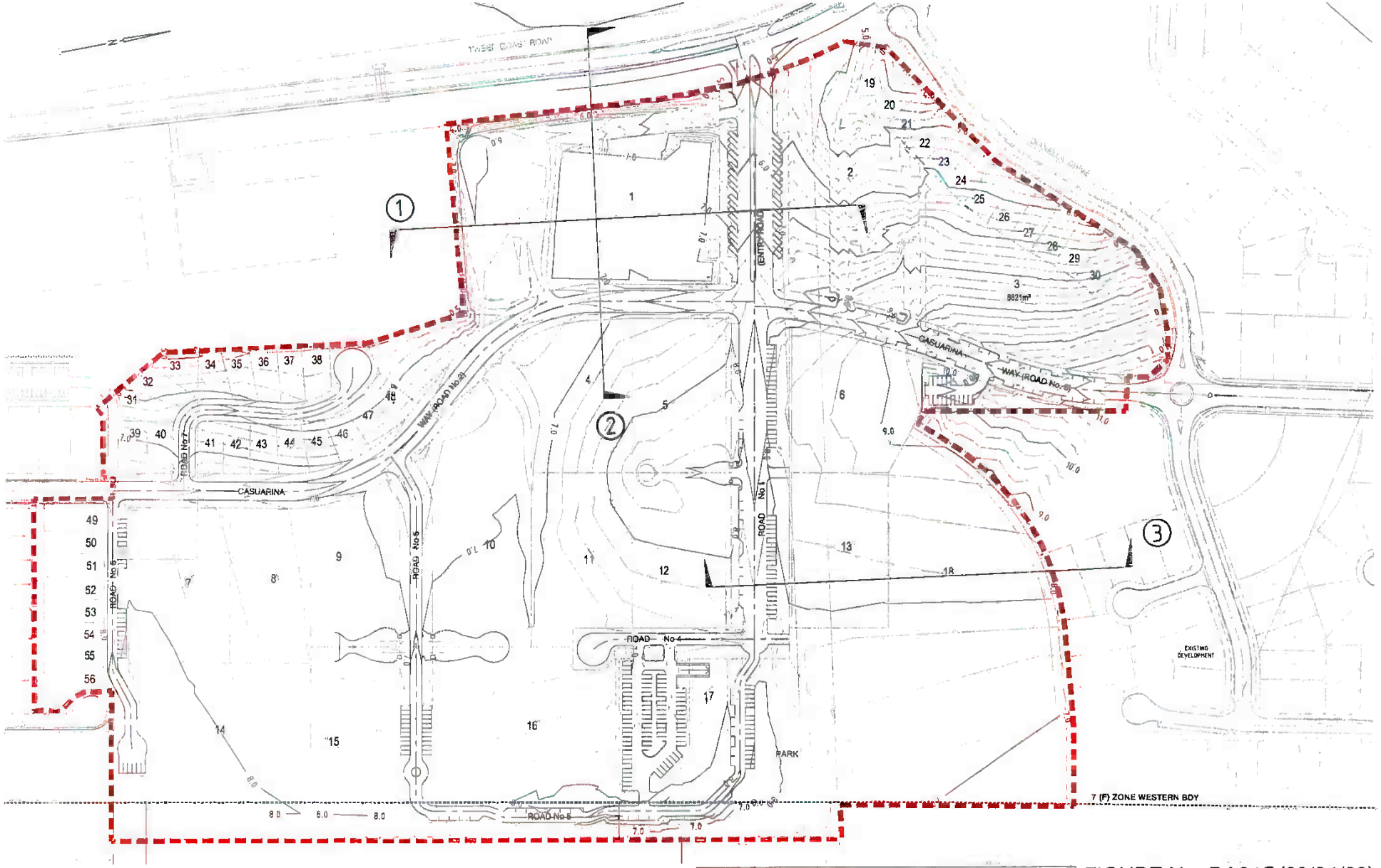
KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:2000 A1 DATE :- 10 JULY, 2007 REV. G DRAWING No 7079/4/1-FIG DA23

FIGURE No. DA23G(28/04/08)

ROAD LAYOUT PLAN



NOTE:
REFER FIGURE DA26 FOR SITE CROSS SECTIONS

20 10 0 20 40 60 80m
SCALE BEFORE REDUCTION 1: 1000

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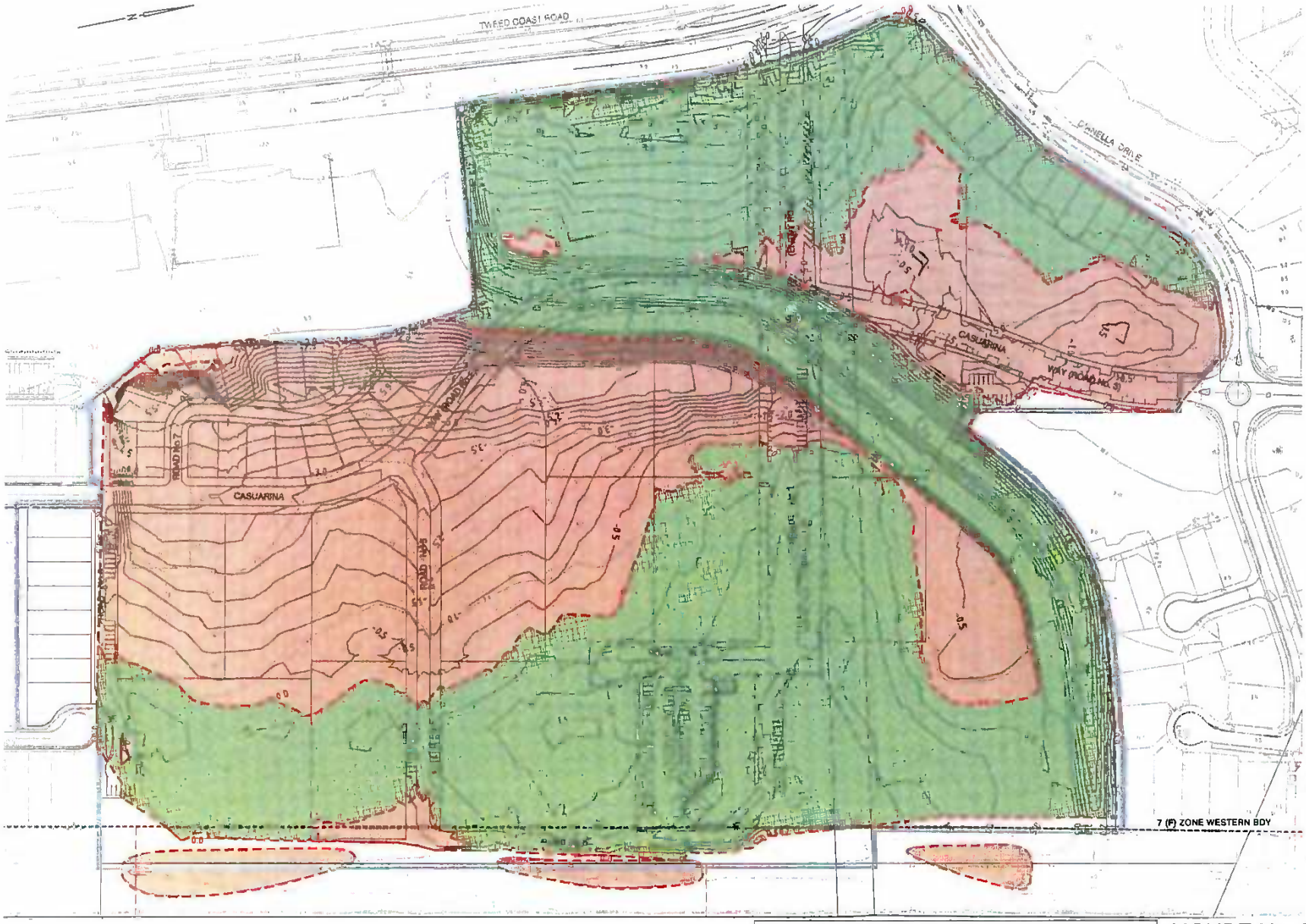
KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE – AS SHOWN A1 DATE – 16 JULY, 2007 REV 0 DRAWING No. 7079/2/1-FIG DA24

