



DETAILED SITE INVESTIGATION

SSD-83069459

Kingscliff Mixed Use Development

July 2026

Prepared For: Bells Boulevard Pty Ltd

Lot 2 DP 1310938
4 - 8 Bells Boulevard
Kingscliff NSW

HMC2025.1646.04

RE: Lot 2 DP 1310938, 4 - 8 Bells Boulevard, Kingscliff NSW.

HMC Environmental Consulting Pty Ltd is pleased to present our report for a Detailed Site Investigation for the abovementioned site.

We trust this report meets with your requirements. If you require further information, please contact HMC Environmental Consulting directly on the numbers provided.

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Title:	Detailed Site Investigation
Job No:	2025.1646.04
Client:	Bells Boulevard Pty Ltd

Document Record:				
Version	Date	Prepared by	Checked by	Issued by
Preliminary 01	22.06.2026	MF	MT	KH
Preliminary 02	02.07.2026	MF	MT	KH
Final Rev 0	02.07.2026	MF	MT	KH
Final Rev 0a	06.07.2026	MT	MT	MJ

Distribution List	Date	Version	Comments
Bells Boulevard Pty Ltd	22.06.2026	P_01	Draft in progress for review
Bells Boulevard Pty Ltd	02.07.2026	P_02	Draft including radiation results for review
Bells Boulevard Pty Ltd	02.07.2026	REV_0	Final for lodgement
Bells Boulevard Pty Ltd	06.07.2026	REV_0a	Final for lodgement

This report should be cited as '*HMC Environmental Consulting (2026). Detailed Site Investigation, Kingscliff Mixed Use Development: Lot 2 DP 1310938, 4 - 8 Bells Boulevard, Kingscliff NSW. Report No. HMC2025.1646.04. June 2026*'

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Enquiries should be addressed to HMC Environmental Consulting Pty Ltd.

EXECUTIVE SUMMARY

BACKGROUND

A mixed-use development (Stage 3 of the master-planned Salt Village landholding) is proposed at Lot 2 DP 1310938, 4–8 Bells Boulevard, Kingscliff NSW, as State Significant Development SSD-83069459. The proposal comprises a five-storey building with a two-level basement carpark (193 spaces) and 71 residential units, requiring bulk excavation to approximately 7m below ground level. Following Tweed Shire Council's Request for Further Information (17 February 2026), this Detailed Site Investigation characterises soil from 1 m to the full excavation depth and incorporates a radiation assessment to address the historic mineral-sand-mining legacy of the site.

OBJECTIVE OF THE INVESTIGATION

The objectives of the investigation were to assess the current and former land use for potentially contaminating activities, to characterise soil (including Naturally Occurring Radioactive Material) to the full proposed excavation depth, and to assess the suitability of the site for the proposed mixed-use development and the need for any further investigation or remediation.

SCOPE OF WORKS

The scope comprised a review of the Preliminary Site Investigation (HMC2025.1646.02) and previous radiation investigations, a detailed site inspection, a soil-profile radiation survey of three boreholes to the base of the proposed excavation undertaken by Radiation Safety Support Services Aus (Rsssa), laboratory gamma spectrometry of selected samples, and the preparation of this report with conclusions, recommendations and an accompanying Remedial Action Plan.

CONCLUSIONS/RECOMMENDATIONS

On the basis of the desktop review, site inspection, soil investigation and radiation assessment, HMC Environmental Consulting concludes that:

- the site has been subject to historic heavy-mineral-sand mining, leaving localised low-level NORM (monazite-bearing residues) within the soil profile;
- of the thirteen samples analysed, eleven are below the 1 Bq/g NORM screening threshold and two (Samples 3 and 8) marginally exceed it, at 1.67 and 1.02 Bq/g respectively;
- all results are far below the 100 Bq/g hazardous-waste threshold, and below the 1 mSv/year public dose constraint, and no material requires off-site disposal as radioactive waste;
- no other contaminants of potential concern were identified — dumped surface waste and fibreboard fragments were assessed, with no asbestos detected; and
- subject to management of the localised elevated material during basement excavation and a final radiation clearance survey, the site is suitable for the proposed mixed-use development.

RECOMMENDATIONS

The following recommendations are made:

- Implement the accompanying Remedial Action Plan (HMC2025.1646.05) for the management of soil exceeding 1 Bq/g during basement excavation, comprising
 - radiation-specialist oversight, segregation and blending/dilution of elevated material, and over-excavation with clean-sand backfill and/or.
 - Excavation and transport of material to Currumbin Minerals located at Currumbin Qld for processing and beneficial reuse
- Engage a qualified radiation specialist (Rsssa or equivalent) to supervise the bulk excavation and undertake real-time gamma monitoring and segregation of elevated material.
- Classify and remove dumped surface waste in accordance with the NSW EPA Waste Classification Guidelines 2014 during initial site stripping.

- Classify any remediated (blended) or surplus excavated material that is to leave the site in accordance with the NSW EPA *Waste Classification Guidelines, Part 3: Waste containing radioactive material (2014)*. Blended material would be below the 1 Bq/g NORM screening threshold and would be Classified in accordance with the NSW EPA *Waste Classification Guidelines, Part 1 Classifying waste (2014)*:
- Submit a Validation Report to the NSW EPA (Radiation Control) and Tweed Shire Council on completion of the works, confirming compliance with the Remedial Action Plan and the 1 Bq/g and 1 mSv/year criteria.

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ABBREVIATIONS/ ACRONYMS

Acronym / Term	Definition
ACM	Asbestos containing material
ANZECC	Australian and New Zealand Environment and Conservation Council
AoPC	Area of potential concern
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
AS	Australian Standard
ASC NEPM	National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013)
Client	Bells Boulevard Pty Ltd (Podia)
CLM Act	Contaminated Land Management Act 1997
CoPC	Contaminants of Potential Concern
CSM	Conceptual site model
DQO	Data quality objective
DSI	Detailed Site Investigation
EIL	Ecological Investigation Level
EPA	Environment Protection Authority
HIL	Health Investigation Level
HMC	HMC Environmental Consulting
Investigation Area	Proposed Stage 3 development area
mBGL	Metres below ground level
NORM	Naturally Occurring Radioactive Material
OEH	[NSW] Office of Environment and Heritage
Proposal	Kingscliff Mixed Use Development
PSI	Preliminary Site Investigation
RAP	Remedial Action Plan
Site	Lot 2 DP 1310938, 4–8 Bells Boulevard, Kingscliff NSW
TLEP 2014	Tweed Local Environmental Plan 2014

TECHNICAL TERMS

Term	Definition
Action level	The regulatory dose rate threshold triggering remediation
Background radiation	The natural ambient radiation level for the area
Becquerel (Bq) / Bq/kg	Unit of radioactivity (decays per second) / activity concentration in soil
Down hole logging	In situ measurement of gamma radiation down a borehole
Gamma radiation	Penetrating electromagnetic radiation emitted by NORM; the dominant exposure pathway on these sites
Gray (Gy) / μGy/h	Absorbed radiation dose / dose rate
Heavy mineral sands	Naturally dense minerals (rutile, zircon, ilmenite, monazite) concentrated in coastal dune deposits
Ilmenite	Titanium iron oxide; the bulk dark residue mineral, weakly radioactive
Monazite	A phosphate accessory mineral containing thorium and uranium; the principal source of elevated radioactivity
Rutile	Titanium dioxide (TiO_2), a primary target mineral
Sievert (Sv) / μSv/h	Equivalent dose (health effect weighted) / dose rate
Tailings / residues	Processed sand returned to the ground after mineral extraction
Zircon	Zirconium silicate (ZrSiO_4), a primary target mineral

1 INTRODUCTION

1.1 BACKGROUND

A mixed-use development is proposed on the property located at Lot 2 DP 1310938, 4-8 Bells Boulevard, Kingscliff NSW. It is proposed to construct a five-storey building with a double level basement, and ancillary works including earthworks and landscaping. The proposal includes a mixture of residential units, retail, wellness facilities and communal areas on the ground floor, and four levels of residential units. This project would be Stage 3 of the master-planned development for this site following the Stage 1 Torrens Title subdivision and Stage 2 Row Housing proposals. The property is currently vacant, and partially used as informal carparking. The site has been subject to approved landform modification including imported fill placement.

A Preliminary Site Investigation Report No: HMC2025.1646.02 (PSI) prepared by HMC Environmental Consulting (HMC) including a desktop assessment of available information and a detailed site inspection was completed and submitted with the development application. Following a review, Tweed Shire Council issued a Request for Further Information dated 17 February 2026 with the following item:

"7. Contaminated Land

A review of the submitted documentation and Council's records indicates that the contamination status of the subject site has only been validated to the existing ground surface and to approximately 1 m below finished ground level. Historic sand mining and the later placement of uncontrolled fill/waste have been identified as potential contamination sources for this site.

Previous development consents (DA02/1422, DA05/0876 and DA16/0667) addressed aspects of contamination, but the following limitations are noted:

- *The remedial validation referenced under DA02/1422 applies only to the existing surface to 1m Below Ground Level (BGL) of the former Lot 169 DP1075495.*
- *DA05/0876 included a requirement for a final radiation survey for any basement excavations in accordance with the RAP/DSI; however, the approved works were never undertaken, and the site remains unvalidated below 1 m BGL.*
- *DA16/0667 No works were proposed for the current Lot 2 DP1311098 and as such no subsequent investigations were undertaken regarding contamination.*
-

The current proposal involves excavation to depths of 7-8m BGL, well beyond the extent of previously validated material. To ensure suitability of the site for the proposed works, a Detailed Site Investigation (DSI) is to be prepared. The DSI must:

- 1. Characterise soil and fill materials from 1 m to the full proposed excavation depth (7-8 m BGL).*
- 2. Include a radiation assessment consistent with prior development conditions requiring radiation validation for below-ground excavations.*
- 3. Confirm whether any contamination exists at depth and provide appropriate remediation or management recommendations where necessary."*

HMC Environmental Consulting has been engaged to prepare a Detailed Site Investigation (DSI) in order to address the RFI, including a summary of previous radiation investigations, and further investigation across the site for any potential residual contamination from historic sand mining activities.

1.2 SITE DESCRIPTION

The site is located at 4-8 Bells Boulevard, Kingscliff and is located in the Tweed Shire Local Government Area. The site is legally known as Lot 2 DP131098.

The site has an approximate area of 4,450sqm and is currently vacant of any structures. An informal bitumen sealed carpark containing 27 spaces is located in the northeast part of the site, which is enforced by way of a restriction on the existing title of the land.

The site has previously been subject to landform modification including the approved hydraulic placement of imported fill material to help achieve final design levels. The centre of the site is clear of vegetation, with any vegetation located along the street frontages or abutting the western boundary. A public reserve runs along the site's western boundary containing a concrete footpath and extensive vegetation.

The site is relatively level around the street frontages, with levels ranging between approximately RL 9.8m at Gunnamatta Avenue to RL 10.4m at the corner of Bells Boulevard and Casuarina Way. A gully on the western part of the site extends to approximately RL 7.1m AHD.

The site is located on the gateway to a part of Kingscliff known as 'the Salt Precinct'. This part of the Salt Precinct is centred around the Salt Central Park, which is bordered by two major tourism developments, those being the Peppers and Mantra resorts. Salt Central Park is activated by a retail precinct with shops, cafes and restaurants known as Salt Village.

1.3 PROJECT DESCRIPTION

The proposed development seeks development consent for a new mixed use building on the site. The proposal will include the following works:

- Construction of a five storey mixed use development with ground level retail fronting Bells Boulevard and Gunnamatta Avenue and ground level residential units, with residential units contained on levels 1-4 (inclusive), and rooftop communal open space.
- A total of 71 residential units of which 2 will be affordable housing units. These affordable housing units are to be retained as such for 15 years and managed by a registered Community Housing Provider,
- Excavation for two basement levels of carparking with 193 carparking spaces and associated services,
- Removal of 23 trees on site, and
- Landscaping and a communal open space network with a focus on wellness including a rooftop pool, indoor communal space and ground level outdoor communal open space designed around a central lawn.
- For the purposes of this report, the investigation area is the entire site within the boundaries of Lot 2 DP 1310938, with focus on the proposed development area to the centre of the subject site.

1.4 OBJECTIVE OF THE INVESTIGATION

The objectives of the Detailed Site Investigation are to:

- Assess the current and former land use on the investigation area for potentially contaminating activities.
- Based on potentially contaminating activities associated with the current and former land use, assess the suitability of the investigation area for the proposed land use and the need for further investigation.

1.5 SCOPE OF WORKS

The scope of work undertaken during the investigation included the following:

- A review of the Preliminary Site Investigation (HMC2025.1646.02) which included a desktop assessment of current and former land use on the site including a search of available records including previous radiation investigations.
- Preparation of a Detailed Site Investigation report including:
 - a detailed site investigation and supervision of the soil investigation
 - assessment of potentially contaminating activities, Contaminants of Potential Concern (CoPC) and review of the prepared
 - conclusions and recommendations including suitability of the site for the proposed development and need for further investigation and remediation.

2 SITE INFORMATION

2.1 SITE IDENTIFICATION

Table 1 - Site Identification Summary

Table 1 - Site Identification Summary		
Street Address		4 - 8 Bells Boulevard, Kingscliff NSW
Allotment Description		Lot 2 DP 1310938
Allotment size		4450m ²
Property Number		114133
Local Government		Tweed Shire
Parish		Cudgen
County		Rous
Geographical Coordinates (MGA Zone 56)		Easting: 556516.15m E Northing: 6871942.41m S (Approximate centre of site).
Zoning		SP3 - Tourist
Land use - Existing		Vacant
Land use - Proposed		Proposed mixed-use development
Site Services		Mains power, town water, sewer
Surround Land Uses	Locality	Salt Village
	North	Commercial/Residential Tourist Accommodation (Peppers Salt Resort & Spa)
	East	Commercial and Tourist accommodation (Mantra on Salt Beach)/commercial tenancies
	South	Residential)
	West	Reserve then Residential
Closest Sensitive Environment		Cudgen Creek is located approximately 260m west of the site while South Kingscliff Beach is located approximately 350m east. Stormwater runoff would be collected by the street stormwater system before eventually being discharged into Cudgen Creek to the west.

Table 2 – Site Characteristics

Topography	Landform modification with imported fill and excavation of borrow pit in the north-east area Landform: Dune Plains Aspect: Southwest Slope: Gentle Gradient: 5-10%
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	Elevation: Approximately 7.15 - 10.39m AHD across the investigation area.
Regional Geology	Quaternary Coastal Dune Deposits Disturbed site due to imported fill and borrow pit. Sand dune systems along the north coast. The sand is deposited by both wind (aeolian) and ocean currents. Older (Pleistocene) dunes are vegetated and stable. Younger (Holocene) dunes are not vegetated and may be highly mobile depending on wind and wave action.
Soil Landscape	Bogangar (bo) landscape: Very disturbed outer barrier (Holocene) dunes. Very disturbed open-heathland and heath. Soils: Deep, very disturbed Podzols and Siliceous sands. Geology: Holocene dunes consisting of marine quartz sands forming the outer barrier system.
Australian Soil Classification	Podosols (PO) Soils with B horizons dominated by the accumulation of compounds of organic matter, aluminium and/or iron.
Regional Hydrogeology	Groundwater vulnerability is not mapped for the site. Given the property is elevated (~RL10m AHD), in dual sand, it is expected that the site would have a groundwater depth >8m (now confirmed by boreholes up to 8.2m depth). No surface water was recorded in the deep borrow pit (NE)
Groundwater Database Search	The online NSW Office of Water groundwater mapping (http://allwaterdata.water.nsw.gov.au/water.stm) shows the nearest mapped registered groundwater bore GW307886 is located 120m northwest of the subject site. The bore is currently registered for commercial use.

3 SUMMARY OF PREVIOUS HMC INVESTIGATION

A PSI for the site (Lot 2 DP 1310938, 4-8 Bells Boulevard, Kingscliff) was completed by HMC in December 2025 (Report No. HMC2025.1646.02) to support the State Significant Development Application (SSD-83069459) for the proposed Stage 3 mixed-use development, and to address SEAR Item 13 (Contamination and Remediation) under the State Environmental Planning Policy (Resilience and Hazards) 2021. The PSI comprised a desktop review of land-use history (historic aerial photography, parish and topographic maps, title records, statutory database searches and a council information request) together with a detailed site inspection. The 4,450 m² site is zoned SP3 (Tourist), is currently vacant and partially used for informal car parking, and forms part of the broader master-planned Salt Village landholding.

The land-use history established that the site and its surrounds were subject to extensive mineral sand mining and on-site processing from before 1961 until the early-to-mid 1970s, consistent with the 1954–1976 mining period documented in the earlier Cardno MBK report. Historic aerials record dredge ponds and processing-related structures in and around the site, after which mining ceased and the area was rehabilitated and revegetated (largely complete by 1991). The site has remained vacant since, with subsequent approved landform modification including the importation of EPA and Council-approved fill (approximately 23,000 m³ under DA16/0667) and levelling of the site in accordance with successive development consents (including the master-planned subdivision and the more recent DA16/0667 and DA20/0466 approvals). Statutory searches returned no NSW EPA contaminated land records, no listed UXO sites, and no nearby cattle dips, and Tweed Shire Council advised that soil contamination (including from sand mining) had been addressed

through the Master Plan Subdivision Consent (02/1422) and Development Consent DA05/0876 for the surrounding Salt development.

In relation to the mineral sand residues specifically, the PSI reviewed the Cardno MBK (2002) *Detailed Site Radiation Investigation Report & Remediation Action Plan* and reproduced its key findings: residual processing material (ilmenite contaminated with monazite) across parts of the Salt Village site exhibited radioactivity above background; approximately 178,000 m³ was identified as requiring remediation or management, of which around 133,000 m³ was to be removed and treated by dilution, with the remainder left in situ and capped with 1.0 m of clean material; and the residues were below 100 Bq/g and therefore not classified as hazardous waste. The PSI noted that the principal remediation areas identified by Cardno were in the south-west of the Salt Village site near Cudgen Creek, and concluded that, on the basis of the previous radiation assessments and the surrounding development approvals, the subject site is considered suitable for the proposed development, subject to standard waste classification and asbestos-assessment controls for any material removed from the site.

4 SUMMARY OF PREVIOUS RADIATION INVESTIGATIONS

A review of the Tweed Shire Council information provided included detail on the former sand mining operation located on the Salt Village subdivision site. A copy of the *Cardno MBK Pty Ltd, Detailed Site Radiation Investigation Report & Remediation Action Plan Salt, South Kingscliff: South Kingscliff Developments Pty Ltd. August 2002* was viewed that included the following site history summary in section 3.0:

"Based on interviews with former mineral sand mining operators, desktop searches and historic photographs of the area, it is apparent that the site has been subject to extensive mineral sand mining activities in the past.

These activities were conducted between 1954 and 1976 (refer to past aerial photograph taken in 1971 presented in Appendix 3). Upon the cessation of mining disturbance, the area was rehabilitated by the planting of Bitou bush, an exotic species imported from South Africa primarily for stabilisation purposes.

Mineral sands were excavated by hydraulic dredge, and partially processed on site before being trucked away for final separation. Following extraction of rutile and zirconium from the sand, residual material was pumped back into the dredge pits on site. There is anecdotal evidence from a number of people, including former workers, that the south-western portion of this site was used for this purpose. This information is supported by historical aerial photographs of the area, which clearly identify the dry mill and disposal area in operation during 1971.

The primary constituent in the process residue is ilmenite, which is a black mineral sand which was considered of little value at the time. Ilmenite is not particularly radioactive. However, on this site, as on most other sites where sand mineral processing took place, the ilmenite is contaminated with a small amount of monazite. Monazite is a creamy coloured sand which is highly radioactive in its pure form, The net result of this contamination is that a significant volume of the residue material exhibits levels of radioactivity which are above normal background values."

The report included details on previous radiation assessment investigations at both the surface and sub-surface undertaken by Cardno MBK in conjunction with the Queensland Department of Health. These investigations found areas on the south-west of the Salt village site near Cudgen Creek that required remediation. The investigations included the subject site for the current proposal. No remediation was proposed for this area.

The report concluded:

The results of the preliminary and detailed site investigation have adequately defined an area proposed for development as have radioactive sand mining residues above the NSW Department of Health - Radiation

Branch action level thresholds for the clean-up and disposal of radioactive residues from commercial operations involving mineral sands.

The detailed investigation has quantified the volume requiring remediation and/or management as 178.000 m³. in areas where proposed residential development is to take place. material displaying elevated radiation levels shall be removed and replaced with treated and clean sand. Areas where parks and roadways are proposed will be capped with 1.0 metre of clean sand to reduce surface radiation levels to near background levels. The volume of materials to be removed and treated by way of dilution is approximately 133.000m³. The remaining material shall be left in-situ and capped with 1.0 metre of clean material.

Detailed site investigation and sample results show that sand mining residuals in the area have radiation levels below 100 Becquerels per gram (Bq/g). These materials therefore do not constitute a Hazardous Waste

It is considered that the detailed investigation of the development site is sufficient that the recommended remediation strategy summarised in section 8.0 be submitted for approval by the New South Wales EPA-Radiation Control and Tweed Shire Council. "

The current proposal introduces a constraint the earlier work did not contemplate: a two-level basement carpark extending below the depth of the previous investigation and potentially below the level at which remediated residues were re-buried. There is therefore potential for excavation to intercept residual or relocated material exceeding residential exposure criteria, which this Detailed Site Investigation and Radiation Assessment is intended to address. Preliminary gamma logging of cores from three boreholes has identified minor exceedances above background, with samples forwarded for laboratory analysis.

5 SITE INSPECTION

A site inspection was undertaken by Mark Tunks of HMC on 27 October 2025 during the Preliminary Site Investigation, and again on 20 May 2026 during the current soil investigation. The site was vacant with some sparse vegetative cover. The site was generally level with some undulation and mounding, and a borrow pit on the north-west corner. There was evidence of the approved fill placement to elevate the site to the level of the surrounding Salt Village tourist/commercial facilities east and north of the site. There were no structures on the site, other than some telecommunication facilities (pad mount).

The project Stages 1 and 2, west of the current Stage 3 location, have been securely fenced, and some works appear to have been commenced within this construction site.

The north-eastern part of the site is currently used for carparking with partial bitumen ground surface. Between the carpark area and the borrow pit further west there is some collection of waste material that includes timber concrete and metal. It is likely this material has been illegally dumped as this area is open to public access at any time.

Waste material would be removed during the initial site stripping work following classification in accordance with NSW EPA Waste Classification Guidelines 2014.

Fibreboard fragments were observed, and two samples were collected for laboratory analysis. Testing did not detect asbestos in the bonded fibreboard material.

There were no indications of any historic cropping on the investigation area, nor any historic structures or other intensive land uses.

5.1 SUMMARY OF SITE CONDITIONS

Table 3 provides a summary of observations during the site inspection.

5.2 SITE PHOTOGRAPHS

See Appendix 6.

No potential off-site effects have been shown to have impacted the subject property.

5.3 SITE LAYOUT

The details of the site inspections are shown in Table 3.

5.4 SITE FEATURES

Table 3 - Site Features Indicating Potential Contamination

Features of Contamination	Comments
Disturbed, discoloured, or stained soil	Some disturbed soil from recent site works associated with Stages 1 and 2 immediately west of the current proposal. No discoloured or stained soil was noted during the site inspection.
Disturbed or distressed vegetation	None observed during site inspection.
Surface water quality	No surface water existing on site.
Agrichemical Storage/Use	None observed during site inspection.
Other chemical/fuel storage	None observed during site inspection.
Waste storage	Small, isolated areas of waste material identified on site during the site inspection, likely dumping due to property being accessible by the public.
Asbestos Waste or Use in Structures	Two collected fibreboard fragments were subject to laboratory testing. No asbestos was recorded.
Fill from unapproved source	Filling activities appear to have been completed in accordance with approved applications. Some opportunistic minor dumping of waste including soil appears to have occurred west of the bitumen carpark area.
Other	Nil

6 SOIL INVESTIGATION

Following the request for further information from Tweed Shire Council, a Senior Health Physicist Simon Turner CEO of Radiation Safety Support Services Australia (RsssA) was engaged to undertake a preliminary radiation and soil characterisation comprising the following:

- Review of previous investigations, as available
- Site investigation including soil profile radiation survey from three representative boreholes drilled across the project site to the base of proposed excavation depth
- Collection of selected soil samples for laboratory testing by NATA-accredited laboratory
- Report preparation with results, interpretation against state radiation exemption thresholds
- Recommendations for further investigation,
- Protocols for remediation/treatment to be included in Remedial Action Plan, if required

7 SUMMARY OF RADIATION ASSESSMENT

Radiation Safety Support Services Aus (RsssA) — Simon Turner, Senior Health Physicist — was engaged to undertake a radiation and soil characterisation of the proposed excavation footprint. The findings are reported in RsssA Report No. Q2026.4049 (site operations 20 May 2026, report dated 29 June 2026), reproduced in full at Appendix 7. This section summarises the methodology, results and conclusions of that assessment.

7.1 METHODOLOGY

Three boreholes (Holes 1–3) were advanced within and adjacent to the proposed basement footprint, each cored to 500 mm below the proposed final excavation depth (approximately 7.5 m). Each core was visually logged and continuously monitored with a calibrated handheld gamma instrument. Laboratory samples were collected at nominal 5.5 m, 6.5 m and 7.5 m depths, at any point where above-background readings were observed during core logging, and from two surface run-off locations in the lower drain area. A total of thirteen (13) samples were analysed by high-resolution gamma spectrometry at the Queensland Health Radiation Health Unit (Radiation Sciences), traceable to the NIST (USA) national standard (Certificates 25PQ904–25PQ916), and compared against the 1 Bq/g NORM screening threshold of the Protection from Harmful Radiation Regulation 2025.

7.2 LABORATORY RESULTS

The results are summarised in the table below. Eleven (11) of the thirteen (13) samples returned total activity concentrations below the 1 Bq/g screening threshold, consistent with the normal range for NSW mineral-rich coastal sands (approximately 0.02–0.30 Bq/g). Two samples exceeded the threshold: Sample 3 (Hole 1 at 7.2 m, 1.67 Bq/g) and Sample 8 (Hole 3 at 1.5 m, 1.02 Bq/g). Both exceedances are dominated by the thorium series (Th 770 and 750 Bq/kg respectively), consistent with localised monazite-bearing residues from the historic mining rather than widespread contamination. Field gamma measurements across all cores otherwise remained at background (typically 0.15–0.25 µSv/hr) with no instrument alarms.

Table 4 – Summary of Radiation Assessment Results (RsssA Q2026.4049)

Sample	Location	Depth (m)	Total Activity (Bq/g)	Dose Rate (µSv/hr)	Interpretation
1	Hole 1	5.5	0.071	0.026	Below threshold
2	Hole 1	6.5	0.205	0.097	Below threshold
3	Hole 1	7.2	1.67	0.84	Above 1 Bq/g – requires management
4	Hole 1	7.5	0.037	0.12	Below threshold
5	Hole 2	5.5	0.038	0.015	Below threshold
6	Hole 2	6.5	0.019	0.005	Below threshold
7	Hole 2	7.5	0.029	0.009	Below threshold
8	Hole 3	1.5	1.02	0.53	Above 1 Bq/g – requires management
9	Hole 3	5.5	0.246	0.102	Below threshold
10	Hole 3	6.5	0.242	0.053	Below threshold
11	Hole 3	7.5	0.46	0.2	Below threshold
12	Run-off 1	Surface	0.271	0.077	Below threshold
13	Run-off 2	Surface	0.289	0.054	Below threshold

7.3 DOSE AND REGULATORY ASSESSMENT

Applying ARPANSA Radiation Protection Series (RPS) dose-conversion factors, soil at 1–2 Bq/g typically contributes less than 50 µSv/year under residential exposure, well below the public dose constraint of 1,000 µSv/year (1 mSv/year). All measured values are also far below the 100 Bq/g threshold above which mineral-sand residues would be classified as radioactive/hazardous waste; consistent with the earlier Cardno MBK (2002) findings for the broader Salt Village land, the material is not classified as hazardous waste. Under the Protection from Harmful Radiation Regulation 2025, material exceeding 1 Bq/g must be managed but not necessarily removed, and dilution, blending or supervised placement is acceptable for low-level NORM.

The RsssA assessment concluded that the elevated material is localised, dispersed and readily managed during excavation, and recommended specialist-supervised excavation with segregation and blending of elevated material, together with over-excavation and clean-sand backfill in the basement area. These measures are detailed in the accompanying Remedial Action Plan (HMC2025.1646.05).

The recommended strategy manages the NORM-impacted soil on site through segregation, blending/dilution and controlled placement, and does not rely on off-site disposal. Where, however, blended (remediated) material — that is, soil that exceeded the 1 Bq/g screening threshold and has been diluted down — is to leave the site for disposal at a landfill or resource-recovery facility, it must first be classified in accordance with the NSW EPA Waste Classification Guidelines, Part 3: *Waste containing radioactive material (2014)*, in addition to its classification for non-radiological characteristics under Part 1 of those Guidelines.

It is noted that where the specific activity ratio and total activity ratio are equal to or less than one, the waste must be classified according to its other characteristics in line with Part 1 of the Guidelines.

Clean material that has remained below the 1 Bq/g screening threshold throughout, and has not required blending, does not require radiological waste classification, and is managed as ordinary excavated material on the basis of its non-radiological characteristics.

The management of any material leaving the site is addressed in detail in the accompanying Remedial Action Plan (HMC2025.1646.05).

8 CONCEPTUAL SITE MODEL

Table 5 – Conceptual Site Model

POTENTIAL SOURCE	PATHWAY	EXPOSURE ROUTE	RECEPTOR	OUTCOME
Radiation from historic sand mining.	Surface water runoff	Chemical/sediment entering local water ways	Ecological receptors	The site appears to have been subject to historic sand mining prior to 1991. A radiation assessment was undertaken including to 8m depth BGL.
	Exposed surface soil	Dermal contact to exposed soil during earthworks, proposed infrequent use	Site worker, Occupier, Visitor	
	Atmospheric dispersion	Inhalation of soil exposed during earthworks and in exposed bare soil areas		
	Leaching to groundwater	Groundwater movement off-site to beneficial users or ecological receptors	Beneficial users/Ecological receptor	

9 DISCUSSION

The site forms part of a former heavy-mineral-sand mining and processing area worked between approximately 1954 and 1976. The principal residue mineral, ilmenite, is only weakly radioactive but is contaminated with monazite — a thorium- and uranium-bearing mineral that is the principal source of elevated radioactivity on these sites. The earlier Cardno MBK (2002) investigation identified approximately 178,000 m³ of material across the broader Salt Village land requiring remediation or management, of which around 133,000

m³ was removed and treated by dilution and the remainder left in situ and capped with 1.0 m of clean material; the principal remediation areas were in the south-west near Cudgen Creek.

The current proposal introduces a constraint the earlier work did not contemplate: a two-level basement extending up to approximately 7m below ground level, beyond the depth of previously validated material (approximately 1 m), and potentially below the level at which remediated residues were reburied during rehabilitation. The radiation assessment confirmed this potential, identifying two localised exceedances of the 1 Bq/g screening threshold within the excavation profile. Both are thorium-dominated, consistent with residual monazite-bearing material rather than a widespread or concentrated source.

Field dose rates remained at background throughout, indicating no external gamma hazard at the surface. The dominant exposure pathways during the works are therefore inhalation of NORM-bearing dust and waterborne dispersal of fines (reflected in the slightly elevated surface run-off samples), both readily controlled by dust suppression, segregation and surface-water management. Groundwater lies deeper than 8 m, and surface run-off reports towards Cudgen Creek approximately 260 m to the west, which informs the erosion, sediment and run-off controls in the Remedial Action Plan.

Initially the preferred option to manage the NORM was the investigation and oversight of the basement excavation by a qualified radiation specialist. The volumes involved are small, localised, and the activity concentrations are well below the hazardous-waste threshold. The option was to manage the material on site without off-site disposal as radioactive waste. Any blended material would be below the 1 Bq/g screening threshold and would be managed in accordance with the NSW EPA *Waste Classification Guidelines 2014 – Part 1 Classifying Waste*, similar to any other material including soil leaving the site.

Further recent discussions with Currumbin Minerals Pty Ltd demonstrates another option to manage the NORM is available. Excavated material including NORM would be transported to a local processing plant in Queensland where NORM is removed as a resource, and beneficial reuse of the residual material is available. Currumbin Minerals advises this is a very common process on the Gold Coast, and the company has also been involved in clean up operations in Byron Bay and other locations in NSW.

10 CONCLUSIONS

On the basis of the desktop review, site inspection, soil investigation and radiation assessment, HMC Environmental Consulting concludes that:

- the site has been subject to historic heavy-mineral-sand mining, leaving localised low-level NORM (monazite-bearing residues) within the soil profile;
- of the thirteen samples analysed, eleven are below the 1 Bq/g NORM screening threshold and two (Samples 3 and 8) marginally exceed it, at 1.67 and 1.02 Bq/g respectively;
- all results are far below the 100 Bq/g hazardous-waste threshold, and below the 1 mSv/year public dose constraint, and no material requires off-site disposal as radioactive waste;
- no other contaminants of potential concern were identified — dumped surface waste and fibreboard fragments were assessed, with no asbestos detected; and
- subject to management of the localised elevated material during basement excavation and a final radiation clearance survey, the site is suitable for the proposed mixed-use development.

10.1 RECOMMENDATIONS

The following recommendations are made:

- Implement the accompanying Remedial Action Plan (HMC2025.1646.05) for the management of soil exceeding 1 Bq/g during basement excavation, comprising
 - radiation-specialist oversight, segregation and blending/dilution of elevated material, and over-excavation with clean-sand backfill and/or.
 - Excavation and transport of material to Currumbin Minerals located at Currumbin Qld for processing and beneficial reuse

- Engage a qualified radiation specialist (RsssA or equivalent) to supervise the bulk excavation and undertake real-time gamma monitoring and segregation of elevated material.
- Classify and remove dumped surface waste in accordance with the NSW EPA Waste Classification Guidelines 2014 during initial site stripping.
- Classify any remediated (blended) or surplus excavated material that is to leave the site in accordance with the NSW EPA *Waste Classification Guidelines, Part 3: Waste containing radioactive material (2014)*. Blended material would be below the 1 Bq/g NORM screening threshold and would be Classified in accordance with the NSW EPA *Waste Classification Guidelines, Part 1 Classifying waste (2014)*.
- Submit a Validation Report to the NSW EPA (Radiation Control) and Tweed Shire Council on completion of the works, confirming compliance with the Remedial Action Plan and the 1 Bq/g and 1 mSv/year criteria.

11 LIMITATIONS

Any conclusions presented in this report are relevant to the site condition at the time of inspection and legislation enacted as at date of this report. Actions or changes to the site after time of inspection or in the future will void this report as will changes in relevant legislation.