FIGURE No. DA24G(28/04/08)
FINISHED SURFACE CONTOURS



SCALE BEFORE REDUCTION

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Gold Coast City, Queensland 4217
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CAD FILE NAME: G:\7079\94\01\DA Approval\7079401DA25E.dwg
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KINGS BEACH (No. 2) PTY LTD

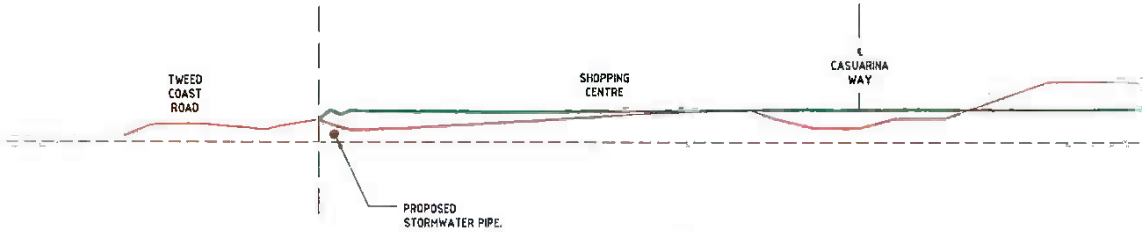
CASUARINA BEACH
TOWN CENTRE
DA SUBMISSION

SCALE :- 1:2000 A1
DATE :- 10 JULY, 2007 REV: E
DRAWING No: 7079/4/1-FIG DA25

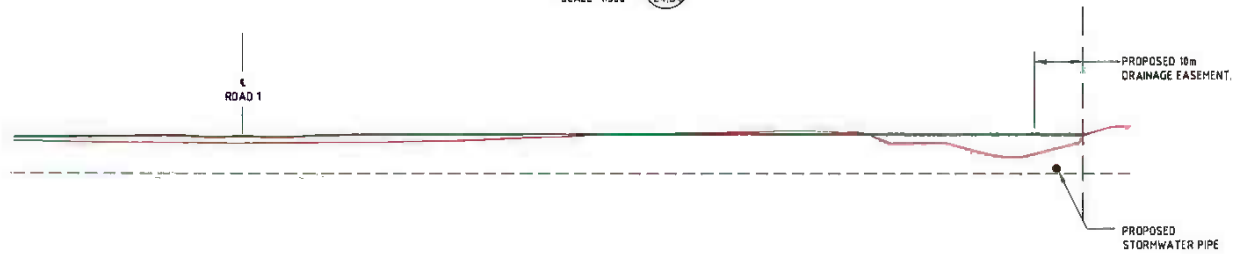
FIGURE No. DA25E(23/04/08)

CUT / FILL DEPTHS LAYOUT PLAN

SECTION 1
SCALE 1:500 24,34



SECTION 2
SCALE 1:500 24,34



SECTION 3
SCALE 1:500 24,34

10 5 0 10 20 30 40m
SCALE BEFORE REDUCTION 1:500

CAD FILE NAME: [illegible]

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KINGS BEACH (No. 2) PTY LTD		
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- AS SHOWN	A1
	DATE :- 10 JULY, 2007	REV D
	DRAWING No 7079/2/1-FIG DA26	

FIGURE No. DA26D(16/01/08)
SITE CROSS SECTIONS

SEDIMENT BASIN SIZES

BASIN NUMBER	MINIMUM BASIN SIZE (m)
SB1A	14 x 42 x 0.6
SB1B	14 x 42 x 0.6
SB2	6 x 17 x 0.6
SB3	8 x 24 x 0.6

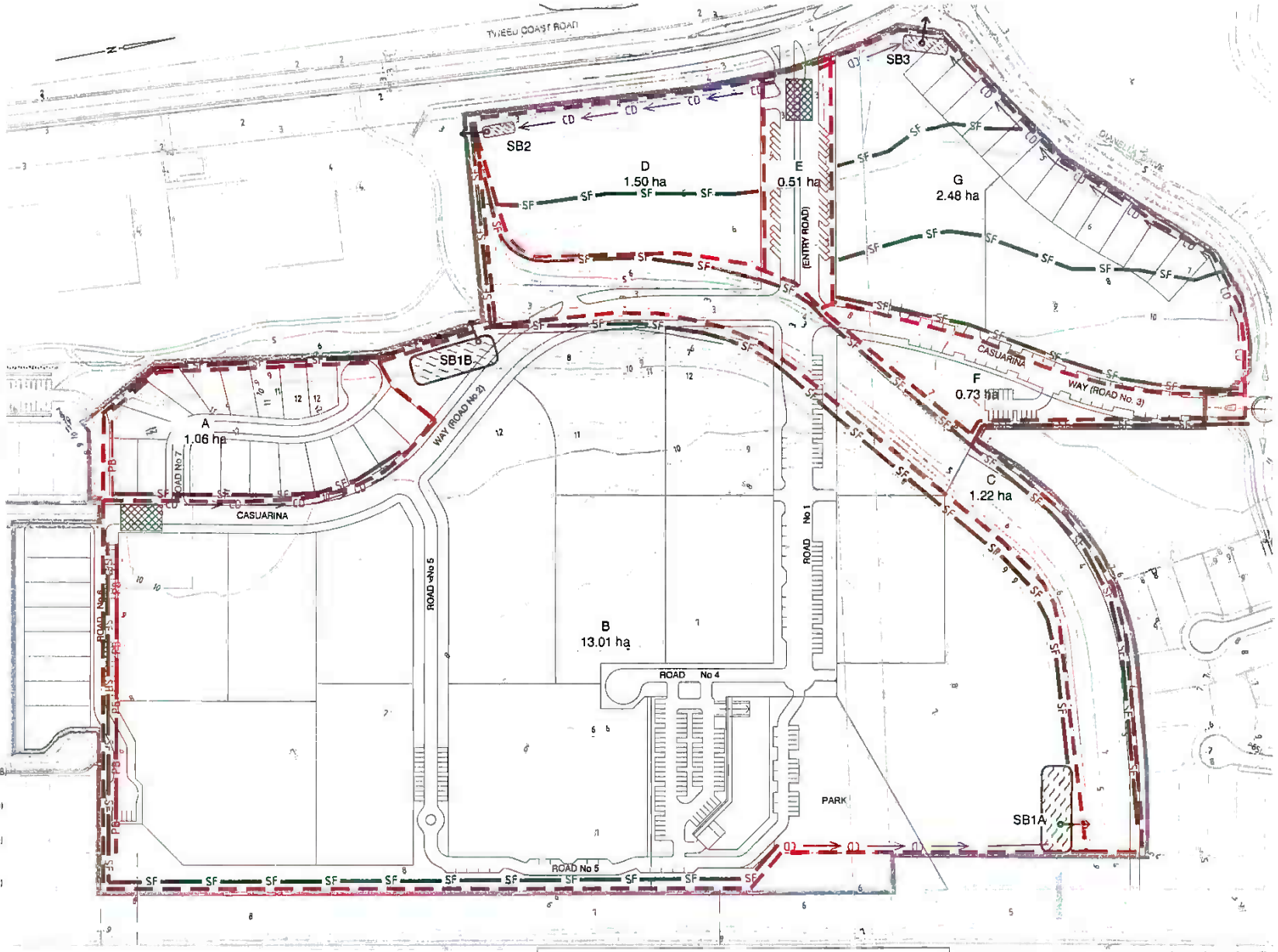
NOTES:

1. EROSION AND SEDIMENT CONTROL MEASURES TO BE INSTALLED AND MODIFIED TO SUIT THE LANDFORM AT THE TIME
2. IT IS EXPECTED THAT RUNOFF WITHIN SEDIMENT BASINS WILL INFILTRATE THROUGH THE SAND FILTER MEDIA.
3. SEDIMENT BASIN SB1A TO BE RELOCATED TO POSITION OF BASIN SB1B AS GRADING OF CATCHMENT VARIES DURING BULK EARTHWORKS
4. TSC's DEVELOPMENT DESIGN SPECIFICATION D7 ANNEXURE A – "CODE OF PRACTICE FOR SOIL AND WATER MANAGEMENT ON CONSTRUCTION WORKS," SECTION D7.A7 SEDIMENT CONTROL CONDITION 7.2 STATES: "SEDIMENT BASIN(S) MUST BE CONSTRUCTED WHERE THE AREA TO BE DEVELOPED EXCEEDS 1 HECTARE. WHERE IT IS LESS THEN 1 HECTARE, OTHER SEDIMENT CONTROL DEVICES MAY BE ACCEPTED." THEREFORE FOR CATCHMENT AREAS OF GENERALLY 1 HECTARE OR LESS EROSION CONTROL DEVICES OTHER THAN SEDIMENTATION BASINS HAVE BEEN UTILISED

LEGEND:

- SB3 — TEMPORARY SEDIMENT BASIN
- SEDIMENT BASIN DISCHARGE ARRANGEMENT (REFER CARDNO STD DRG S5/6-20)
- SS — EXISTING CONTOURS
- SF — SEDIMENT FILTER FENCE (REFER TSC STD DRG S 0.501 REV B)
- PB — PERIMETER BUND (REFER CARDNO STD DRG S5/6-20)
- CD — CATCH DRAIN (REFER CARDNO STD DRG S5/6-20)
- STABILISED SITE ACCESS (REFER CARDNO STD DRG S5/6-20)
- E 0.51 ha — PRELIMINARY BULK EARTHWORKS CATCHMENT AREA
- SITE BOUNDARY

20 10 0 20 40 60 80 1:1000
SCALE BEFORE REDUCTION



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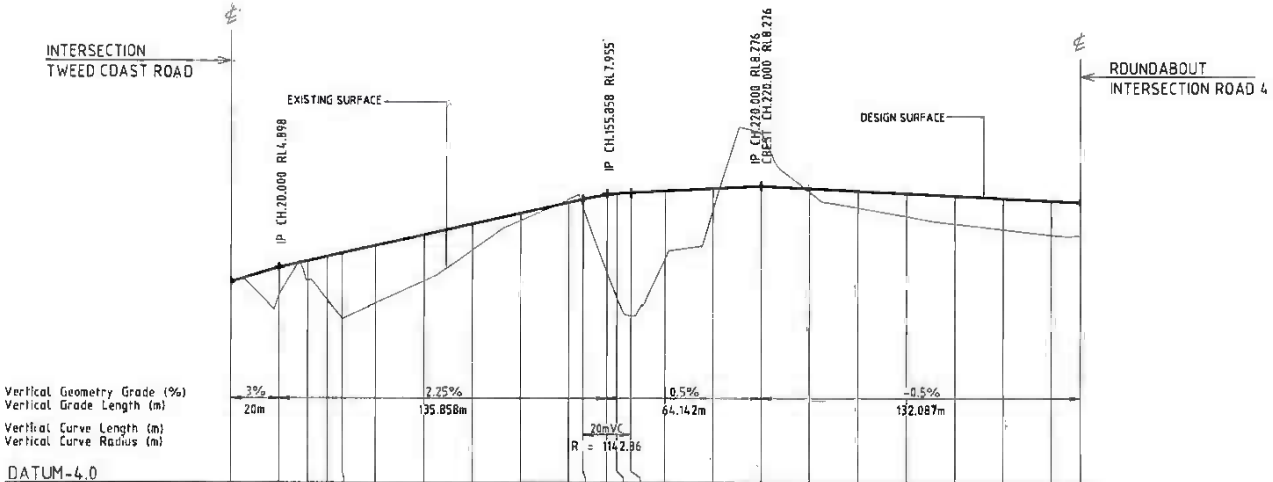
CAD FILE NAME: G:\7079\04-10\DA Approval\7079040-IDA27G.dwg

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:1000 A3 DATE :- 10 JULY, 2007 REV. 0 DRAWING No. 7079/4/1-FIG DA27

FIGURE No.DA27G(23/04/08)

EROSION & SEDIMENT CONTROL LAYOUT PLAN



EXISTING NATURAL SURFACE LEVEL	4.299	3.777	4.374	3.546	2.784	3.423	4.341	5.613	6.838	7.276	7.405	4.699	3.637	2.911	5.256	7.285	10.441	8.096	7.379	7.021	6.711	6.486	6.266	6.228
CUT / FILL DEPTH TO EXISTING	0.001	-1.121	-0.298	-1.802	-2.702	-2.375	-1.907	-1.085	-0.310	0.128	-0.324	-3.212	-4.223	-5.093	-2.819	-0.890	2.165	-0.140	-0.696	-0.955	-1.165	-1.290	-1.410	-1.387
CONTROL LINE FINISHED LEVEL	4.298	4.898	5.164	5.348	5.486	5.798	6.248	6.698	7.148	7.598	7.730	2.911	2.961	8.005	8.076	8.176	8.276	8.176	8.076	7.976	7.876	7.776	7.676	7.615
CONTROL LINE CHAINAGE	0.000	20.000	31.831	40.000	46.125	60.000	80.000	100.000	120.000	140.000	145.858	155.858	160.000	165.858	180.000	200.000	220.000	240.000	260.000	280.000	300.000	320.000	340.000	352.087

LONGITUDINAL SECTION
ROAD No 1.

HOR. 20 10 0 20 40 60 80 1 : 1000
VERT. 2 1 0 2 4 6 8 1 : 100
SCALE BEFORE REDUCTION

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Gold Coast City, Queensland 4213
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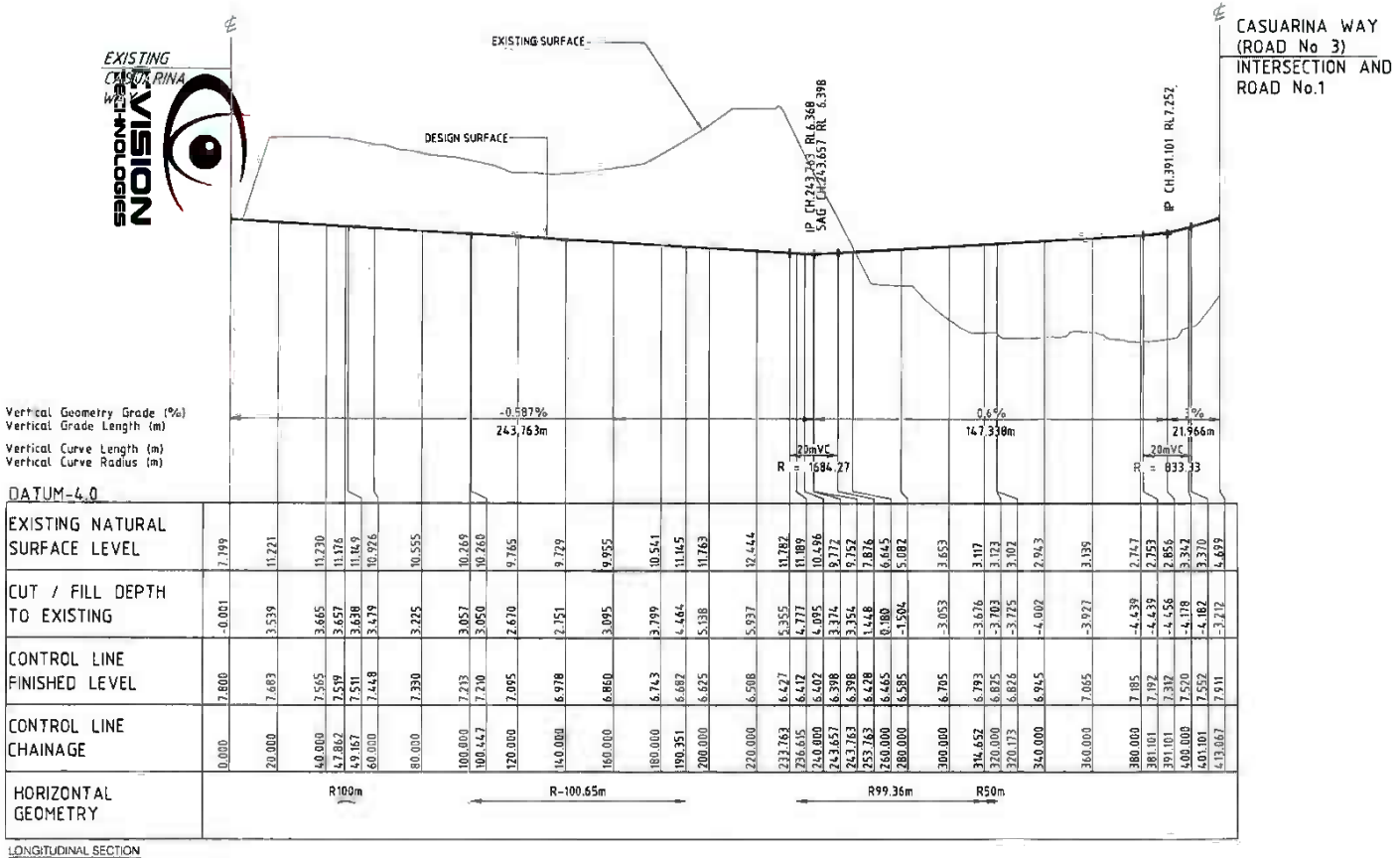
CAD FILE NAME: DA7079\8\1\DA Approval\7079\8\DA28D.dwg