The findings of this report are based on the objectives and scope of work outlined in Section 1. HMC Environmental has performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties or guarantees expressed or implied, are given. This report does not comment on any regulatory issues arising from the findings, for which a legal opinion should be sought. This report relates only to the objectives and scope of work stated and does not relate to any other works undertaken for the client. The report and conclusions are based on the information obtained at the time of the assessment.

The site history and associated uses, areas of use, and potential contaminants were determined based on the activities described in the scope of work. Additional site information held by the client, regulatory authorities or in the public domain, which was not provided to HMC Environmental or was not sourced by HMC Environmental under the scope of work, may identify additional uses, areas of use and/or potential contaminants. The information sources referenced have been used to determine the site history.

Whilst HMC Environmental has used reasonable care to avoid reliance on data and information that is inaccurate and unsuitable, HMC Environmental is not able to verify the accuracy or completeness of all information and data made available. Further chemicals or categories of chemicals may exist at the sites, which were not identified in the site history, and which may not be expected at the site. The absence of any identified hazardous or toxic materials on the subject land should not be interpreted as a warranty or guarantee that such materials do not exist on the site. If additional certainty is required, additional site history or desktop studies, or environmental sampling and analysis should be commissioned.

The results of this assessment are based upon site inspections and fieldwork conducted by HMC Environmental personnel and information provided by the client. All conclusions regarding the property area are the professional opinions of the HMC Environmental personnel involved with the project, subject to the qualifications made above. HMC Environmental assume no responsibility or liability for errors in any data obtained from regulatory agencies, information from sources outside of HMC Environmental, or developments resulting from situations outside the scope of this project.

12 SIGNATURE

This report has been prepared by Mark Tunks of HMC Environmental Consulting, a suitably qualified environmental consultant, in accordance with the NSW EPA (2020) *Consultants reporting on contaminated land – Contaminated land guidelines*. Note that HMC Environmental Consulting holds current Professional Indemnity Insurance to 4th August 2026.

.....


Mark Tunks
Principal

6 July 2026
Completion Date

13 REFERENCES

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Series (RPS) – dose constraints for public exposure (1 mSv/year).

Cardno MBK Pty Ltd (2002) Detailed Site Radiation Investigation Report & Remediation Action Plan, Salt, South Kingscliff. South Kingscliff Developments Pty Ltd, August 2002.

HMC Environmental Consulting (2026) Remedial Action Plan, Kingscliff Mixed Use Development: Lot 2 DP 1310938, 4–8 Bells Boulevard, Kingscliff NSW. Report No. HMC2025.1646.05.

Protection from Harmful Radiation Act 1990 No 13 (NSW) and Protection from Harmful Radiation Regulation 2025 (NSW).

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NSW Department of Health, Radiation Branch – action level criteria for clean-up and disposal of radioactive residues from mineral sands operations (as cited in Cardno MBK, 2002).

NSW Environment Protection Authority (2020) Consultants reporting on contaminated land - Contaminated land guidelines

Radiation Control Regulation 1993 (NSW), Section 3.5 – Classification of Waste Containing Radioactive Substances.

State Environmental Planning Policy (Resilience and Hazards) 2021

Tweed Shire Council – *Heavy Mineral Sand Mining Paths and Heavy Mineral Sand Plants and Tailings (September 2004)* mapping.

14 GLOSSARY

Conceptual site model (CSM) is a description of a site including the environmental setting, geological, hydrogeological and soil characteristics together with the nature and distribution of contaminants. Potentially exposed populations and exposure pathways are identified. Presentation is usually graphical or tabular with accompanying explanatory text.

Contamination means the condition of land or water where any chemical substance or waste has been added as a direct or indirect result of human activity at above background level and represents, or potentially represents, an adverse health or environmental impact.

Investigation levels and **screening levels** are the concentrations of a contaminant above which further appropriate investigation and evaluation will be required. Investigation and screening levels provide the basis of Tier 1 risk assessment.

Multiple-lines-of-evidence approach is the process for evaluating and integrating information from different sources of data and uses best professional judgement to assess the consistency and plausibility of the conclusions which can be drawn.

Screening is the process of comparison of site data to screening criteria to obtain a rapid assessment of contaminants of potential concern.

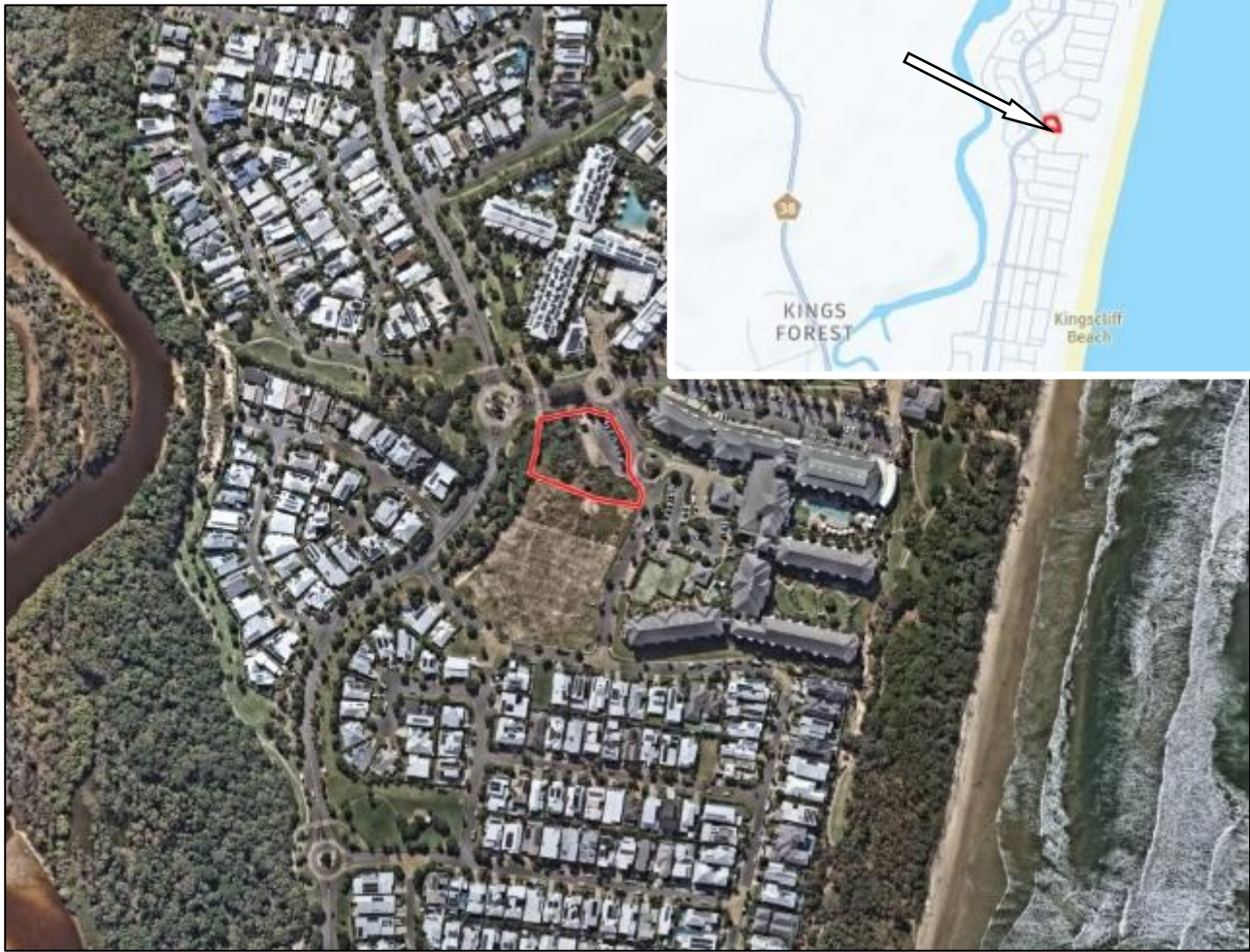
Tier 1 assessment is a risk-based analysis comparing site data with investigation and screening levels for various land uses to determine the need for further assessment or development of an appropriate management strategy.

15 APPENDICES

See following pages

APPENDIX 1 - LOCATION MAPS





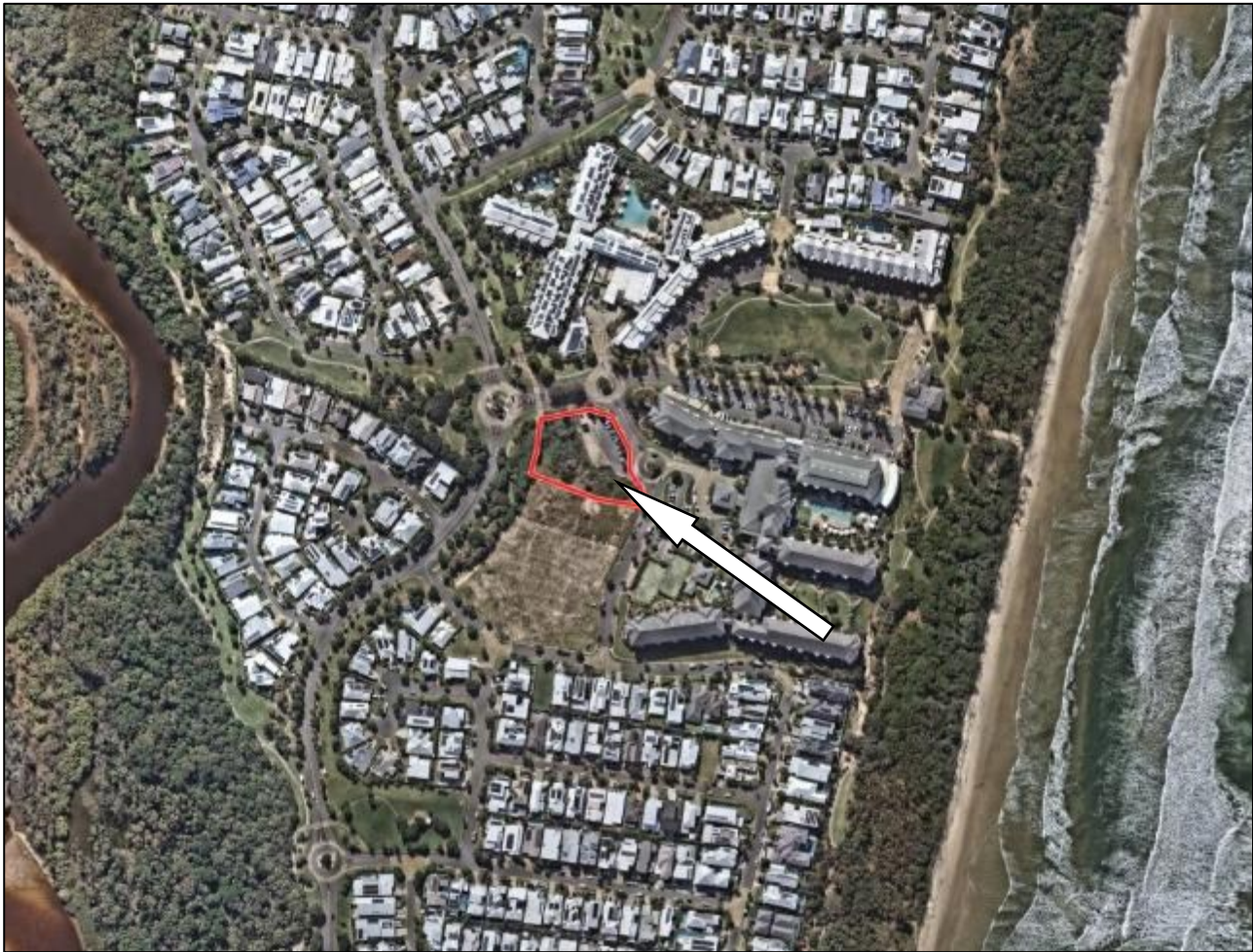


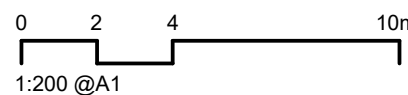
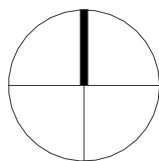
Figure 1 - Surrounding Area (Source: Nearmap 2025)



Figure 2 – Subject Site (Source: Nearmap 2025)

APPENDIX 2 - SITE PLAN PROPOSED DEVELOPMENT

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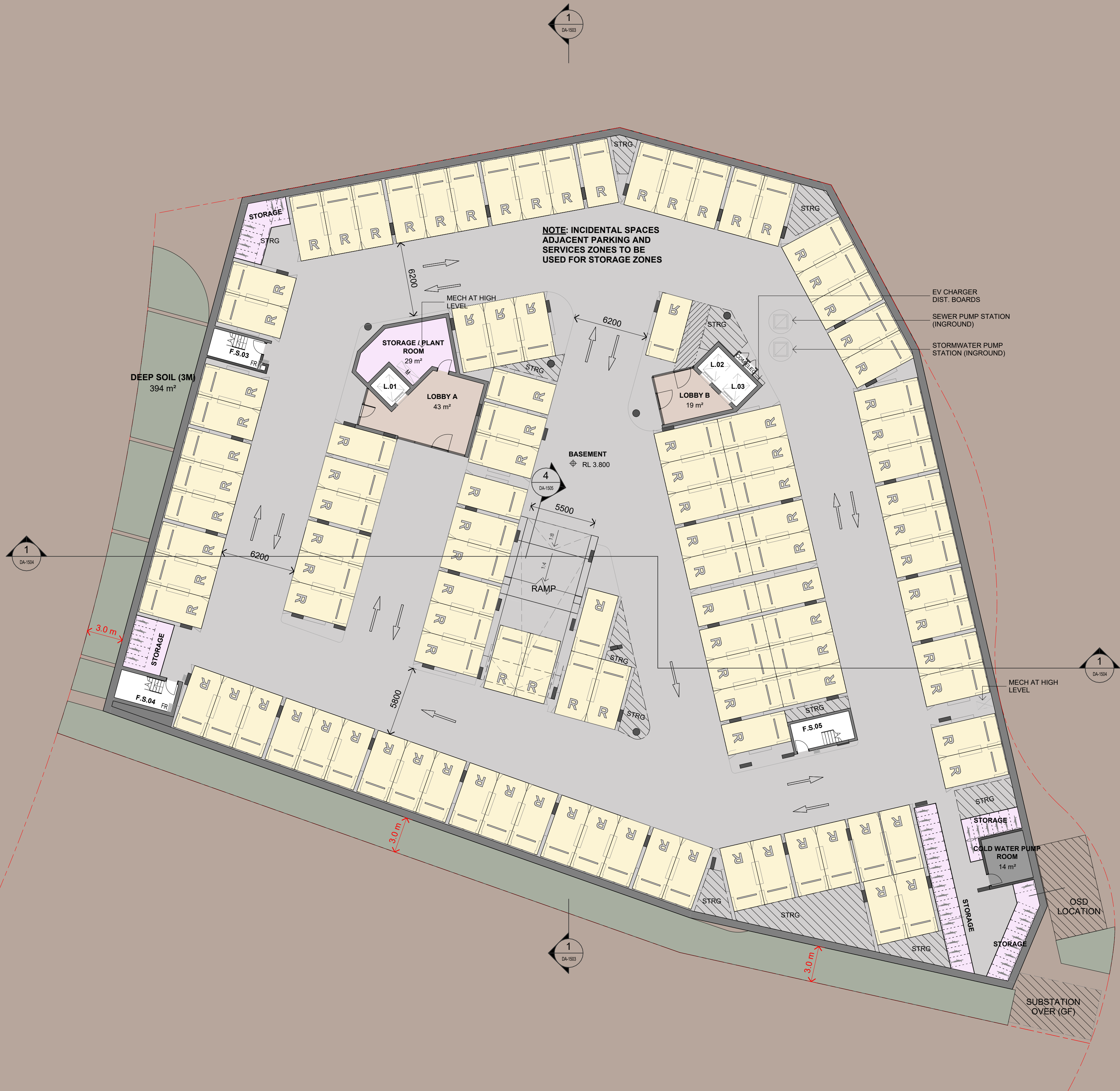
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PARKING LEGEND

(E)	EASEMENT
(E)	EASEMENT ACCESSIBLE
(R)	RESIDENTIAL
(SCR)	SMALL CAR RESIDENTIAL
(V)	VISITOR
(RT)	RETAIL
(RT)	RETAIL ACCESSIBLE
(RTS)	RETAIL STAFF
(RTS)	RETAIL STAFF ACCESSIBLE

BICYCLE PARKING SCHEDULE

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RETAIL	12
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RESIDENTIAL	25
VISITOR	10
BASEMENT 02	
RESIDENTIAL	44
TOTAL	91

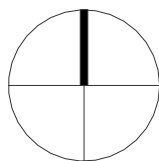
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SUBTOTAL	110
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RESIDENTIAL PARKING	116
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RETAIL ACCESSIBLE	1
RETAIL STAFF PARKING	6
RETAIL STAFF ACCESSIBLE	1
VISITOR PARKING	18
TOTAL	193