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE - 1:1000H 1:100 V — A1 DATE - 19 JULY, 2007 — REV 0 DRAWING No 7079/4/1-FIG DA28

FIGURE No. DA28D(16/01/08)
ROAD No.1
LONGITUDINAL SECTION



CONTROL LINE CHAINAGE	EXISTING NATURAL SURFACE LEVEL	CUT / FILL DEPTH TO EXISTING	CONTROL LINE FINISHED LEVEL
0.000	7.199	-0.001	7.800
20.000	11.221	3.539	7.683
40.000	11.230	3.665	7.565
47.862	11.176	3.657	7.519
49.167	11.149	3.638	7.511
60.000	10.926	3.479	7.448
80.000	10.555	3.225	7.330
100.000	10.269	3.057	7.213
100.447	10.268	3.050	7.218
120.000	9.765	2.670	7.095
140.000	9.729	2.751	6.978
160.000	9.955	3.095	6.860
180.000	10.541	3.799	6.743
190.351	11.145	4.464	6.682
200.000	11.763	5.138	6.625
220.000	12.444	5.937	6.508
232.763	11.782	5.355	6.427
236.615	11.189	4.777	6.412
240.000	10.496	4.095	6.402
243.657	9.772	3.374	6.398
243.763	9.752	3.354	6.398
253.763	7.876	1.448	6.428
260.000	6.645	0.180	6.465
280.000	5.082	-1.504	6.585
300.000	3.653	-3.053	6.705
314.652	3.117	-3.676	6.793
320.000	3.123	-3.703	6.825
320.173	3.102	-3.725	6.826
340.000	2.943	-4.002	6.945
360.000	3.139	-3.927	7.065
380.000	2.747	-4.439	7.185
381.101	2.753	-4.439	7.192
391.101	2.856	-4.456	7.312
400.000	3.342	-4.178	7.520
401.101	3.370	-4.182	7.552
413.067	4.699	-3.212	7.911

LONGITUDINAL SECTION
CASUARINA WAY (ROAD No. 2)

HOR 20 10 0 20 40 60 80 1 : 1000
VERT. 2 1 0 2 4 6 8 1 : 100
SCALE BEFORE REDUCTION

CAD FILE NAME: G:\7079\04\DRDA Approval\7079040DA29C.dwg

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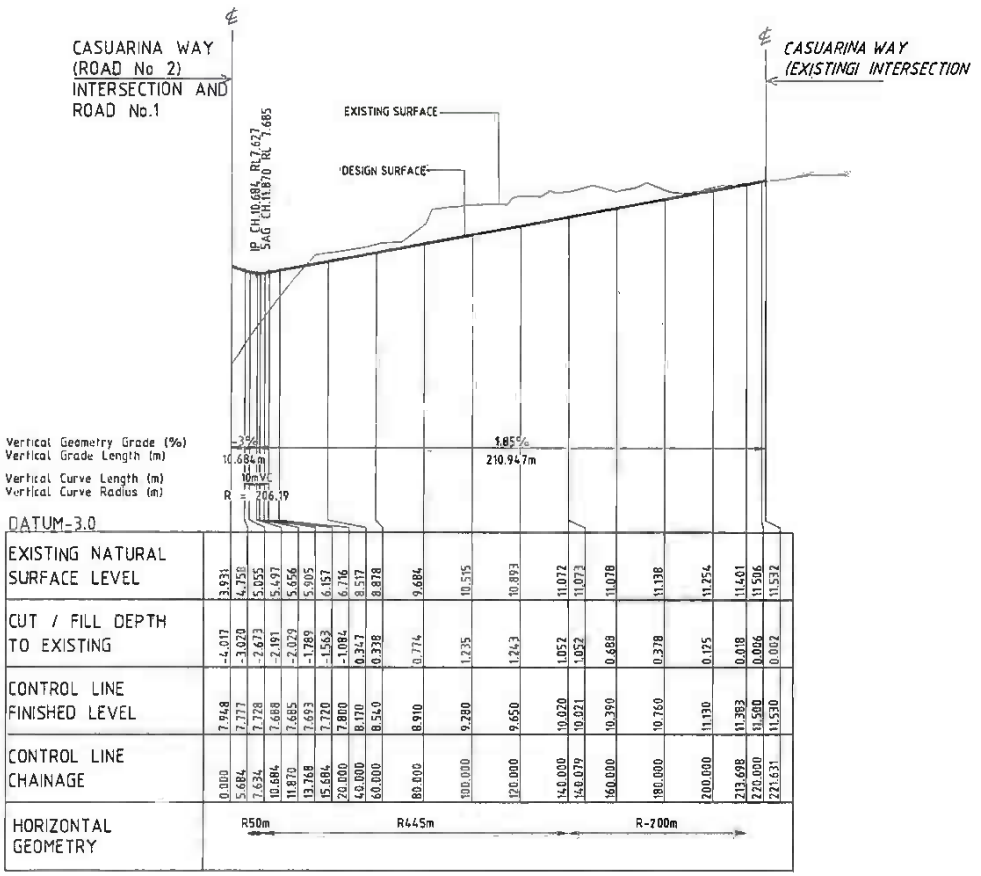
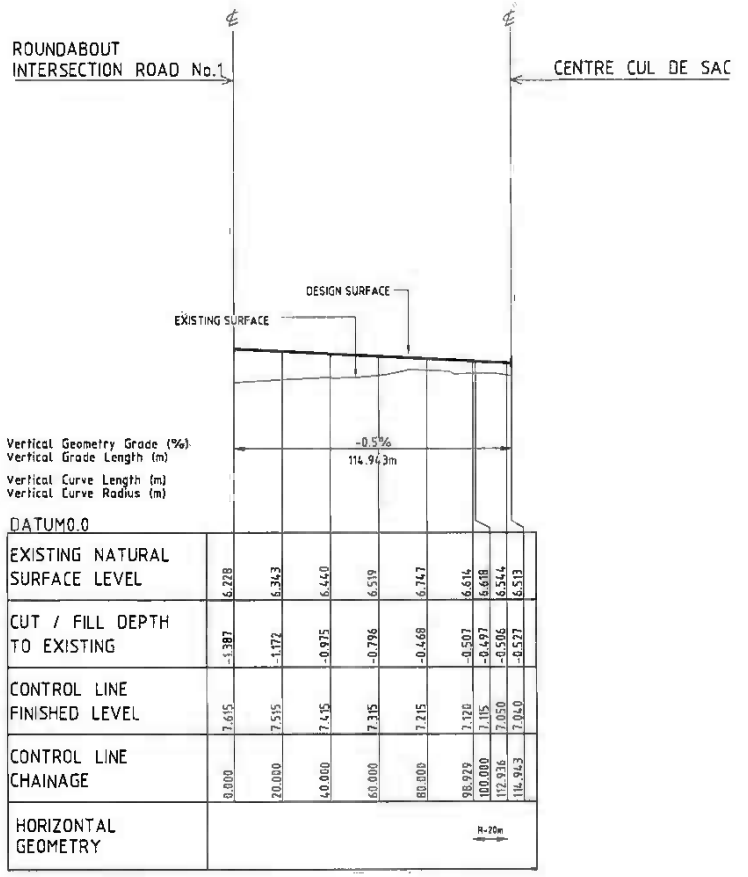
KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1 100(H) 1:100 V A1 DATE :- 19 JULY, 2007 REV C DRAWING No. 7079/4/1-FIG DA29

FIGURE No. DA29C(16/01/08
CASUARINA WAY (ROAD No.2)
LONGITUDINAL SECTION



LONGITUDINAL SECTION
ROAD No 3 (CASUARINA WAY)



LONGITUDINAL SECTION
ROAD No 4

HOR 20 10 0 20 40 60 80 1:1000
VERT. 2 1 0 2 4 6 8 1:100
SCALE BEFORE REDUCTION

CAD FILE NAME: L:\7079\1\041\DA Approval\7079041DA30C.dwg

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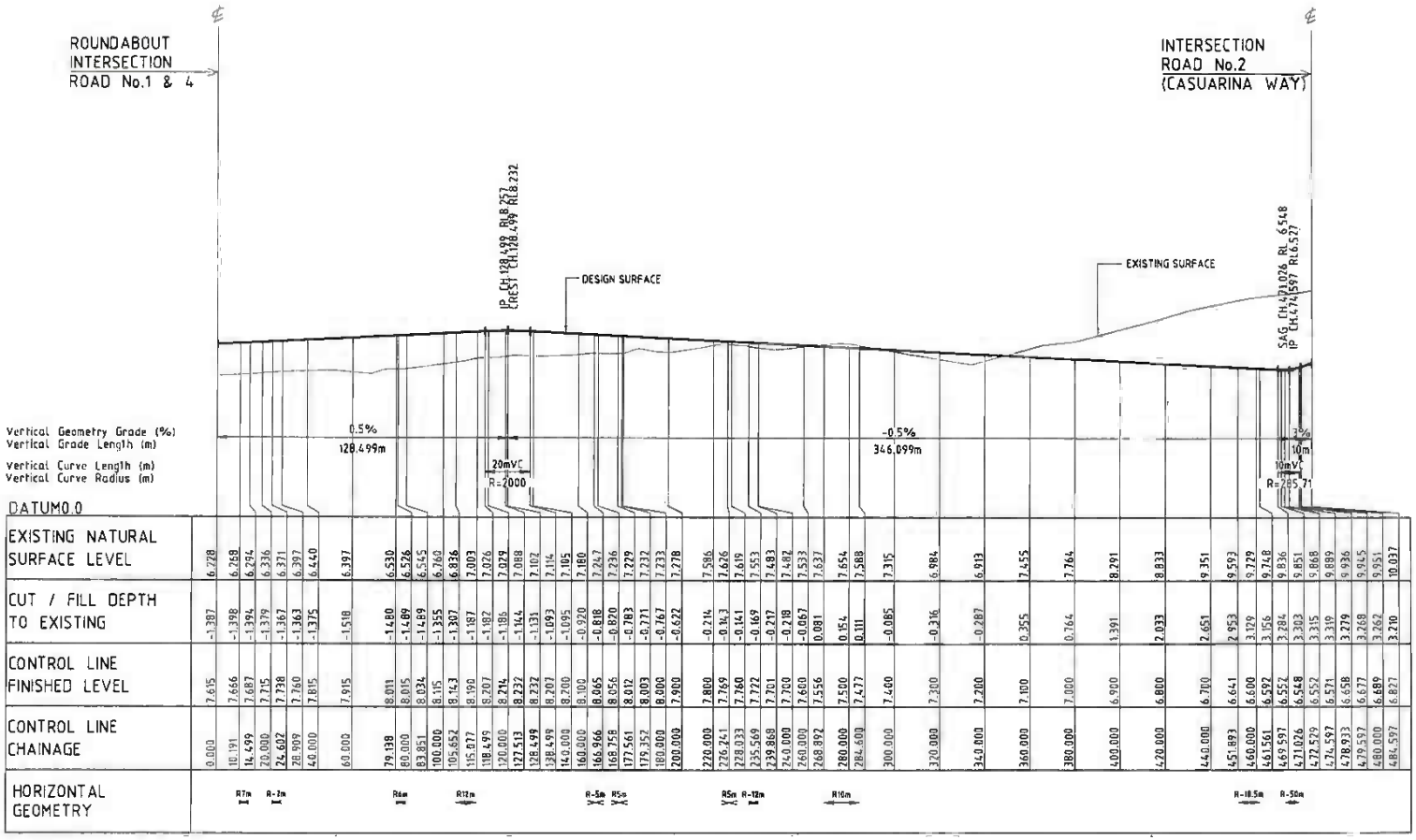
KINGS BEACH (No. 2) PTY LTD		
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE H: 1:1000@A1 1:100 V	A1
	DATE: 10 JULY, 2007	REV: C
	DRAWING No: 7079/4/1-FIG DA30	

FIGURE No.DA30C(16/01/08)

ROAD No 3 (CASUARINA WAY)
AND ROAD No 4
LONGITUDINAL SECTIONS



CONTROL LINE CHAINAGE	EXISTING NATURAL SURFACE LEVEL	CUT / FILL DEPTH TO EXISTING	CONTROL LINE FINISHED LEVEL
0.000	6.728	-1.387	7.615
10.191	6.758	-1.398	7.666
14.499	6.294	-1.394	7.687
20.000	6.336	-1.379	7.715
24.602	6.371	-1.367	7.738
28.909	6.397	-1.363	7.760
40.000	6.440	-1.375	7.815
60.000	6.397	-1.518	7.915
79.138	6.530	-1.480	8.011
80.000	6.526	-1.489	8.015
83.851	6.545	-1.489	8.034
100.000	6.760	-1.355	8.115
105.652	6.836	-1.307	8.143
115.077	7.003	-1.187	8.190
118.499	7.026	-1.182	8.207
120.000	7.029	-1.186	8.214
127.513	7.088	-1.144	8.232
128.499	7.102	-1.131	8.232
138.499	7.114	-1.093	8.207
140.000	7.105	-1.095	8.200
160.000	7.180	-0.920	8.100
166.966	7.247	-0.818	8.065
168.758	7.236	-0.820	8.056
177.561	7.229	-0.783	8.012
179.352	7.232	-0.771	8.003
180.000	7.233	-0.767	8.000
200.000	7.278	-0.622	7.900
220.000	7.586	-0.214	7.800
226.241	7.626	-0.143	7.769
228.033	7.619	-0.141	7.760
235.569	7.553	-0.169	7.722
239.868	7.483	-0.217	7.701
240.000	7.482	-0.218	7.700
260.000	7.533	-0.067	7.600
268.892	7.637	0.081	7.556
280.000	7.654	0.154	7.500
284.600	7.588	0.111	7.477
300.000	7.315	-0.085	7.400
320.000	6.984	-0.316	7.300
340.000	6.913	-0.287	7.200
360.000	7.455	0.355	7.100
380.000	7.764	0.764	7.000
400.000	8.291	1.391	6.900
420.000	8.833	2.033	6.800
440.000	9.351	2.651	6.700
451.893	9.593	2.953	6.641
460.000	9.729	3.129	6.600
461.561	9.748	3.156	6.592
469.597	9.836	3.284	6.552
471.026	9.851	3.303	6.548
472.529	9.868	3.315	6.552
474.597	9.889	3.319	6.571
478.933	9.936	3.279	6.658
479.597	9.945	3.269	6.677
480.000	9.951	3.262	6.689
484.597	10.037	3.210	6.827