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(SCR)	SMALL CAR RESIDENTIAL
(V)	VISITOR
(RT)	RETAIL
(RT)	RETAIL ACCESSIBLE
(RTS)	RETAIL STAFF
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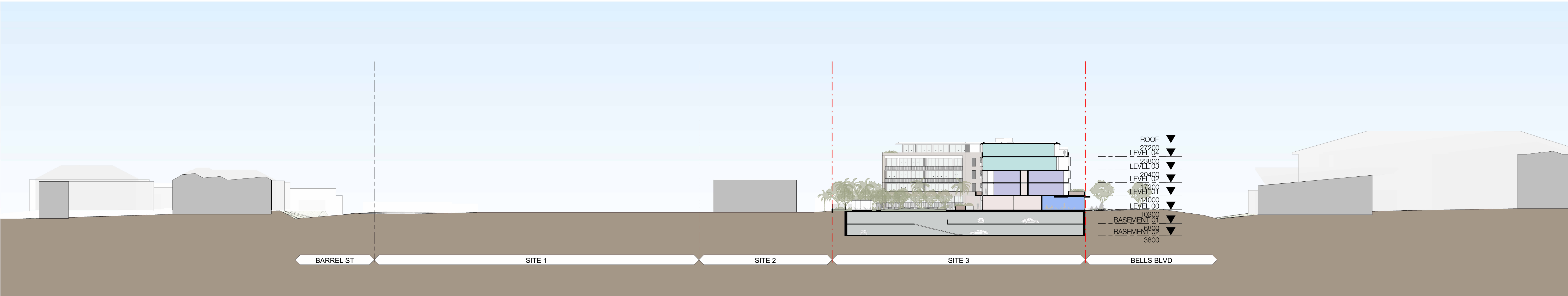
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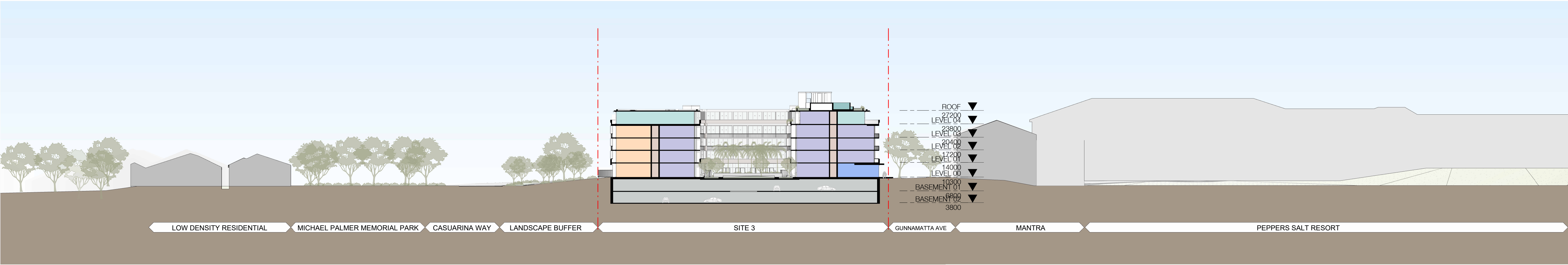
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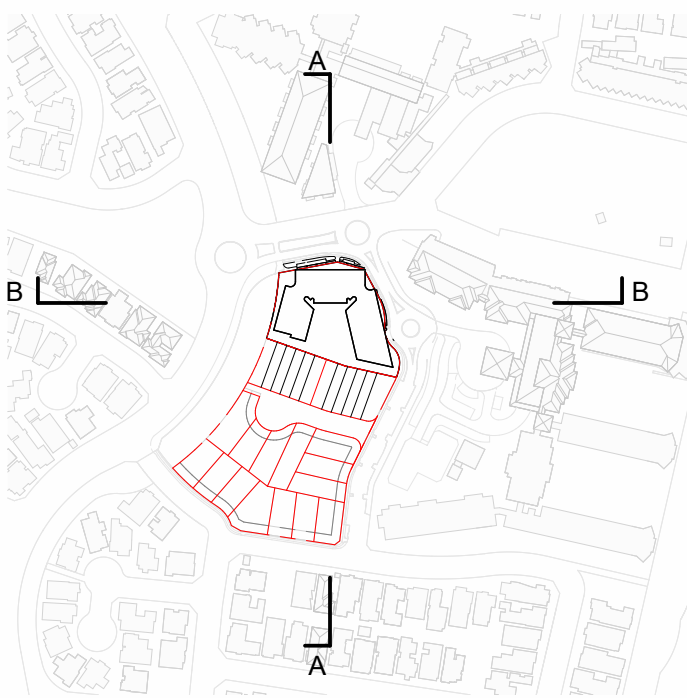
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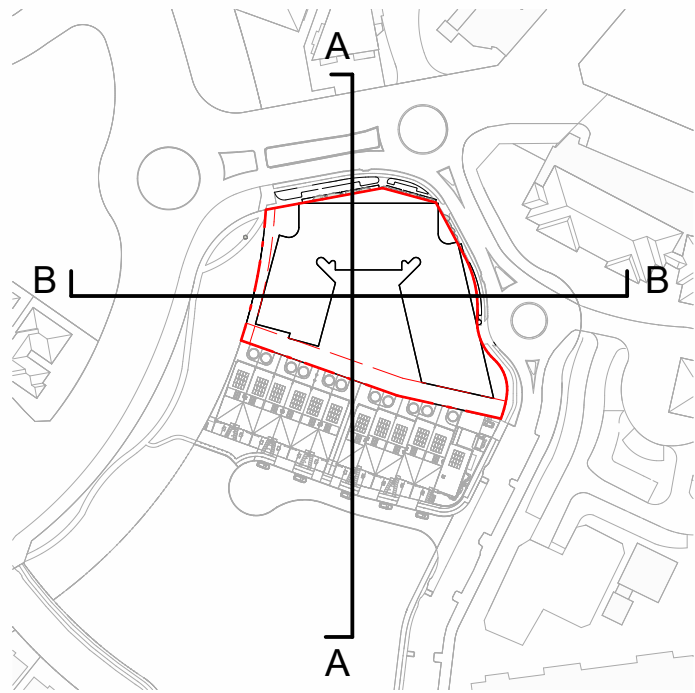
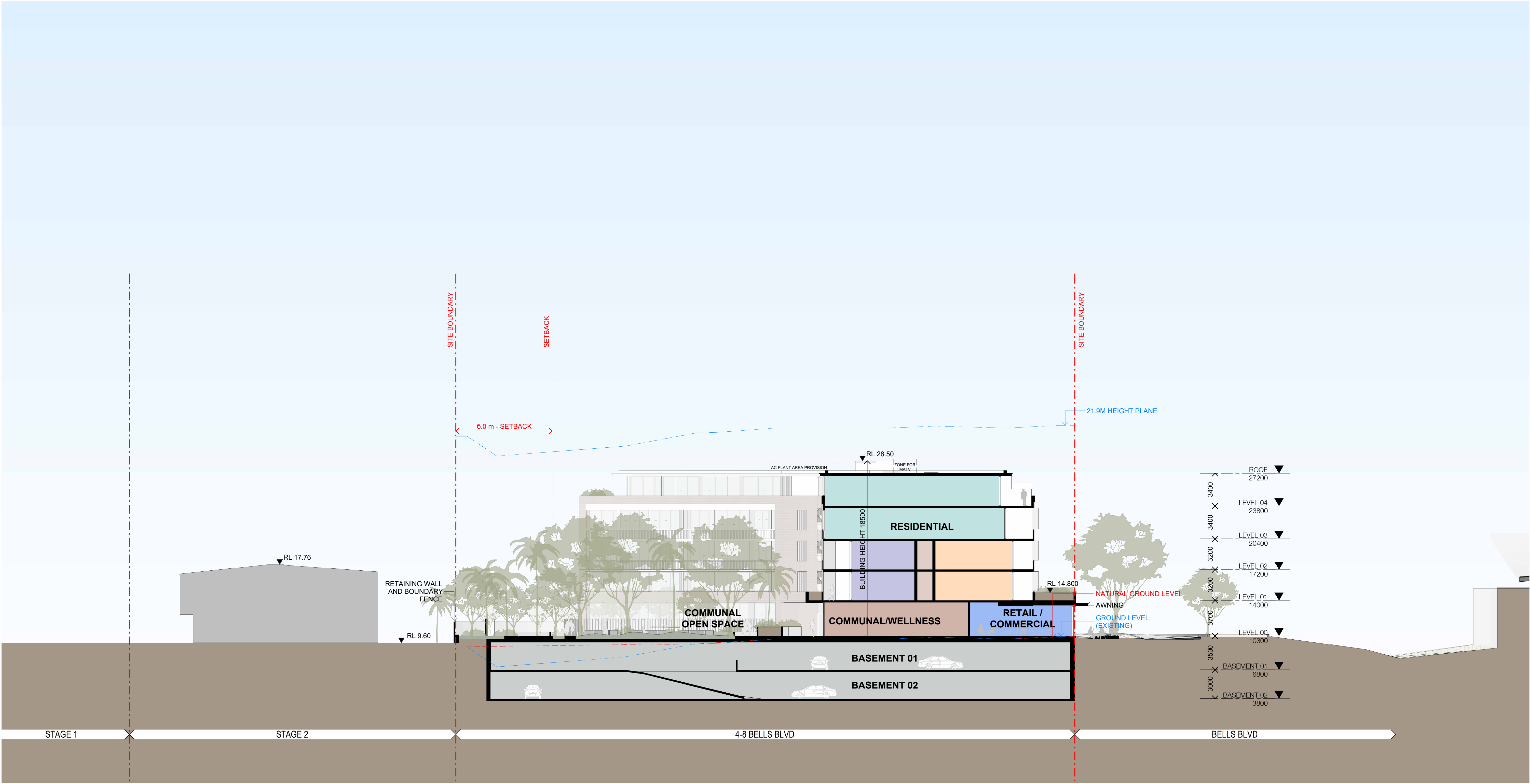
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Revision

/ B

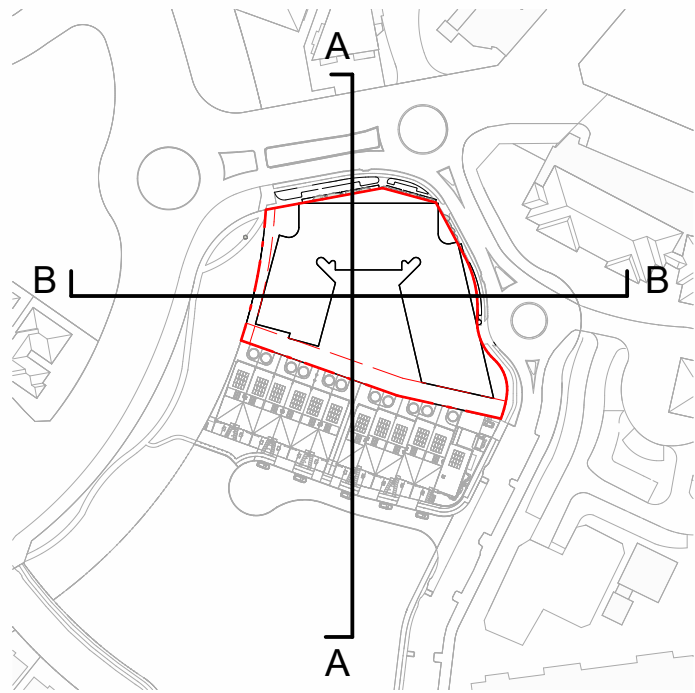
SJB Architects

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Sunny Hills NSW 2010

T 61 2 9380 9911

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SECTION B
SCALE 1:200

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Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
A	28-11-2025	FOR SSDA	LR	JV
1	05-06-2026	FOR INFORMATION	MQ	WG
2	17-06-2026	FOR INFORMATION	MQ	WG
B	24-06-2026	FOR RFI	MQ	WG

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

Client

BELLS BOULEVARD PTY LTD

Project

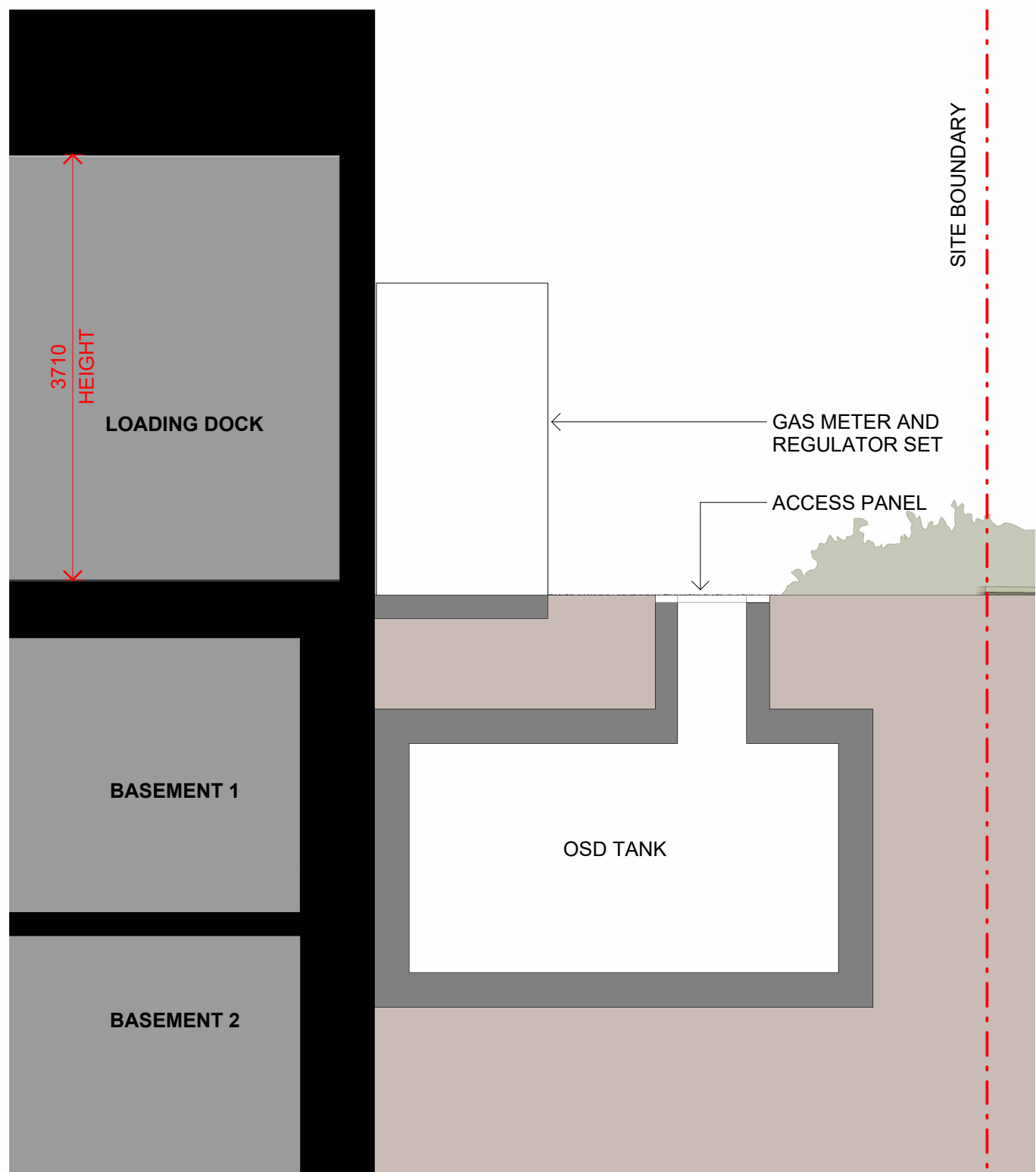
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4-8 BELLS BOULEVARD, KINGSCLIFF**

Drawing Name
BUILDING SECTION B

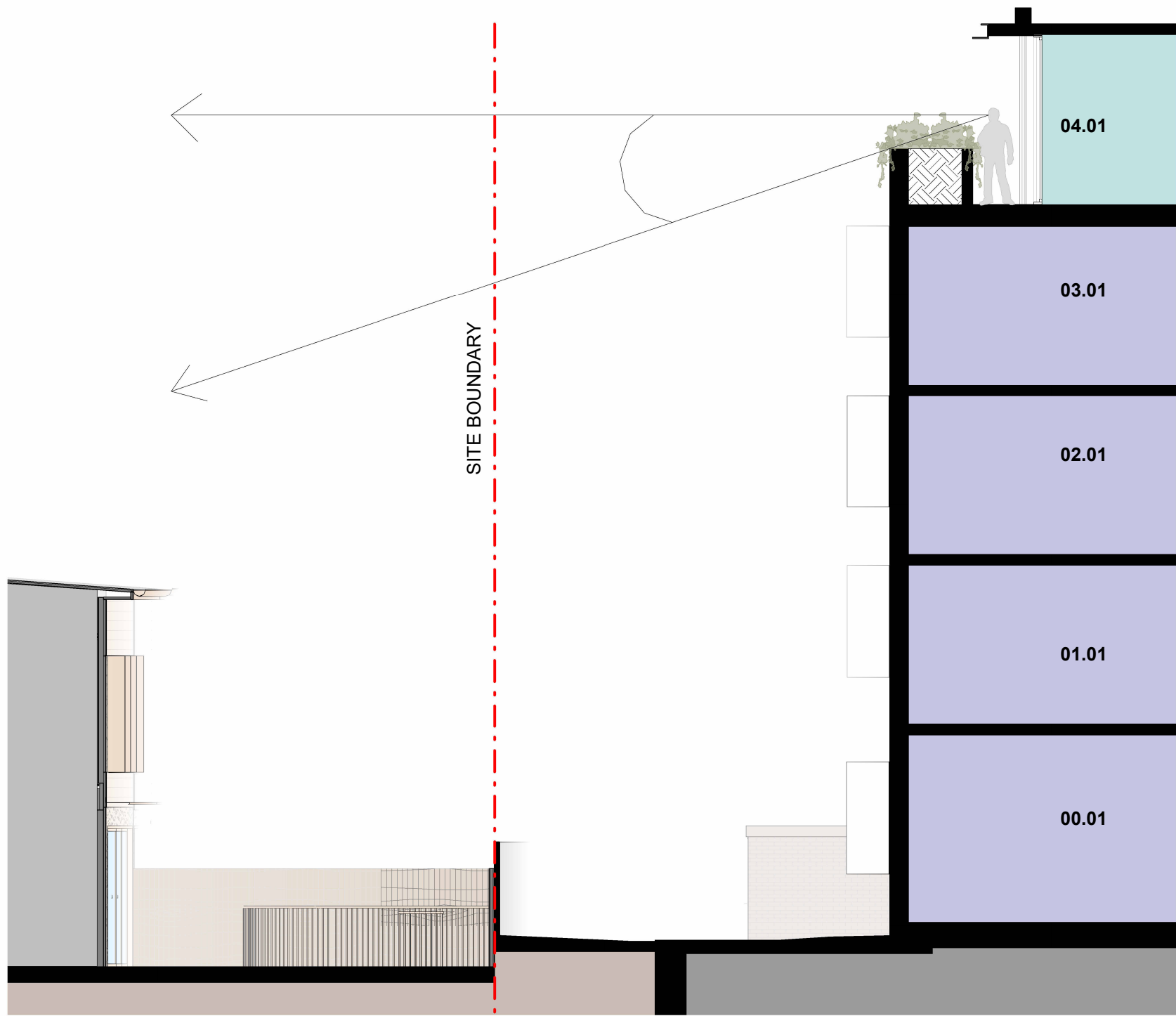
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24-06-2026	1:200	A1
Drawn	Chk.	Job No.
LR	JV	6906
Drawing No.	Revision	
DA-1504	/ B	