LONGITUDINAL SECTION
ROAD No 5

HOR 20 10 0 20 40 60 80 1:1000
VERT. 2 1 0 2 4 6 8 1:100
SCALE BEFORE REDUCTION

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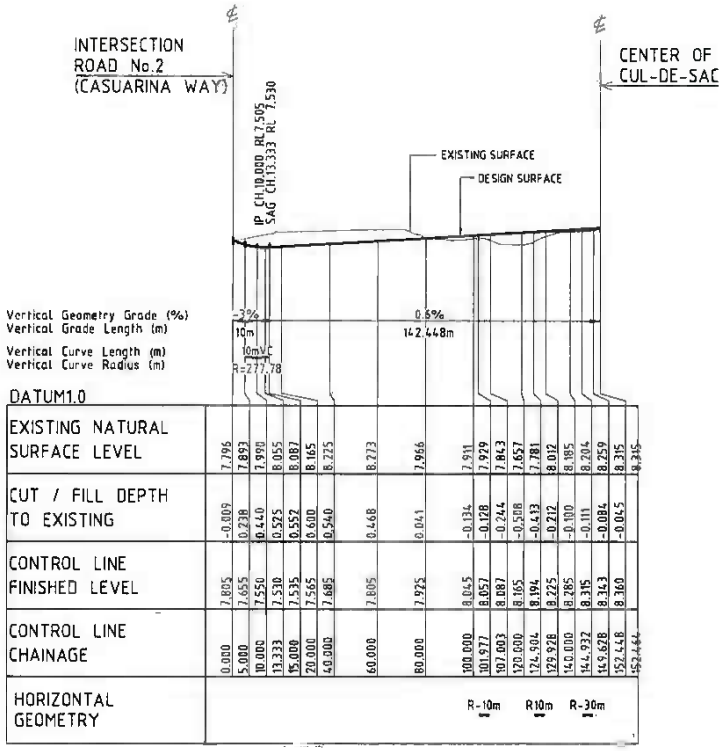
KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE - 1:1000H 1:100V A1 DATE - 18 JULY, 2007 REV E DRAWING No 7079/4/1-FIG DA31

FIGURE No.DA31E(17/02/08)
ROAD No 5
LONGITUDINAL SECTION



LONGITUDINAL SECTION
ROAD No 6

HOR 20 10 0 20 40 60 80 1:1000
VERT. 2 1 0 2 4 6 8 1:100
SCALE BEFORE REDUCTION

CAD FILE NAME: G:\7079\DA\01\DA-Approval\7079401DA32.dwg

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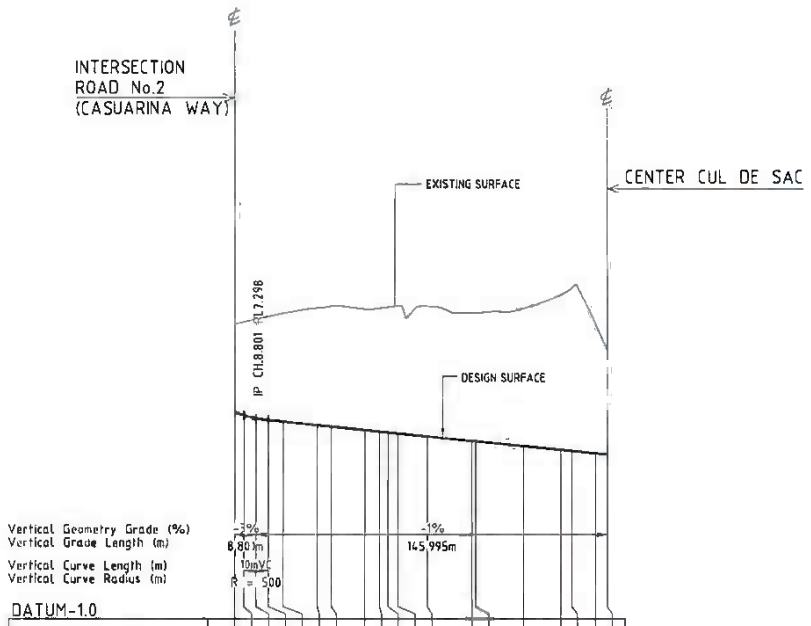
KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:1000H 1:100 V — A1 DATE :- 10 JULY, 2007 — REV E DRAWING No. 7079/4/1-FIG DA32

FIGURE No. DA32E(17/02/08)
ROAD No 6
LONGITUDINAL SECTION



LONGITUDINAL SECTION
ROAD No 7

HOR 20 10 0 20 40 60 80 1 : 1000
VERT. 2 1 0 2 4 6 8 1 : 100
SCALE BEFORE REDUCTION

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Gold Coast City, Queensland 4217
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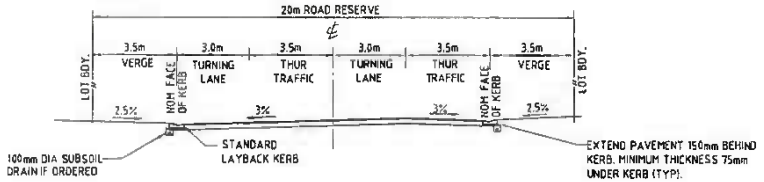
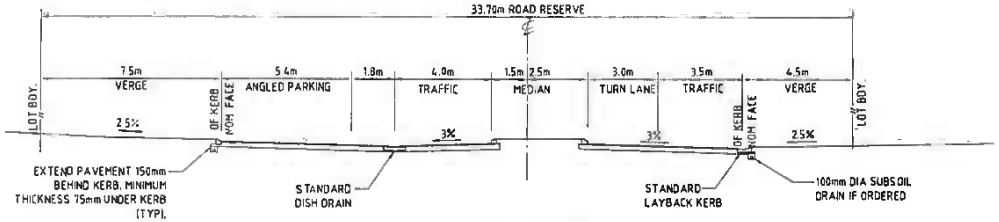
CAD FILE NAME: G:\BALLINA OFFICE\DWG\DWGS\ROAD\RD LAYOUT.dwg

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1 : 1000H 1 : 100 V A1 DATE :- 16 JULY, 2007 REV. E DRAWING No 7079/4/1-FIG DA33

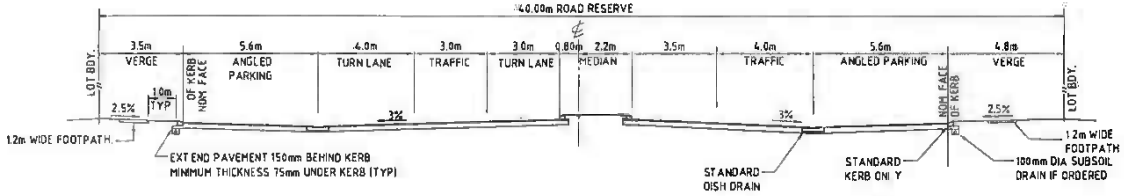
FIGURE No. DA33E(17/02/08)
ROAD No.7
LONGITUDINAL SECTIONS



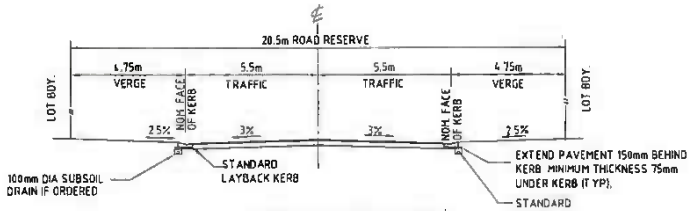
CASUARINA WAY (ROAD No 2)
AT INTERSECTION



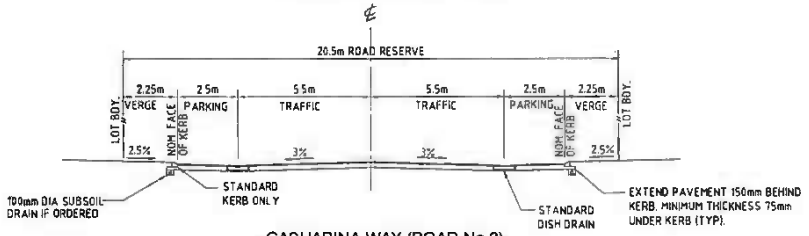
MAIN ROAD
(EAST OF CASUARINA WAY)



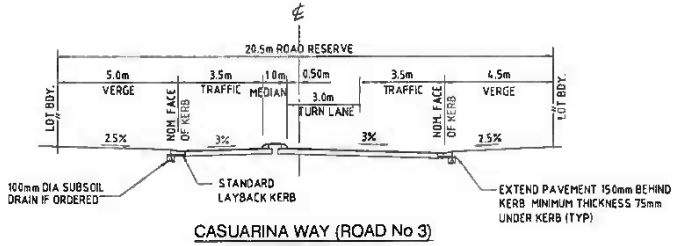
THE BOULEVARD
(TWEED COAST ROAD TO CASUARINA WAY)



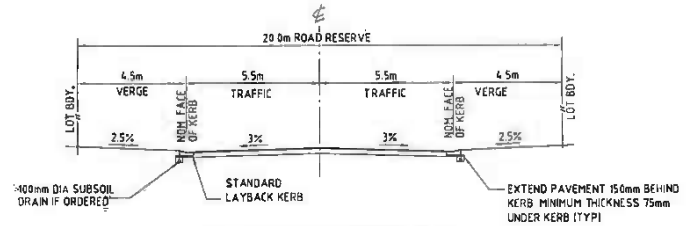
CASUARINA WAY (ROAD No 3)
WITHOUT PARALLEL PARKING



CASUARINA WAY (ROAD No 3)
AT PARALLEL PARKING



CASUARINA WAY (ROAD No 3)
AT INTERSECTION



CASUARINA WAY (ROAD No 2)
TYPICAL SECTION

2 1 0 2 4 6 8m
SCALE BEFORE REDUCTION 1:100

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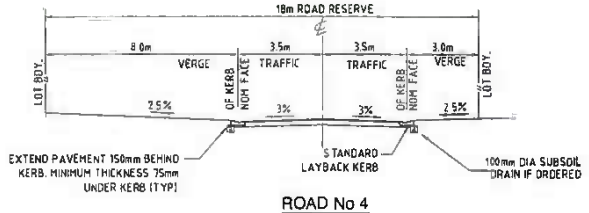
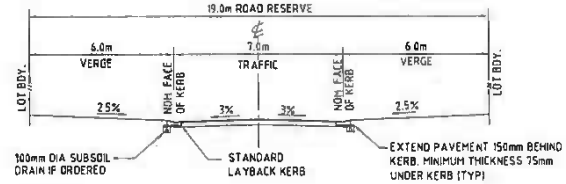
CAD FILE NAME: G:\7079\04\1\DA Approval\7079%20DA34.dwg

KINGS BEACH (No. 2) PTY LTD		
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE - 1:100	A1
	DATE - 10 JULY, 2007	REV B
	DRAWING No 7079/4/1-FIG DA34	

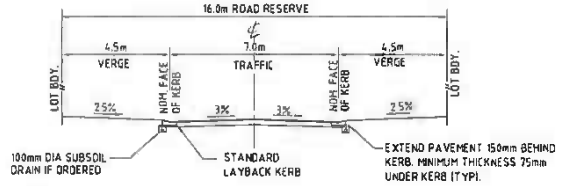
FIGURE No. DA34B(16/01/08)
TYPICAL CROSS SECTIONS
SHEET 1



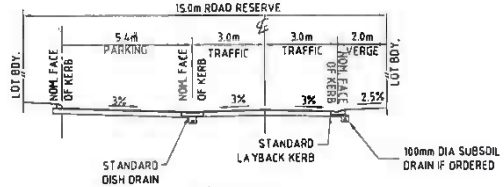
ROAD No 4



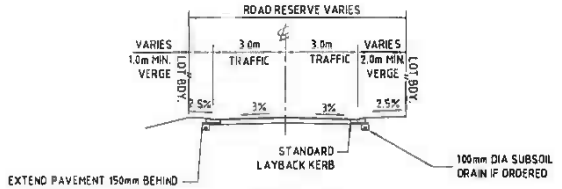
ROAD No 6
CH.107.003-END



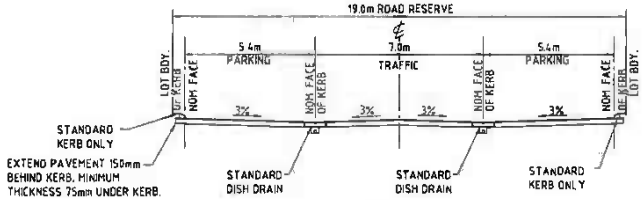
CH 10 TO 59.749
ROAD No 5



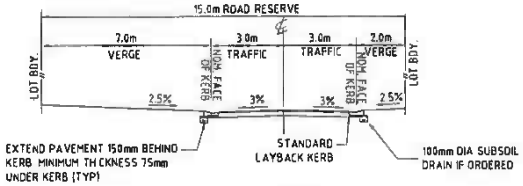
ROAD No.6
CH.0-101.977
WITH PARKING BAYS



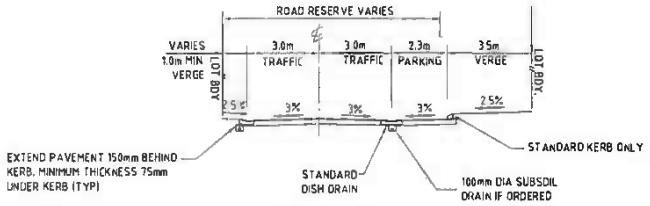
ROAD No 5
CH. 0 - 268.892
WITHOUT PARKING



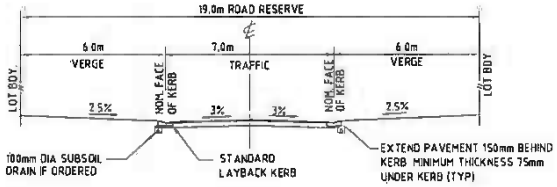
ROAD No 5
CH.268.892-471.409
WITH PARKING BAYS



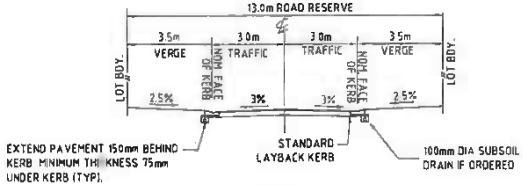
ROAD No.6
CH.0-101.977
WITHOUT PARKING BAYS



ROAD No 5
CH. 0 - 268.892
WITH PARALLEL PARKING



ROAD No 5
CH.268.892-471.409
WITHOUT PARKING BAYS



ROAD No.7

2 1 0 2 4 6 8m
SCALE BEFORE REDUCTION 1:100

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KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH	SCALE – 1:100 A1
TOWN CENTRE	DATE – 16 JULY, 2007 REV 0
DA SUBMISSION	DRAWING No 7079/4/1-FIG DA35

CAD FILE NAME: G:\7079\04\01\DA Approval\7079040IDA35.dwg

FIGURE No.DA35D(17/02/08)