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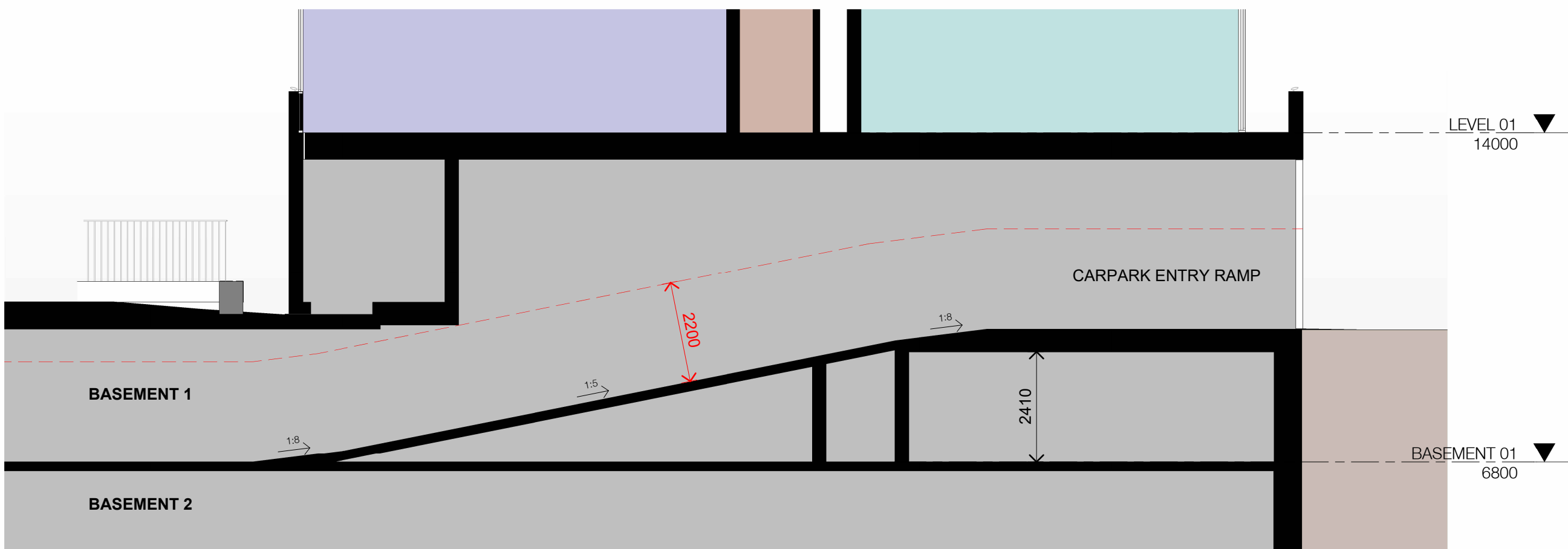




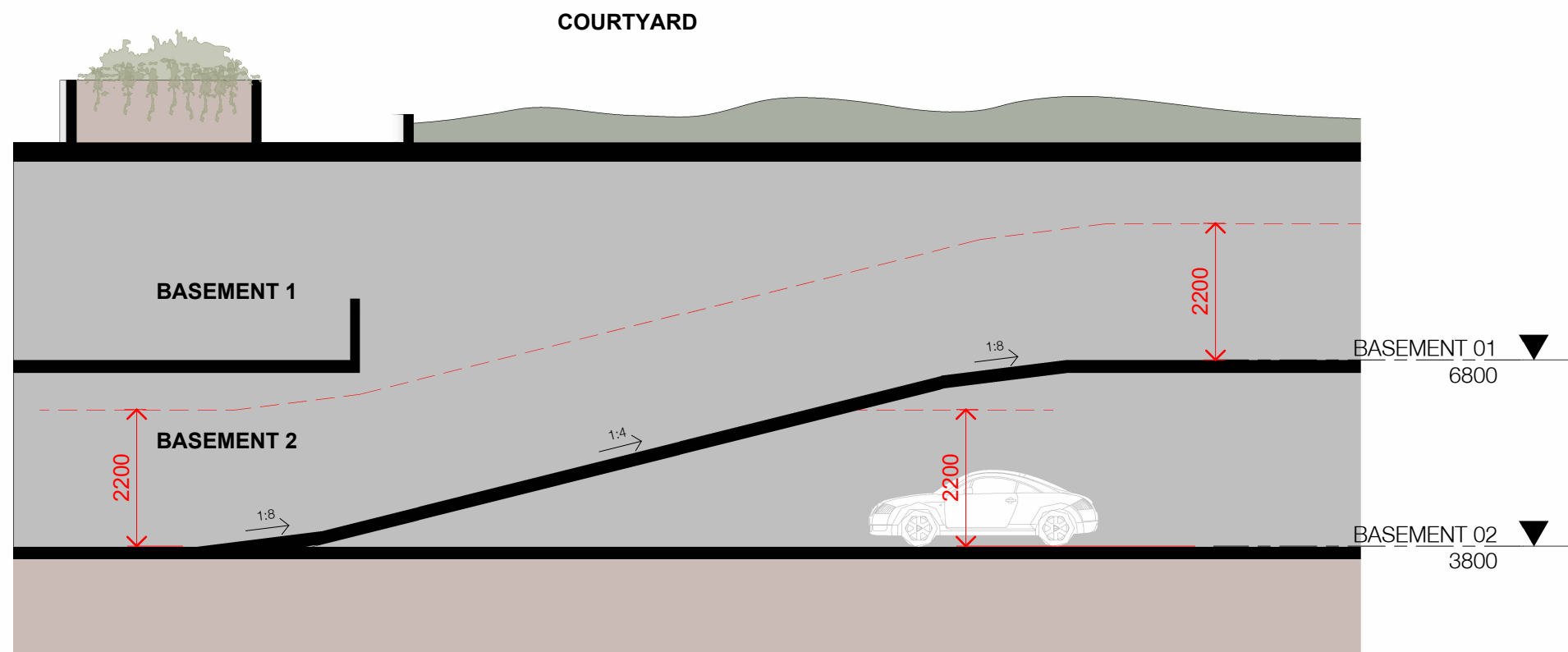
1 SECTION_LOADING DOCK & OSD TANK
DA-1001 SCALE 1:50



2 SECTION_OVERLOOKING STUDY
DA-1002 SCALE 1:100



3 SECTION_CARPARK RAMP
DA-1002 SCALE 1:100



4 SECTION_BASEMENT RAMP
DA-1001 SCALE 1:100

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Nominated Architects: Adam Haddow-7188 | John Pradel-7004

Rev	Date	Revision	By	Chk.
1	17-06-2026	FOR INFORMATION	MQ	WG
A	24-06-2026	FOR RFI	MQ	WG

NOTE: MINOR CHANGES TO FORM AND CONFIGURATION MAY BE REQUIRED WHEN DRAWINGS ARE SUBSEQUENTLY PREPARED FOR CONSTRUCTION PURPOSES AFTER THE GRANT OF DEVELOPMENT CONSENT.

Client

BELLS BOULEVARD
PTY LTD

Project

BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF

Drawing Name

DETAIL SECTIONS

Date

24-06-2026 1:200

Scale

Sheet Size

A1

Drawn

MQ

Chk.

WG

Job No.

6906

Revision

DA-1505

Revision

/ A

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APPENDIX 3 - GEOLOGY AND SOIL LANDSCAPE



Figure 3 - Geology Map (Source: Geoscience Australia)



Figure 4 - Soil Landscape (Source: eSPADE NSW)

APPENDIX 4 - LICENSED GROUNDWATER BORES





Figure 5 – Groundwater Bore Locations (Source: <http://allwaterdata.water.nsw.gov.au/water.stm>)

APPENDIX 5 - HISTORICAL AERIAL PHOTOGRAPHY





Figure 6 - Historical Aerial 1961 (NSW Spatial Services Historical Imagery <https://portal.spatial.nsw.gov.au>)



Figure 7 - Historical Aerial 1971 (NSW Spatial Services Historical Imagery <https://portal.spatial.nsw.gov.au>)



Figure 8 - Historical Aerial 1991 (NSW Spatial Services Historical Imagery <https://portal.spatial.nsw.gov.au>)



Figure 9 - Historical Aerial 1996 (NSW Spatial Services Historical Imagery <https://portal.spatial.nsw.gov.au>)

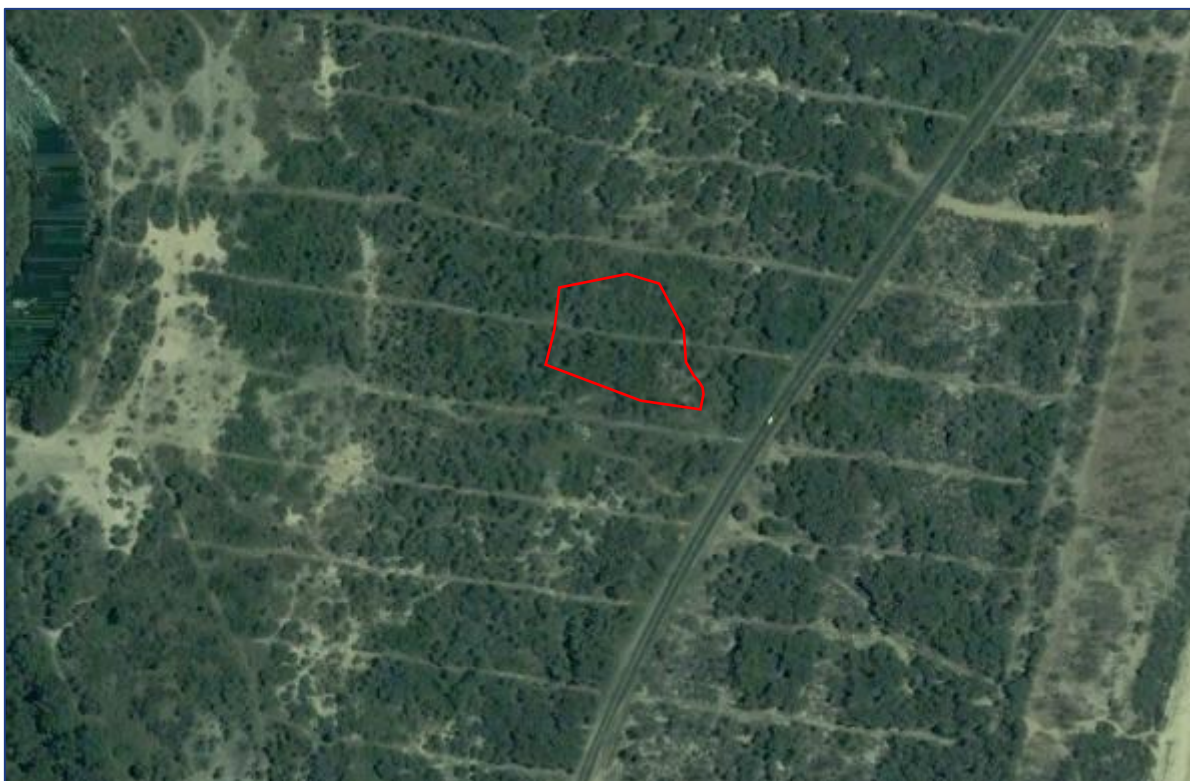


Figure 10 - Historical Aerial 2003 (Google Earth)



Figure 11 - Historical Aerial 2009 (Google Earth)



Figure 12 - Historical Aerial 2012 (Google Earth)



Figure 13- Historical Aerial 2020 (Google Earth)



Figure 14 – Past Sand Mining Operation

Source: Appendix 3 - Cardno MBK Pty Ltd, Detailed Site Radiation Investigation Report & Remediation Action Plan Salt, South Kingscliff: South Kingscliff Developments Pty Ltd. August 2002.

APPENDIX 6 - PHOTOGRAPHIC LOG

Photo No. 1	Date 27/10/2025	
Description: View north across the site showing existing bitumen carpark.		

Photo No. 2	Date 20/05/2026	
Description: BH1 (Radiation sampling location) view south-east		

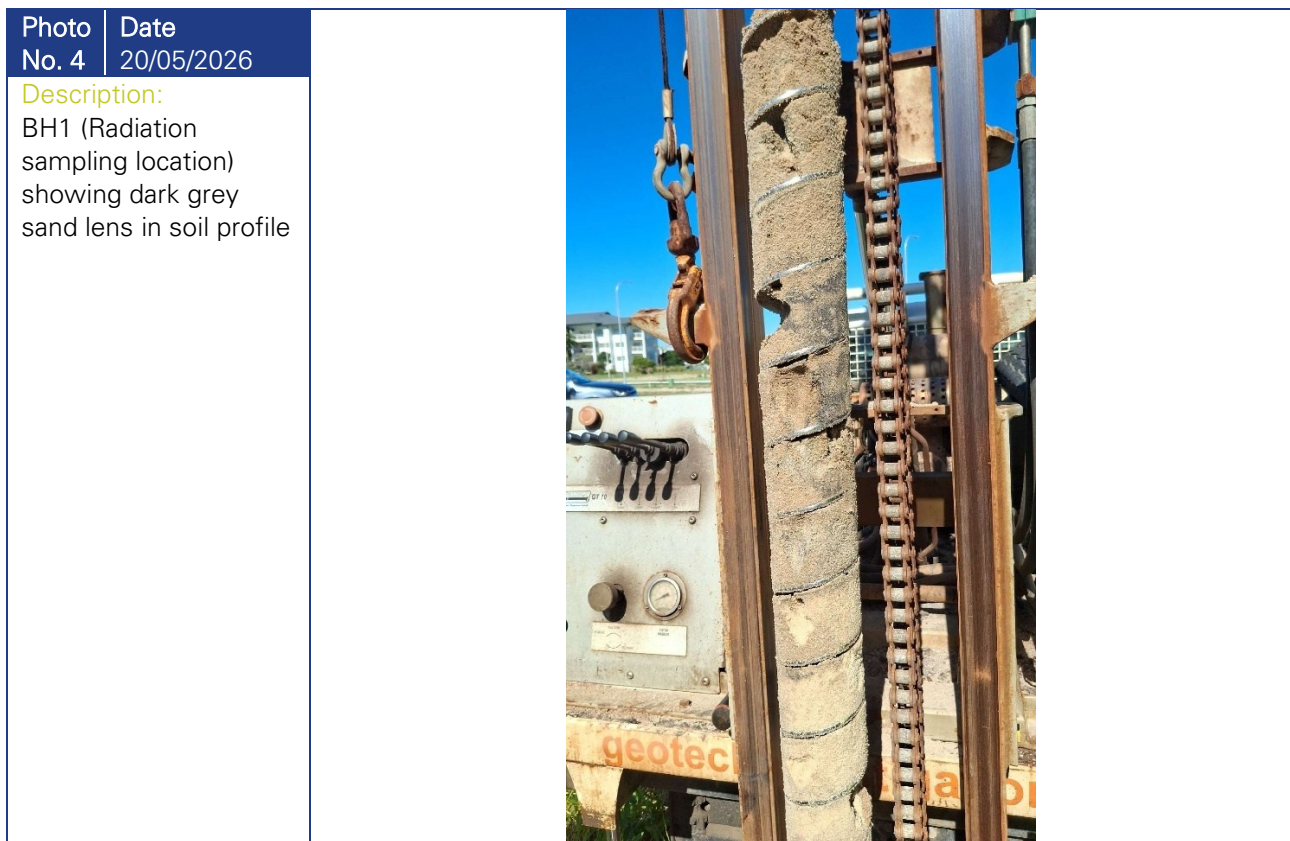
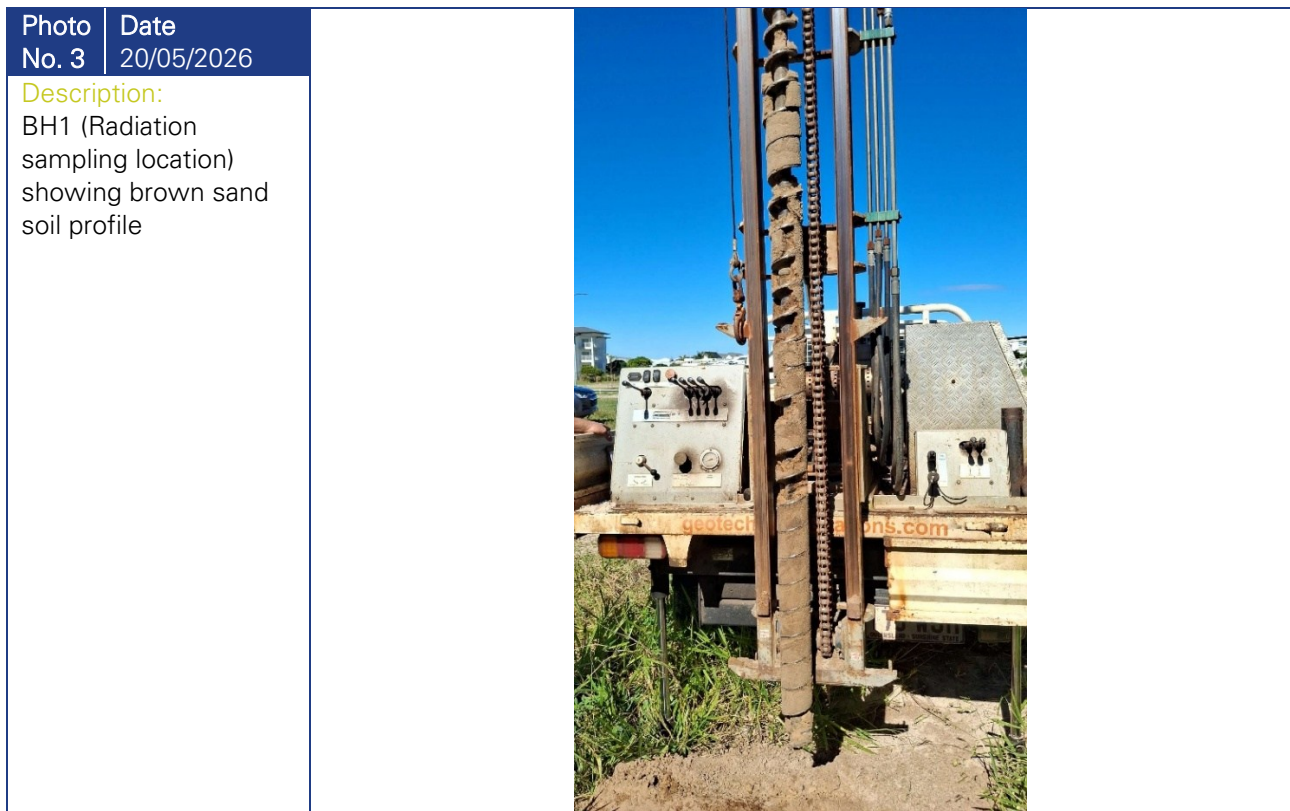


Photo No. 5	Date 20/05/2026	
Description: BH2 (Radiation sampling location) showing brown sand in soil profile		

Photo No. 6	Date 20/05/2026	
Description: BH3 (Radiation sampling location) view east		

Photo No. 7	Date 20/05/2026	
Description: BH3 (Radiation sampling location) view east		

Photo No. 8	Date 20/05/2026	
Description: BH3 (Radiation sampling location) view north west		

Photo No. 9	Date 27/10/2025	
Description: View north west across the site		

Photo No. 10	Date 27/10/25	
Description: View north west showing borrow pit area		

Photo No. 5	Date 27/10/25	
Description: View north along western side of existing carpark showing opportunistic waste dumping		

Photo No. 6	Date 27/10/2025	
Description: View south-east along western boundary of site.		

APPENDIX 7 - RADIATION ASSESSMENT - Rsssa (2026)



RADIATION ASSESSMENT REPORT – PROPERTY DEVELOPMENT (NSW)- 4-8 Bells Boulevard Kingscliff Q2026.4049

Prepared in accordance with:

- Protection from Harmful Radiation Act 1990 No 13
- Protection from Harmful Radiation Regulation 2025
- EPA NORM Management Framework (1 Bq/g screening threshold)
- Guidance Note QGN12 (QLD Health Radiation Health)
 - Radiation protection from naturally occurring radioactive materials (NORM) during exploration (1 Bq/g screening threshold)
- ARPANSA RPS dose constraints (public exposure limit: 1 mSv/year)

Site operations 20/5/26, Report 29/6/26 - Reporting Officer

Simon Turner

Medical Health Physicist

Instrumentation

Thermo RadEye B20 ER (Calibration due Feb 2027)

Exploranium GR-130 (Calibration due 28 Aug 2026)

3rd party Laboratory-Queensland Health Radiation Health Unit Radiation Sciences

traceable to NIST (USA) national standard.

1. Purpose of Assessment

This radiation assessment was undertaken to determine whether soil at the proposed development site for the underground garage locations contains levels of Naturally Occurring Radioactive Material (NORM) that require management under NSW legislation. The assessment evaluates:

- Soil activity concentrations (Bq/g)
- Compliance with the 1 Bq/g NORM screening threshold
- Compliance with the 1 mSv/year (1000 μ Sv/year) public dose constraint
- Field gamma measurements
- Management options for non-uniform, dispersed elevated material
- Protocols for future excavation, blending, and remediation

Note this report does not replace the initial findings of the Cardno or QLD Health radiation reports.

2. Sample Collection Methodology

To obtain a representative and defensible understanding of radiological activity across the proposed garage excavation area, a structured sampling program was undertaken in accordance with good radiation-survey practice and NSW regulatory expectations for NORM investigations.

Selection of Drilling Locations

Three drilling locations were selected within and adjacent to the planned garage footprint. These locations were chosen to provide:

- Coverage across the excavation zone
- Representation of lateral variability in soil composition
- Identification of any localised pockets of elevated NORM
- An initial indication of vertical distribution of soil radiation activity

The selection strategy ensures that the results reflect both horizontal and vertical variability in the soil profile.

Depth of Sampling

Each drilling location was sampled down to 500 mm below the proposed final excavation depth. This approach provides:

- A clear understanding of radiological conditions throughout the full excavation profile
- Assurance that deeper layers do not contain elevated material that may be exposed during construction
- A conservative assessment of potential NORM impacts

Core Examination and Radiation Monitoring

Every millimetre of each core was:

- Visually inspected for changes in soil colour, texture, mineralisation, or unusual inclusions
- Assessed using a handheld radiation monitor, with readings taken continuously along the length of the core

This method ensures that any subtle changes in radiological activity are detected, even when dispersed or non-uniform.

Selection of Laboratory Samples

Laboratory samples were selected at:

- **5.5 m depth**
- **6.5 m depth**
- **7.5 m depth**

These depths were chosen to:

- Capture representative material across the deeper excavation profile
- Assess radiological behaviour at intervals where soil composition changes were observed
- Provide a structured dataset for comparison across drilling locations

In addition, any point at which elevated readings (above background) were observed during core monitoring was also sampled for laboratory analysis. This ensures that:

- Localised elevated pockets are captured
- Dispersed NORM is properly characterised
- No elevated material is overlooked due to non-uniform distribution



Field Instrumentation

The handheld radiation monitor used for core assessment:

- Recorded background-level gamma radiation throughout all cores
- Samples were taken at both hotspot readings

This supports the conclusion that elevated samples are dispersed, non-uniform, and not detectable as external radiation hazards.

3. Site Observations

- The site presents as a typical NSW mineral-bearing soil environment.
- Please review Cardno report for indepth surface level site survey.
- No visible contamination, industrial residues, or unusual materials were observed.
- No legacy waste, fill, or infrastructure indicating radiological concern.
- Soil appears naturally variable, consistent with a dispersed NORM distribution.
- No concentrated or anomalous materials were identified during visual inspection.
 - During sample bores, 2 thin elevated activity locations were identified through manual monitoring and sent for analysis to an approved laboratory.

4. Field Measurements (Handheld Gamma Instrument)

Handheld gamma survey instruments recorded:

- Background radiation only
- Typical NSW background range: 0.15–0.25 $\mu\text{Sv/hr}$
 - in keeping with a natural mineral-rich sand location
- 2 hotspots with slightly elevated readings were detected
- No instrument alarms or dose-rate anomalies

Interpretation:

Field conditions do not indicate any external gamma hazard.

The elevated laboratory results are discernible in the field, confirming that the material can be easily managed through onsite monitoring and operations.

5. Laboratory Results

Regulatory Trigger (Protection from Harmful Radiation Regulation 2025):

1 Bq/g NORM screening threshold

Sample Number	Location	depth (m)	U (Bq/Kg)	TH (Bq/Kg)	K (Bq/Kg)	Total activity (Bq/Kg)	Total activity (Bq/g)	Doserate (μSv/hr)
1	Hole 1	5.5	29	22	20	71	0.071	0.026
2	Hole 1	6.5	100	85	20	205	0.205	0.097
3	Hole 1	7.2	880	770	20	1670	1.67	0.84
4	Hole 1	7.5	10	11	16	37	0.037	0.12
5	Hole 2	5.5	12	16	10	38	0.038	0.015
6	Hole 2	6.5	6	3	10	19	0.019	0.005
7	Hole 2	7.5	8	8	13	29	0.029	0.009
8	Hole 3	1.5	190	750	80	1020	1.02	0.53
9	Hole 3	5.5	120	76	50	246	0.246	0.102
10	Hole 3	6.5	57	35	150	242	0.242	0.053
11	Hole 3	7.5	200	180	80	460	0.46	0.2
12	run off 1	0	51	80	140	271	0.271	0.077
13	run off 2	0	41	48	200	289	0.289	0.054

Sample	Activity (Bq/g)	Interpretation
1	0.071	Below threshold
2	0.205	Below threshold
3	1.67	Above 1 Bq/g – requires management
4	0.037	Below threshold
5	0.038	Below threshold
6	0.019	Below threshold
7	0.029	Below threshold
8	1.02	Above 1 Bq/g – requires management
9	0.246	Below threshold
10	0.242	Below threshold
11	0.46	Below threshold
12	0.271	Below threshold
13	0.289	Below threshold

Summary

- 11 samples are below the NSW NORM threshold.
- 2 samples exceed 1 Bq/g (Samples 3 and 8).
- All values remain below levels associated with >1 mSv/year dose.
- No sample indicates a radiological hazard requiring off-site disposal.

6. Interpretation of Results

6.1 Activity Levels

The majority of samples fall within normal NSW background soil activity (0.02–0.30 Bq/g).

Only two samples exceed the 1 Bq/g NORM screening threshold, indicating localised elevated NORM, not widespread contamination.

6.2 Dose Assessment

Using ARPANSA RPS dose-conversion factors:

- Soil at 1–2 Bq/g typically contributes <50 $\mu\text{Sv}/\text{year}$ under residential exposure.
- This is well below the public dose limit of 1000 $\mu\text{Sv}/\text{year}$.

6.3 Regulatory Interpretation

Under the Protection from Harmful Radiation Regulation 2025:

- Material >1 Bq/g must be managed, not necessarily removed.
- Dilution, blending, or supervised placement is acceptable for low-level NORM.
- No sample indicates a radiological hazard requiring excavation or disposal as radioactive waste.

7. Summary of Investigation

- Field measurements show no external radiation hazard.
- Laboratory results show low-level NORM, typical of NSW soils.
- Only two samples exceed the 1 Bq/g threshold.
- All results are well below dose constraints.
- The site is safe for development with minor NORM management controls.

8. Recommended Management Options

Because the elevated material is dispersed and non-uniform, and because field gamma measurements remain at background, the site can be safely managed using the following low-cost, practical methods. Combining Option B with Option C will give the best outcome, ensuring an operationally achievable approach and a safe, compliant outcome.

Option A – Stockpiling and Onsite Blending (Excavator Mixing)

Where elevated material is encountered during excavation:

1. **Stockpile soil in a controlled location on-site.**
2. **Monitor the stockpile using handheld gamma instruments.**
3. **Blend elevated soil with clean sand or low-activity soil using an excavator.**

This reduces the average activity to **below 1 Bq/g**, achieving compliance with NSW NORM thresholds.

Advantages:

- Very low cost
- No off-site disposal required
- Rapid compliance
- Suitable for large-volume earthworks

Disadvantages:

- Due to the initial scoping approach, the extent of the elevated material is unknown
- Could create a hard-to-manage stockpile of hot material
- More days of excavation equipment hire
- Double handling

Option B – Radiation Specialist Oversight (Highly Recommended)

A qualified radiation specialist supervises excavation activities and:

- Identifies elevated activity material in real time
- Segregates small pockets of elevated soil
- Minimises the volume requiring blending
- Ensures compliance with the 1 Bq/g threshold
- Provides regulatory assurance and documentation

Advantages:

- Most efficient and cost-effective
- Minimises unnecessary soil movement
- Reduces blending volume
- Ensures accurate identification of elevated NORM pockets

Option C – Over-Excavation and Clean Sand Backfill (Garage Area)

Around the garage excavation:

1. Over-excavate by approximately 1200 mm.
2. Remove or blend elevated soil as encountered.
3. Backfill with clean pore-silicate sand.

This provides:

- Increased shielding
- Greater separation distance
- Reduced potential exposure pathways
- Long-term compliance with the 1 mSv/year public dose constraint

Advantages:

- Creates a clean, low-activity zone
- Provides physical shielding
- Simple to implement during construction

9. Protocols for Future Investigation & Remediation

9.1 Additional Sampling (If Required by EPA)

- Target areas around Samples 3 and 8
- Collect 6–10 additional samples per hole to confirm the spatial distribution
- Utilise grid pattern review 2-5m grid spacing.

9.2 Soil Management Protocol

- Track soil >1 Bq/g
- Blend or place under controlled conditions
- Maintain a simple soil-movement log

9.3 Construction Controls

- Use clean fill for final surface layers
- Avoid stockpiling elevated soil near public access
- Maintain dust suppression

9.4 Final Verification

- Post-dilution sampling to confirm <1 Bq/g
- Provide results to NSW EPA if requested

10. Conclusion

The site contains low-level NORM, with only two samples exceeding the 1 Bq/g NSW threshold under the Protection from Harmful Radiation Regulation 2025.

All measured values are well below the 1000 μ Sv/year public dose constraint.

With simple, low-cost management options—sand dilution, specialist-supervised excavation, controlled placement, or over-excavation with clean sand—the site can be fully compliant with NSW radiation requirements and is safe for property development.

Material of interest Hole #1 @7.2m



Material of interest - runoff in the lower drain area



Material of interest Hole #3 @1.5m



CERTIFICATE OF ANALYSIS

CLIENT: RADIATION SAFETY SUPPORT
RADIATION SAFETY SUPPORT SERVICES AUS
27 ARINGA CRESCENT
KARANA DOWNS QLD 4306
ATTN: SIMON TURNER

CC: simon@sensaweb.com.au

Laboratory Reference : 26050053
Client Order Number :
Quote Number :
Client Project :
Client Batch Reference :
Date Received : 22/05/2026
Laboratory Number/s : 25PQ904-25PQ916

Submitting Authority: Simon Turner, Radiation Safety Support

Number of Samples: 13

Reason for Analysis: Not specified

HIGH RESOLUTION GAMMA SPECTROMETRY

Method of Analysis QIS 25279 QHFSS in-house method, based on ISO18589-2&3:2015 (soil) and ISO10703:2021 (water).

Remarks Results indicate individual radionuclide concentration only.
Sample Preparations: Samples were prepared as per standard operating procedure of gamma spectrometry method.
Ra-226 CAN be considered as being in secular equilibrium with the short-lived progeny for samples counted 21 days after preparation.
Results HAVE NOT been decay corrected to the time of sampling.
Correction factors for full decay series activity should be considered before comparison to regulatory compliance/guideline/action levels as required.
dAKR calculated with conversion factor published by Malins et. al. [1]

Sample Geometry

- ☐ 2L Marinelli Beaker
☒ 80mL Aluminium Jar (with radon tight viton gasket)

Detector Specifications

- ☒ Sys1a: GMX40-76 s/n 53-N13245A
☒ Sys3a: GMX30P4-ST s/n 47-TN50207A
☒ Sys5a: GX6020 s/n 5416
☒ Sys6a: GL3825 s/n 8689
☒ Sys7: GMX20P4-70 s/n 54-TN23648B

Calibration File

- S1a_80AJ-S_28April2023.Clb
S3a_80AJ-S_09Feb2024.Clb
S5a_80AJ-S_29Jan2026.Clb
S6a_80AJ-S_30Apr2024.Clb
S7_80AJ-S_14Nov2024.Clb

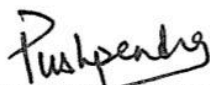
Traceability

- ☐ Standard Radionuclide Source: 2 L, 1.0 g/cc, sn:2220-84-3 traceable to NIST (USA) national standard.
☒ Standard Radionuclide Source: 85 mL, 1.5 g/cc, sn:2220-84-1 traceable to NIST (USA) national standard.

Uncertainty

Activity concentrations stated as $x \pm U$ ($k=2$, 95%CI) or as <MDL (minimum detectable level).

[1] Malins, A., M. Machida and K. Saito *Comment on 'Update of 40K and 226Ra and 232Th series y-to-dose conversion factors for soil'*. Journal of Environmental Radioactivity, 2015. 144: p. 179-180.



Pushpendra Chauhan, Senior Health Physicist
Radiation Health, Radiation Sciences
23 June 2026

25PQ904-25PQ916916

This report overrides all previous reports. The results relate solely to the sample/s as received and are limited to the specific tests undertaken as listed on the report. The results of this report are confidential and are not to be used or disclosed to any other person or used for any other purpose, whether directly or indirectly, unless that use is disclosed or the purpose is expressly authorised in writing by Queensland Health and the named recipient on this report. To the fullest extent permitted by law, Queensland Health will not be liable for any loss or claim (including legal costs calculated on an indemnity basis) which arise because of (a) problems related to the merchantability, fitness or quality of the sample/s, or (b) any negligent or unlawful act or omissions by Queensland Health that is connected with any activities or services provided by Queensland Health under this agreement (including the timing and/or method under which the sample/s were taken, stored or transported).