TYPICAL CROSS SECTIONS
SHEET 2

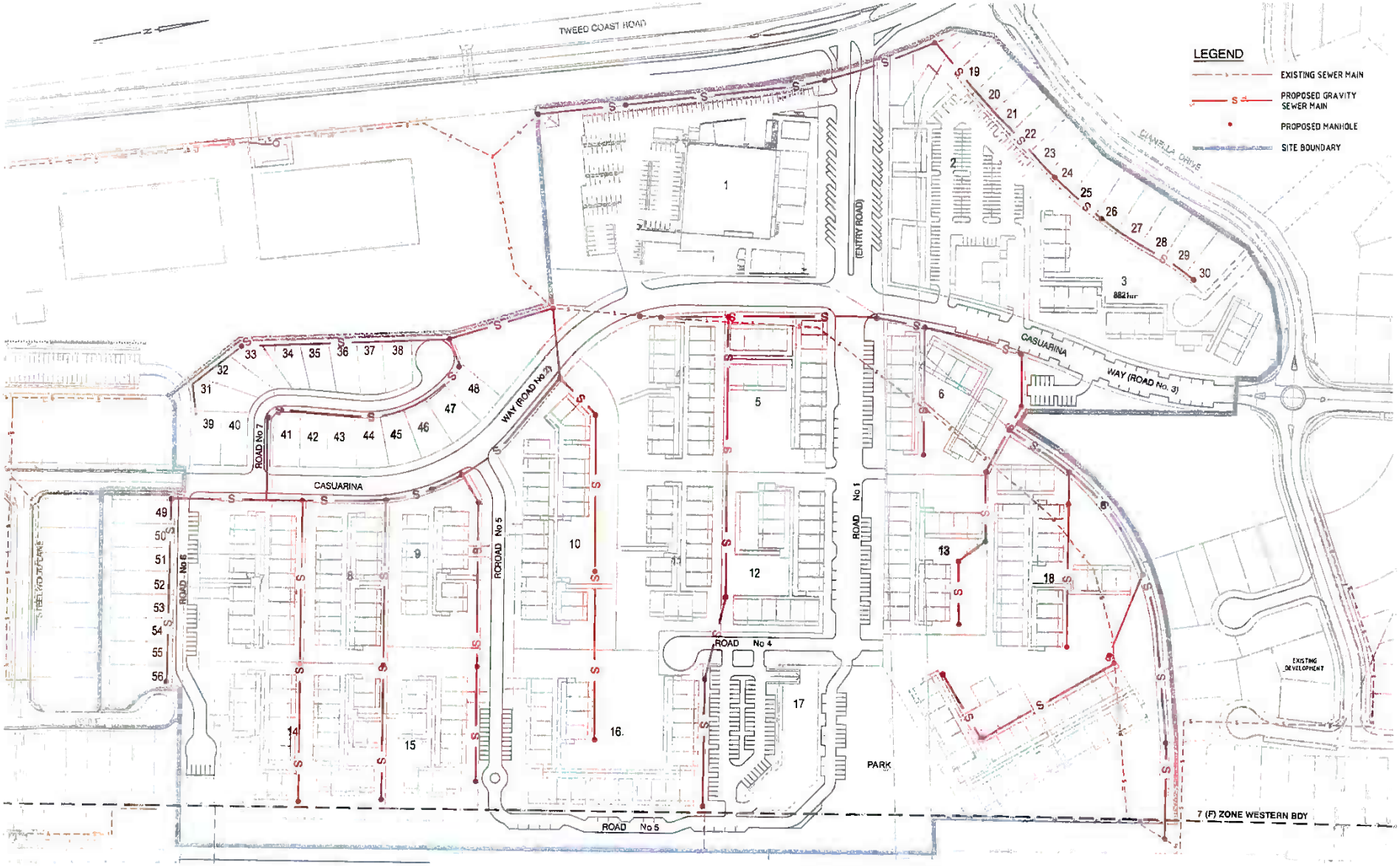
SCALE BEFORE REDUCTION

Cardno (Qld) Pty Ltd ACN 051 074 992

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH	SCALE :- 1:2000 A1
TOWN CENTRE	DATE :- 16 JULY, 2007 REV 0
DA SUBMISSION	DRAWING No 7079/4/1-FIG DA36

FIGURE No.DA36BG(23/04/08)

CATCHMENT AREAS AND DRAINAGE PATHS



SCALE BEFORE REDUCTION 20 10 0 20 40 60 80m 1 : 1000

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KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:1000 A1 DATE :- 10 JULY, 2007 REV. G DRAWING No 7079/4/1-FIG DA37

FIGURE No.DA37G(28/04/08)

SEWER RETICULATION
LAYOUT PLAN

20 10 0 20 40 60 80m
SCALE BEFORE REDUCTION 1:(1000)

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CAD FILE NAME: G:\7079\04\01\DA Approval\7079-04-01-DA38.dwg

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:2000 A1 DATE :- 10 JULY, 2007 REV G DRAWING No. 7079/4/1-FIG DA38

FIGURE No.DA38G(28/04/08)

WATER RETICULATION LAYOUT PLAN

SCALE BEFORE REDUCTION

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KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:1000 A1 DATE :- 18 OCTOBER, 2007 REV F DRAWING No. 7079/4/1-FIG DA39

FIGURE No.DA39F(28/04/08)

SUBDIVISION
LAYOUT PLAN

SCALE BEFORE REDUCTION 1 : 1000

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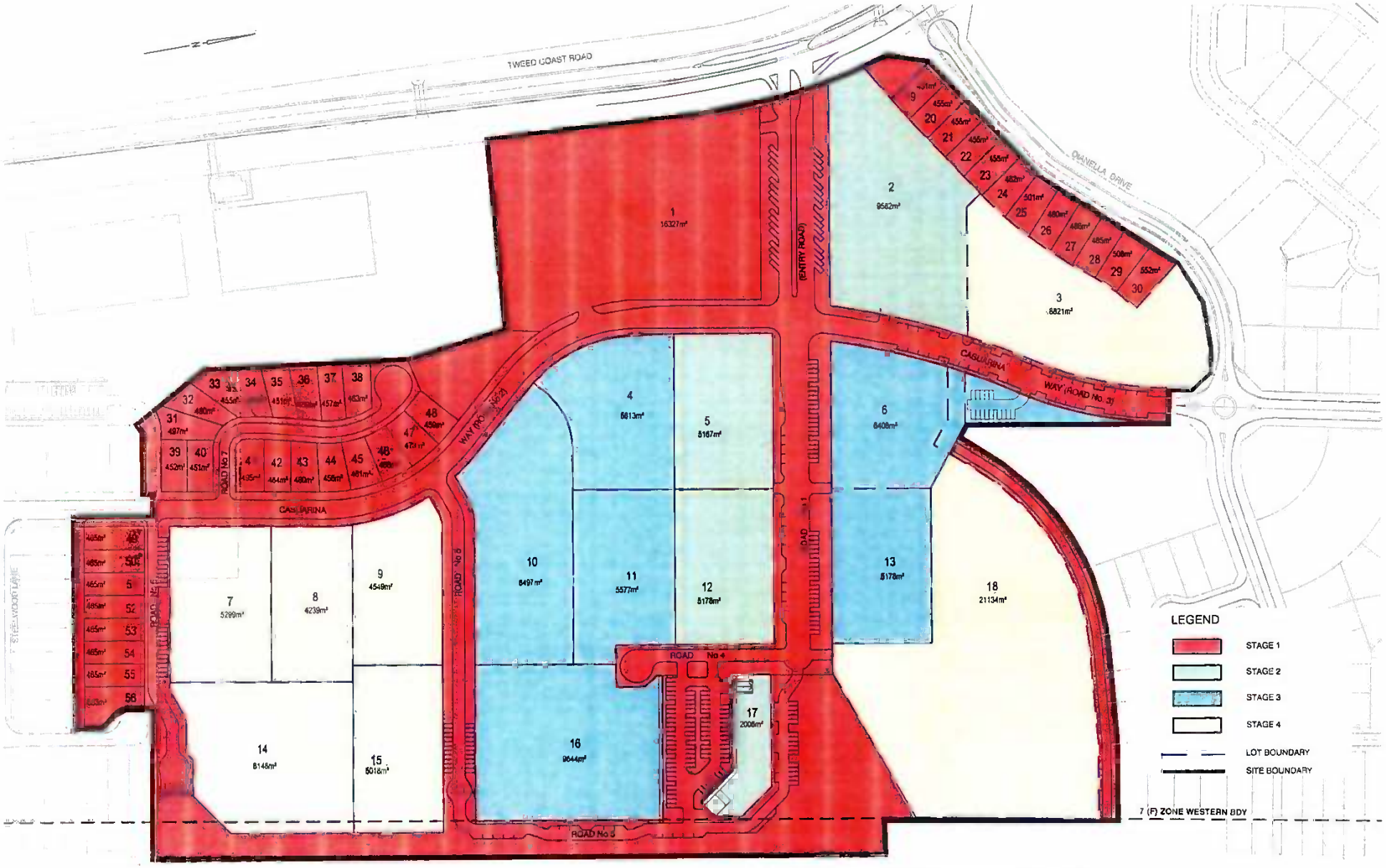
Gold Coast City, Queensland 4217
Email: gcc@cardno.com.au

CAD FILE NAME: G:\7079\03\07\Da Approval\7901 DA\Da Approval\7079201 - 25.dwg

KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH	SCALE :- 1:1000 A1
TOWN CENTRE	DATE :- 17 DECEMBER, 2007 REV: G
DA SUBMISSION	DRAWING No. 7079/4/1-FIG DA40

FIGURE No.DA40G(15/07/08)

DEDICATION AND EASEMENT PLAN



20 10 0 20 40 60 80m
SCALE BEFORE REDUCTION 1:1000

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Cardno (Qld) Pty Ltd ACN: 001 074 902
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Email: gca@cardno.com.au

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KINGS BEACH (No. 2) PTY LTD	
CASUARINA BEACH TOWN CENTRE DA SUBMISSION	SCALE :- 1:1000 A1 DATE :- 17 DECEMBER, 2007 REV E DRAWING No 7079/4/1-FIG DA41

FIGURE No. DA41E(28/04/08)

STAGING PLAN