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Archerfield QLD 4108
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CERTIFICATE OF ANALYSIS
25PQ916916

25PQ904-

Client Reference					#1 _5.5 M	#1 _6.5 M	#1 _7.2 M	#1 _7.5 M
Sample Type					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Sample Description					-	-	-	-
Sampling Time / Date					-	-	-	-
Preparation Date					27/05/2026	27/05/2026	29/05/2026	27/05/2026
Analysis Date					17/06/2026	17/06/2026	19/06/2026	17/06/2026
Detector					S1a	S3a	S7	S5a
Sample Density (g/cc)					1.56	1.56	1.55	1.54
^Sample in analysed matrix by mass (%)					89.1	87.9	83.0	88.8
Method	Analysis Description	Comparison Levels	Units	Radionuclide	25PQ904	25PQ905	25PQ906	25PQ907
QIS 25279	Gamma Spec.	-	Bq/kg	*Ra-226 (U-238)	29 ± 3	100 ± 10	880 ± 80	10 ± 1
QIS 25279	Gamma Spec.	-	Bq/kg	*Ra-224 (Th-232)	22 ± 4	85 ± 9	770 ± 70	11 ± 3
QIS 25279	Gamma Spec.	-	Bq/kg	K-40	< 20	< 20	< 20	16 ± 7
			µGy/h	dAKR	0.026 ± 0.003	0.097 ± 0.007	0.840 ± 0.050	0.012 ± 0.002

* Radionuclide activity concentration determined from progeny:

- The activity of Ra-226 can be determined by measuring the activities of its progeny, Pb-214 and Bi-214. Under conditions of secular equilibrium, the activity of U-238 is equal to the activity of Ra-226.
- The activity of Ra-224 can be determined by measuring the activities of its progeny, Pb-212, Bi-212, and Tl-208. Under conditions of secular equilibrium, the activity of Th-232 is equal to the activity of Ra-224.

^ To ensure consistency with calibration geometry, pulverised solid sample were combined with polyethylene filler to achieve optimal matrix density to match the mass of the reference standard geometry.

This report overrides all previous reports. The results relate solely to the sample/s as received and are limited to the specific tests undertaken as listed on the report. The results of this report are confidential and are not to be used or disclosed to any other person or used for any other purpose, whether directly or indirectly, unless that use is disclosed or the purpose is expressly authorised in writing by Queensland Health and the named recipient on this report. To the fullest extent permitted by law, Queensland Health will not be liable for any loss or claim (including legal costs calculated on an indemnity basis) which arise because of (a) problems related to the merchantability, fitness or quality of the sample/s, or (b) any negligent or unlawful act or omissions by Queensland Health that is connected with any activities or services provided by Queensland Health under this agreement (including the timing and/or method under which the sample/s were taken, stored or transported).

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CERTIFICATE OF ANALYSIS
25PQ916916

25PQ904-

Client Reference					#2_5.5 M	#2_6.5 M	#2_7.5 M	#3_1.5 M
Sample Type					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Sample Description					-	-	-	-
Sampling Time / Date					-	-	-	-
Preparation Date					27/05/2026	27/05/2026	28/05/2026	29/05/2026
Analysis Date					19/06/2026	17/06/2026	19/06/2026	19/06/2026
Detector					S1a	S7	S3a	S5a
Sample Density (g/cc)					1.54	1.56	1.56	1.55
^Sample in analysed matrix by mass (%)					88.6	89.8	89.6	86.9
Method	Analysis Description	Comparison Levels	Units	Radionuclide	25PQ908	25PQ909	25PQ910	25PQ911
QIS 25279	Gamma Spec.	-	Bq/kg	*Ra-226 (U-238)	12 ± 1	6 ± 1	8 ± 1	190 ± 20
QIS 25279	Gamma Spec.	-	Bq/kg	*Ra-224 (Th-232)	16 ± 2	< 3	8 ± 3	750 ± 70
QIS 25279	Gamma Spec.	-	Bq/kg	K-40	< 10	< 10	13 ± 9	80 ± 10
			µGy/h	dAKR	0.015 ± 0.002	0.005 ± 0.002	0.009 ± 0.002	0.530 ± 0.040

* Radionuclide activity concentration determined from progeny:

- The activity of Ra-226 can be determined by measuring the activities of its progeny, Pb-214 and Bi-214. Under conditions of secular equilibrium, the activity of U-238 is equal to the activity of Ra-226.
- The activity of Ra-224 can be determined by measuring the activities of its progeny, Pb-212, Bi-212, and Tl-208. Under conditions of secular equilibrium, the activity of Th-232 is equal to the activity of Ra-224.

^ To ensure consistency with calibration geometry, pulverised solid sample were combined with polyethylene filler to achieve optimal matrix density to match the mass of the reference standard geometry.

This report overrides all previous reports. The results relate solely to the sample/s as received and are limited to the specific tests undertaken as listed on the report. The results of this report are confidential and are not to be used or disclosed to any other person or used for any other purpose, whether directly or indirectly, unless that use is disclosed or the purpose is expressly authorised in writing by Queensland Health and the named recipient on this report. To the fullest extent permitted by law, Queensland Health will not be liable for any loss or claim (including legal costs calculated on an indemnity basis) which arise because of (a) problems related to the merchantability, fitness or quality of the sample/s, or (b) any negligent or unlawful act or omissions by Queensland Health that is connected with any activities or services provided by Queensland Health under this agreement (including the timing and/or method under which the sample/s were taken, stored or transported).

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CERTIFICATE OF ANALYSIS
25PQ916916

25PQ904-

Client Reference					#3_5.5 M	#3_6.5 M	#3_7.5 M	RUN OFF_# 1	RUN OFF_# 2
Sample Type					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Sample Description					-	-	-	-	-
Sampling Time / Date					-	-	-	-	-
Preparation Date					29/05/2026	28/05/2026	28/05/2026	28/05/2026	28/05/2026
Analysis Date					19/06/2026	18/06/2026	18/06/2026	18/06/2026	18/06/2026
Detector					S6a	S3a	S5a	S6a	S7
Sample Density (g/cc)					1.56	1.56	1.56	1.56	1.56
*Sample in analysed matrix by mass (%)					87.2	89.5	88.3	94.1	94.7
Method	Analysis Description	Comparison Levels	Units	Radionuclide	25PQ912	25PQ913	25PQ914	25PQ915	25PQ916
QIS 25279	Gamma Spec.	-	Bq/kg	*Ra-226 (U-238)	120 ± 10	57 ± 5	200 ± 20	51 ± 6	41 ± 4
QIS 25279	Gamma Spec.	-	Bq/kg	*Ra-224 (Th-232)	76 ± 8	35 ± 9	180 ± 20	80 ± 10	48 ± 5
QIS 25279	Gamma Spec.	-	Bq/kg	K-40	50 ± 20	150 ± 30	80 ± 20	140 ± 20	200 ± 30
			µGy/h	dAKR	0.102 ± 0.008	0.053 ± 0.006	0.200 ± 0.010	0.077 ± 0.007	0.054 ± 0.004

* Radionuclide activity concentration determined from progeny:

- The activity of Ra-226 can be determined by measuring the activities of its progeny, Pb-214 and Bi-214. Under conditions of secular equilibrium, the activity of U-238 is equal to the activity of Ra-226.
 - The activity of Ra-224 can be determined by measuring the activities of its progeny, Pb-212, Bi-212, and Tl-208. Under conditions of secular equilibrium, the activity of Th-232 is equal to the activity of Ra-224.
- * To ensure consistency with calibration geometry, pulverised solid sample were combined with polyethylene filler to achieve optimal matrix density to match the mass of the reference standard geometry.

This report overrides all previous reports. The results relate solely to the sample/s as received and are limited to the specific tests undertaken as listed on the report. The results of this report are confidential and are not to be used or disclosed to any other person or used for any other purpose, whether directly or indirectly, unless that use is disclosed on the purpose is expressly authorised in writing by Queensland Health and the named recipient on this report. To the fullest extent permitted by law, Queensland Health will not be liable for any loss or claim (including legal costs calculated on an indemnity basis) which arise because of (a) problems related to the merchantability, fitness or quality of the sample/s, or (b) any negligent or unlawful act or omissions by Queensland Health that is connected with any activities or services provided by Queensland Health under this agreement (including the timing and/or method under which the sample/s were taken, stored or transported).

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APPENDIX 8 - DETAILED SITE RADIATION INVESTIGATION REPORT & REMEDIATION ACTION PLAN - CARDO



SOUTH KINGSCLIFF DEVELOPMENTS PTY LTD



A village life by the sea

DETAILED SITE RADIATION INVESTIGATION REPORT & REMEDIATION ACTION PLAN SALT, SOUTH KINGSCLIFF

**AUGUST 2002
JOB NO. 7083/01-05**

CLIENT	South Kingscliff Developments Pty Ltd		Job No. 7083/01-05
DOCUMENT NAME	Detailed Site Radiation Investigation Report & Remediation Action Plan SALT – South Kingscliff		
Preliminary	☐	Author	S. Groth
Draft	☐	Signature	
Draft Final	☐	Date	
Final	☐	Reviewer	T. Johnson
Superseded	☐	Signature	
Other (Specify)	☐	Date	

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DETAILED SITE RADIATION INVESTIGATION REPORT & REMEDIATION ACTION PLAN, KINGSCLIFF SOUTH, NSW

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- 1 Site Layout/Sample Locations
- 2 Contamination Isopach Plan
- 3 Past Aerial Photographs
- 4 Queensland Department of Health Radiation Investigation Reports
- 5 Remediation Excavation Plan
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DETAILED SITE RADIATION INVESTIGATION REPORT & REMEDIATION ACTION PLAN, KINGSCLIFF SOUTH, NSW

1.0 INTRODUCTION

South Kingscliff Developments Pty Ltd is the proponent for the SALT resort and associated urban development project in Tweed Shire. Cardno MBK has been commissioned by South Kingscliff Developments to undertake a site contamination assessment over the subject site, particularly in respect of radioactive residues from previous sand mining and mineral processing activities. The investigation has been carried out to determine the following:

- The extent and level of soil contamination;
- Potential effects of radioactive contaminants on public health and the environment;
- Establishment of a suitable remediation/management strategy.

All investigations have been 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 surface and 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 investigation is located in the northern section of the coastal zone between Kingscliff and Cabarita in Tweed Shire. The site lies approximately two kilometres north of the recently completed Northern Precinct of the Casuarina Beach Development, and is presently undeveloped. In its developed form, the site will provide resort-style accommodation for tourists, as well as permanent residential accommodation.

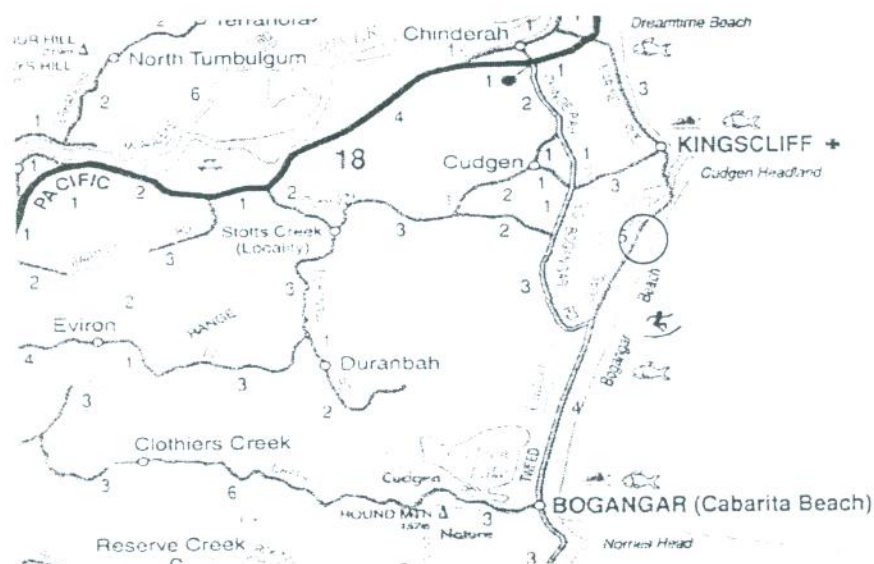


Figure 2.1 Locality map with site location circled

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 currently undeveloped, although it has been subject to major disturbance in the past as a result of mineral sand mining activities. While the rehabilitated vegetation on the site consists primarily of Bitou bush, *Casuarina sp.* and *Banksia sp.*, it is important to note that the coverage is quite sparse, and that ground cover is non-existent in many areas.

Topographically, the site is part of a narrow peninsula, and is bounded by the Pacific Ocean on the east and Cudgen Creek to the west. The maximum existing ground level is about 10.0 m AHD.

A summary of the features of the site is presented in the detailed layout and recent aerial photograph in Appendix 1.

3.0 SITE HISTORY

Based on interviews with former mineral sand mining operators, desktop searches and historic photographs of the area, it is apparent that the site has been subject to extensive mineral sand mining activities in the past.

These activities were conducted between 1954 and 1976 (refer to past aerial photograph taken in 1971 presented in Appendix 3). Upon the cessation of mining disturbance, the area was rehabilitated by the planting of Bitou bush, an exotic species imported from South Africa primarily for stabilisation purposes.

Mineral sands were excavated by hydraulic dredge, and partially processed on site before being trucked away for final separation. Following extraction of rutile and zirconium from the sand, residual material was pumped back into the dredge pits on site. There is anecdotal evidence from a number of people, including former workers, that the south-western portion of this site was used for this purpose. This information is supported by historical aerial photographs of the area, which clearly identify the dry mill and disposal area in operation during 1971 (refer Appendix 3).

The primary constituent in the process residue is ilmenite, which is a black mineral sand which was considered of little value at the time. Ilmenite is not particularly radioactive. However, on this site, as on most other sites where sand mineral processing took place, the ilmenite is contaminated with a small amount of monazite. Monazite is a creamy coloured sand which is highly radioactive in its pure form. The net result of this contamination is that a significant volume of the residue material exhibits levels of radioactivity which are above normal background values.

4.0 SITE INSPECTION

Several site inspections were conducted between February and July 2002 by Mr Simon Groth, Environmental Scientist of Cardno MBK Gold Coast, and Mr Ross Kleinschmidt, Senior Health Physicist – Queensland Health Scientific Services, to examine:

- The horizontal and vertical extent of mineral residue deposit identified in on-site and its radiation levels;
- Identify any other areas within the development which may have been effected by tailings residues and determine radiation levels, and
- The possible remediation/management options.

4.1 Topography and Vegetation

The topography in the local area consists of relatively flat land densely vegetated with Bitou Bush, *Casuarina sp.* and *Banksia sp.* Due to the dense nature of the scrub on site, a series of transects have been cleared every 50 metres to allow site investigations to proceed efficiently.

4.2 Geology

The eastern and central parts of the site are underlain by beach and dune sand, with the extreme western part of the site underlain by river gravels, alluvium, sand and clay. Site investigations and past aerial photography confirms that sand mining (for rutile) has been undertaken in the area and that areas in the south west of the site were used to deposit ilmenite and monazite residues in relatively large quantities.

5.0 RADIATION SURVEY METHODOLOGY

5.1 Preliminary Radiation Site Investigation

The preliminary radiation investigation involved applying a 50 metre patterned grid over the proposed development site (Grid pattern and Survey points are illustrated in Appendix 1). In areas where the existing vegetation was dense enough to interfere with the investigation, transect paths were cut using a modified mulcher to facilitate access. Surface radiation levels were measured using a hand held SE International Radiation Alert Monitor 4 radiation detector. Field investigations involved monitoring radiation levels whilst walking transects and recording surface radiation levels every 25 metres. Areas that displayed elevated radiation levels above 0.2 $\mu\text{Sv/hr}$ were also recorded every 10 metres to track the horizontal extent of the elevated radioactive area. All monitoring points were recorded with corresponding GPS coordinates for future reference.

Any area that recorded a gamma radiation level above 0.3 $\mu\text{Gy/h}$ was earmarked for further investigation by the Queensland Department of Health Scientific Services to validate the preliminary reading. The radiation validation survey was conducted using a calibrated Bicron Micro Sievert survey monitor to measure surface gamma radiation levels.

The dominant form of radiation from low-level wastes of this type is gamma radiation, measured in units of $\mu\text{Gy/hr}$ (micro-Grays per hour) and $\mu\text{Sv/hr}$ (micro-Seiverts per hour), 1Sievert (Sv) = 1Grey (Gy).

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. The relevant criteria 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 $\mu\text{Gy h}^{-1}$ (or 70 $\mu\text{R h}^{-1}$) 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 $\mu\text{Gy h}^{-1}$ (100 $\mu\text{R h}^{-1}$) 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- $\mu\text{Gy h}^{-1}$ (250 $\mu\text{R h}^{-1}$) 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- $\mu\text{Gy h}^{-1}$ (10 $\mu\text{R h}^{-1}$).

These Action Level Criteria were used in the assessment of the site and development of the RAP.

5.2 Detailed Radiation Site Investigation

The 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 36 boreholes and inserting a 90mm PVC pipe into the newly constructed bores to conduct Down Hole Logging surveys. The location of the bores were recorded by handheld GPS units and confirmed by detailed site survey. 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.

Borehole locations were selected by areas that exhibited elevated surface radiation readings in the preliminary investigation. A radiation activity count meter was lowered into the bore and minute-long radiation counts were taken at 500 mm intervals to a depth of 6 metres from the surface or where groundwater was intercepted, whichever was the shallower.

The raw gamma radiation counts were then processed by the Queensland Department of Health Scientific Services, to produce derived gamma radiation levels for buried material redeposited on the surface. That is, if the material at depth was brought to the surface and deposited in a layer 200 mm thick, the calculated values are the approximate radiation levels which would be recorded 1 m above the surface.

Bore hole locations and results of the radiation surveys conducted onsite are presented in Appendix 2.

6.0 INVESTIGATION RESULTS

6.1 Summary Of Preliminary Site Investigation Results

In-Situ surface level radioactivity results ranged from 0.1 $\mu\text{Sv/hr}$ to 3.0 $\mu\text{Sv/hr}$. The total surface area on-site above 0.35 $\mu\text{Sv/hr}$ was approximately 54,000 m^2 . Surface radiation results are summarised in Appendix 2, and show surface radiation levels encountered on site.

6.2 Detailed Site Investigation Results

The Detailed Site Investigation bore logging results indicate elevated radioactive material over 0.35 $\mu\text{Gy/hr}$ at a variety of depths ranging from surface level to 5.5 metres. The total volume of radioactive sands above 0.35 $\mu\text{Gy/hr}$ is estimated to be approximately 178,000 m^3 . These results are presented Appendix 2 of this report.

6.3 Radioactive Substance Classification

Uranium and thorium activity concentrations were determined by sampling material taken from visibly stained areas in the nearby Casuarina Beach Development. This sand residue material is considered to be entirely consistent with material likely to be found on the SALT site. Samples were analysed by Queensland Health Scientist Services, with the results summarised in Table 6.1 (Refer to Queensland Health Scientist Services Report in Appendix 4). These results show that sand mining residuals in the area have radiation levels below 100 Becquerels per gram (Bq/g).

Consequently, these materials do not constitute a Hazardous Waste in the context of Section 3.5 Classification of Waste Containing Radioactive Substances of the Radiation Control Regulations 1993.



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7083/1-5

Table 6.2: Uranium and Thorium Activity Concentrations in Soil Samples

Sample Identification	Description	Uranium 238(1) Activity (Bq/kg)	Thorium 232(2) Activity (Bq/kg)	Bq/kg To Bq/g conversion	Bq/kg To Bq/g conversion	Uranium 238(1) decay progeny multiplication factor	Thorium 232(2) decay progeny multiplication factor	Uranium 238(1) result x 14	Thorium 232(2) result x 10	Combined Uranium 238(1) and Thorium 232(2) Total	Radiation Control Regulations 1993 - Hazardous Waste Threshold (Bq/g)
				Uranium 238(1) Activity (Bq/g)	Thorium 232(2) Activity (Bq/g)						
Sample 1	0mm-200mm	900+-100	2400+-200	0.9+-0.1	2.4+-0.2	14	10	12.6	24	36.6	100
Sample 2	50mm-200mm	1000+-100	2500+-200	1.0+-0.10	2.5+-0.2	14	10	14	25	39	100

8.0 REMEDIATION STRATEGIES

The remediation strategy developed for the contaminated areas is required to achieve the following aims:

- To remove any risk of potential long term human exposure to radioactive sand residues.
- To set suitable remediation goals based on future land use of specific areas and associated likely occupancy/exposure.

In order to achieve these aims, a combination of remediation strategies were considered for specific areas, based upon the anticipated final land use of each area, the potential for human exposure, and the likely occupancy rate. The possible remediation strategies are summarised as follows:

- Excavation and off-site disposal
- Excavation and burial at depth on-site
- Excavation and on-site treatment and processing
- Excavation, mixing with clean material, then burial at depth on-site
- Capping radioactive material in-situ with clean fill

Following detailed assessment of likely cost and approval issues for each alternative, it was determined that only the final two options are likely to provide practical solutions. Each are proposed to be used on this site, depending upon the specifics of the location.

8.1 Remediation of Proposed Residential Areas

This operation would involve excavation of the radioactive sand, for mixing with clean sand sourced elsewhere from the site. The final mixed material will display radiation levels of no greater than 0.35 $\mu\text{Gy/hr}$, and will be used as subgrade material in areas on-site which require filling to meet final design levels. These filled areas will be finally capped with 1.0 metre of clean sand.

The placed material at depth will exhibit radiation levels of less than half of the allowable surface value for residential areas, and will have no adverse impact if excavated or otherwise disturbed during the construction of swimming pools or other structures.

8.2 Remediation of Parks, SEPP 14 Buffer Area and Roads

This operation would involve replacement of the top 1.0 metre of radioactive sand with clean sand, with the excavated material subjected to mixing and disposal as deep fill. Areas capped in this way will display radiation levels no higher than uncontaminated background.

Appropriate environmental management measures have been developed and will be implemented to mitigate potential migration by wind and water erosion and an Occupational Health and Safety plan specific to the handling of low level radioactive materials. A copy of the Occupational Health and Safety Guide for Sites Contaminated with Radiologically Enhanced Mineral Sand Products is provided in Appendix 4. Validation of the remediation works conducted would be carried out by recording surface radiation levels of the remediated area and a report submitted to Council and NSW EPA Radiation Control for sign off on the suitability of the prescribed areas for their future uses.

9.0 REMEDIATION ACTION PLAN

The remediation of radioactive materials on site shall be handled using two methods described below.

9.1 Remediation of Proposed Residential Areas

The following procedure will be adopted in areas designated for residential purposes:

- All material with radioactivity in excess of 0.35 $\mu\text{Gy/hr}$ will be excavated.
- The radioactive material will be mixed with clean sand, generally in the ratio of 1 to 1,
- If material fails the remediation target it shall be excavated and mixed with additional clean material until the remediation target is achieved.
- Areas filled with mixed material will be capped with one metre of clean fill. Areas where radioactive material was removed and treated will be validated before being filled and compacted with clean validated material sourced on site. A Remediation Excavation Plans are provided in Appendix 5.

9.2 Remediation of Proposed Parks, Buffer Areas and Roads

The following procedure will be adopted in open space areas including parks, buffer area and roads:

- Once final design level has been achieved, the uppermost 1.0 m of material shall be excavated, and replaced with clean sand.
- The excavated material will be mixed with clean sand, such that the final radiation level is less than 0.35 $\mu\text{Gy/hr}$. It will then be placed as fill, with the radiation level of each 300 mm layer validated by site monitoring prior to placement of the next layer.
- If material fails the remediation target it shall be excavated and mixed with additional clean material until the remediation target is achieved.
- Capping is expected to reduce surface radiation levels to natural background levels. These areas shall be validated to ensure that surface radiation levels are below 0.35 $\mu\text{Gy/hr}$. Remediation Excavation Plans are provided in Appendix 5.

Remediation of areas and areas receiving treated fill are presented in Appendix 5.

10.0 CONCLUSIONS

The results of the preliminary and detailed site investigation have adequately defined an area proposed for development as have radioactive sand mining residues above the NSW Department of Health - Radiation Branch action level thresholds for the clean up and disposal of radioactive residues from commercial operations involving mineral sands.

The detailed investigation has quantified the volume requiring remediation and/or management as 178,000 m³. In areas where proposed residential development is to take place, material displaying elevated radiation levels shall be removed and replaced with treated and clean sand. Areas where parks and roadways are proposed will be capped with 1.0 metre of clean sand to reduce surface radiation levels to near background levels. The volume of materials to be removed and treated by way of dilution is approximately 133,000m³. The remaining material shall be left in-situ and capped with 1.0 metre of clean material.

Detailed site investigation and sample results show that sand mining residuals in the area have radiation levels below 100 Becquerels per gram (Bq/g). These materials therefore do not constitute a Hazardous Waste.

It is considered that the detailed investigation of the development site is sufficient that the recommended remediation strategy summarised in section 8.0 be submitted for approval by the New South Wales EPA – Radiation Control and Tweed Shire Council.

South Kingscliff Developments Pty Ltd
7083/1-5

APPENDIX 1

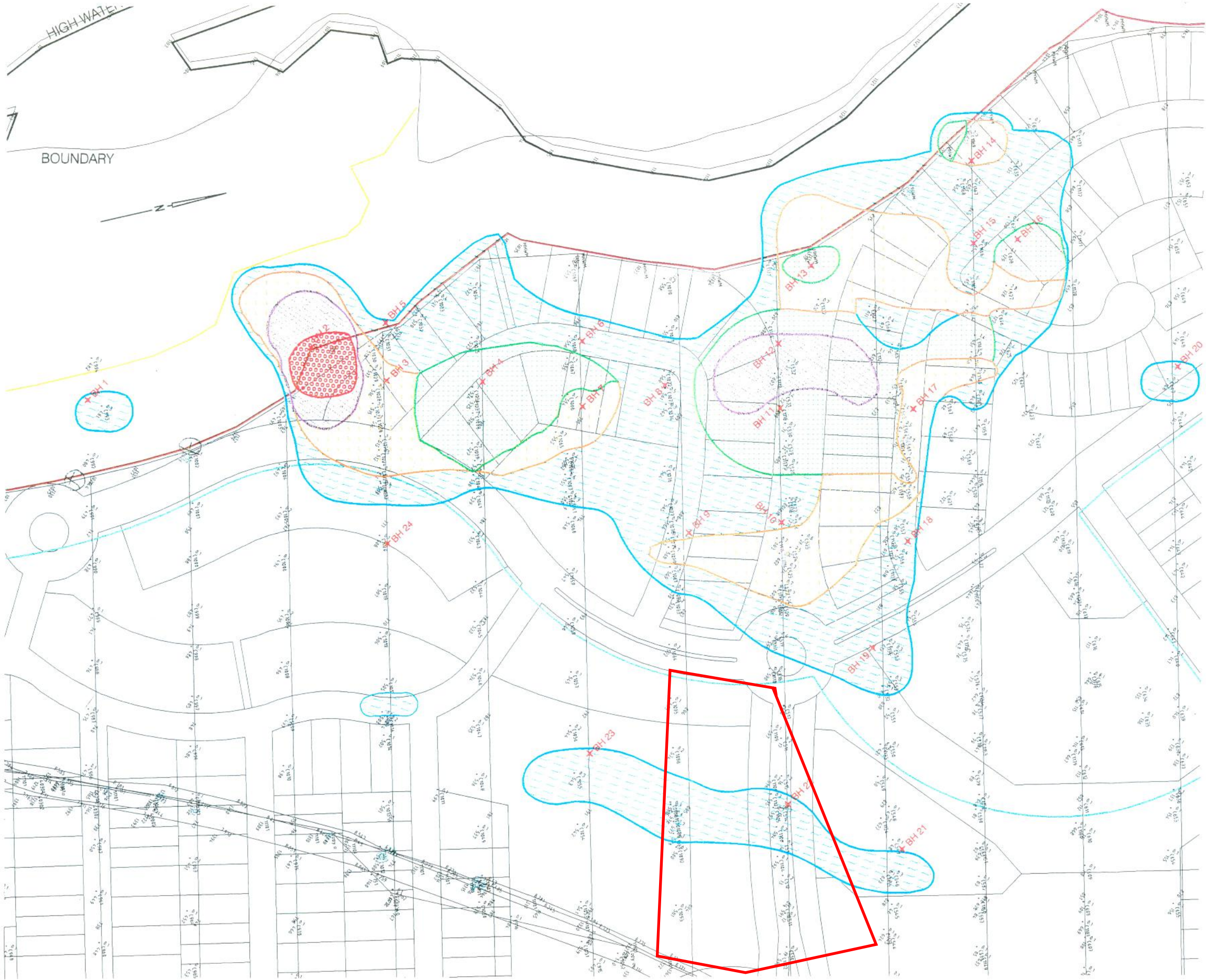
SITE LAYOUT/SITE INVESTGATION PLAN



South Kingscliff Developments Pty Ltd
7083/1-5

APPENDIX 2

CONTAMINATION ISOPACH PLANS



LEGEND

	0.3 - 0.7 uGy/hr
	0.7 - 1.0 uGy/hr
	1.0 - 1.5 uGy/hr
	1.5 - 2.5 uGy/hr
	2.5 - 3.5 uGy/hr
	BORE HOLE

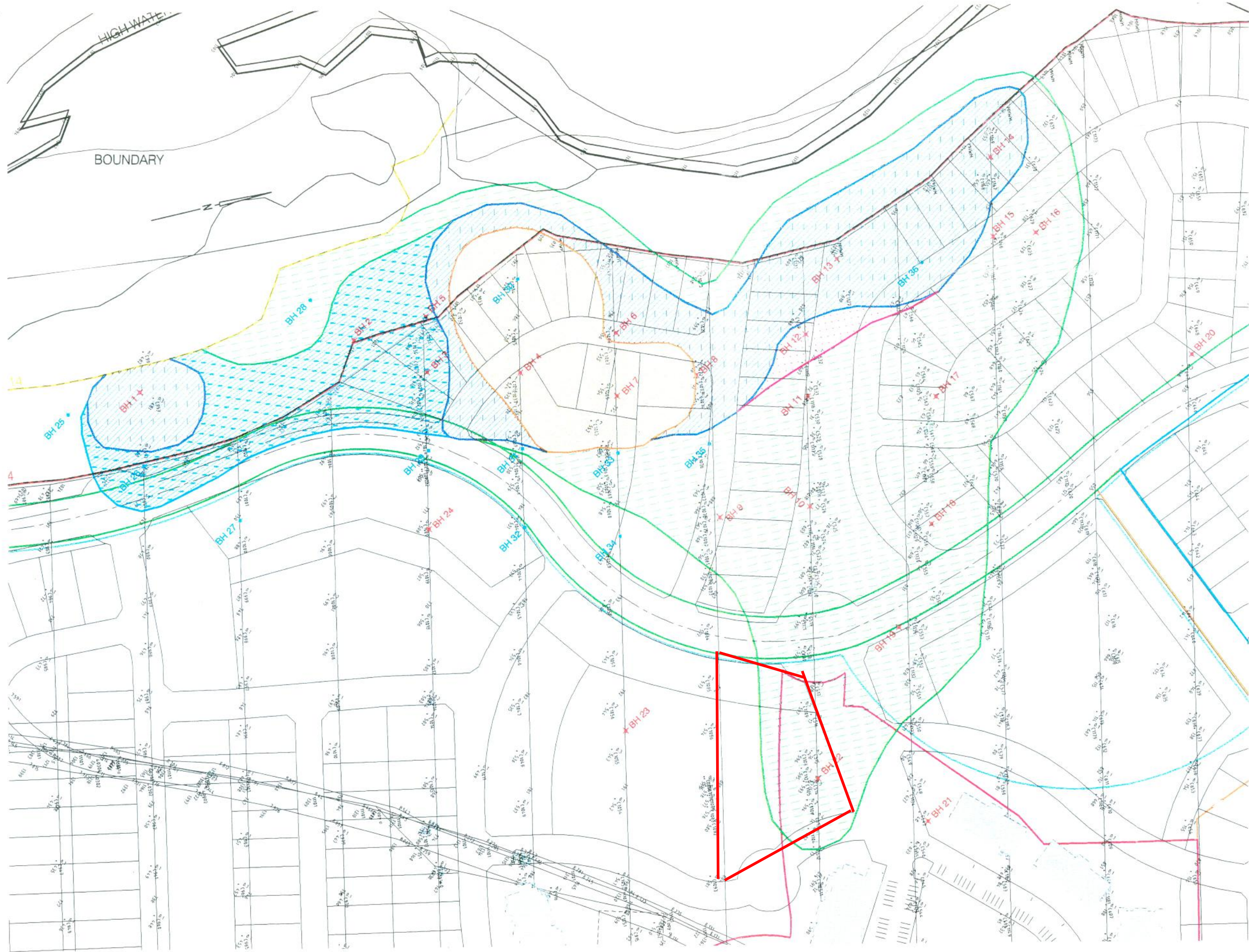


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CLIENT SALT	
DESCRIPTION KINGSCLIFF SOUTH PROJECT CONTAMINATION INVESTIGATION	
SCALE - 1:1000	A1
DATE - May 2007	Rev 0
JOB No.	7083/1-5

SK No. 4 (29/06/02)
CONTAMINATION INVESTIGATION
SURFACE RADIATION LEVELS



LEGEND

- BH 23 EXISTING BORE HOLE
- BH 33 BORE HOLE
- 1.0
- 2.0
- 3.0
- 3.5
- 5.0

CO-ORDINATE TABLE

BORE HOLE No.	EASTINGS	NORTHINGS
BH1	356168.512	1870399.363
BH2	356162.182	1870515.667
BH3	356185.796	1870550.636
BH4	356195.147	1870598.562
BH5	356156.853	1870555.112
BH6	356183.701	1870651.691
BH7	356216.445	1870646.330
BH8	356213.245	1870688.984
BH9	356289.497	1870688.104
BH10	356292.433	1870735.545
BH11	356234.933	1870744.564
BH12	356202.414	1870749.204
BH13	356166.453	1870772.194
BH14	356128.675	1870861.026
BH15	356169.965	1870855.131
BH16	356171.933	1870877.374
BH17	356247.412	1870811.012
BH18	356313.250	1870796.952
BH19	356363.945	1870770.266
BH20	356249.769	1870946.862
BH21	356467.420	1870767.711
BH22	356434.784	1870714.545
BH23	356391.665	1870620.042
BH24	356267.751	1870537.090
BH25	356173.006	1870359.873
BH26	356207.324	1870394.456
BH27	356205.472	1870440.568
BH28	356137.097	1870496.007
BH29	356226.648	1870543.954
BH30	356146.474	1870605.771
BH31	356234.839	1870592.465
BH32	356276.060	1870586.404
BH33	356246.147	1870641.430
BH34	356289.855	1870634.898
BH35	356250.183	1870689.222
BH36	356176.480	1870815.998

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

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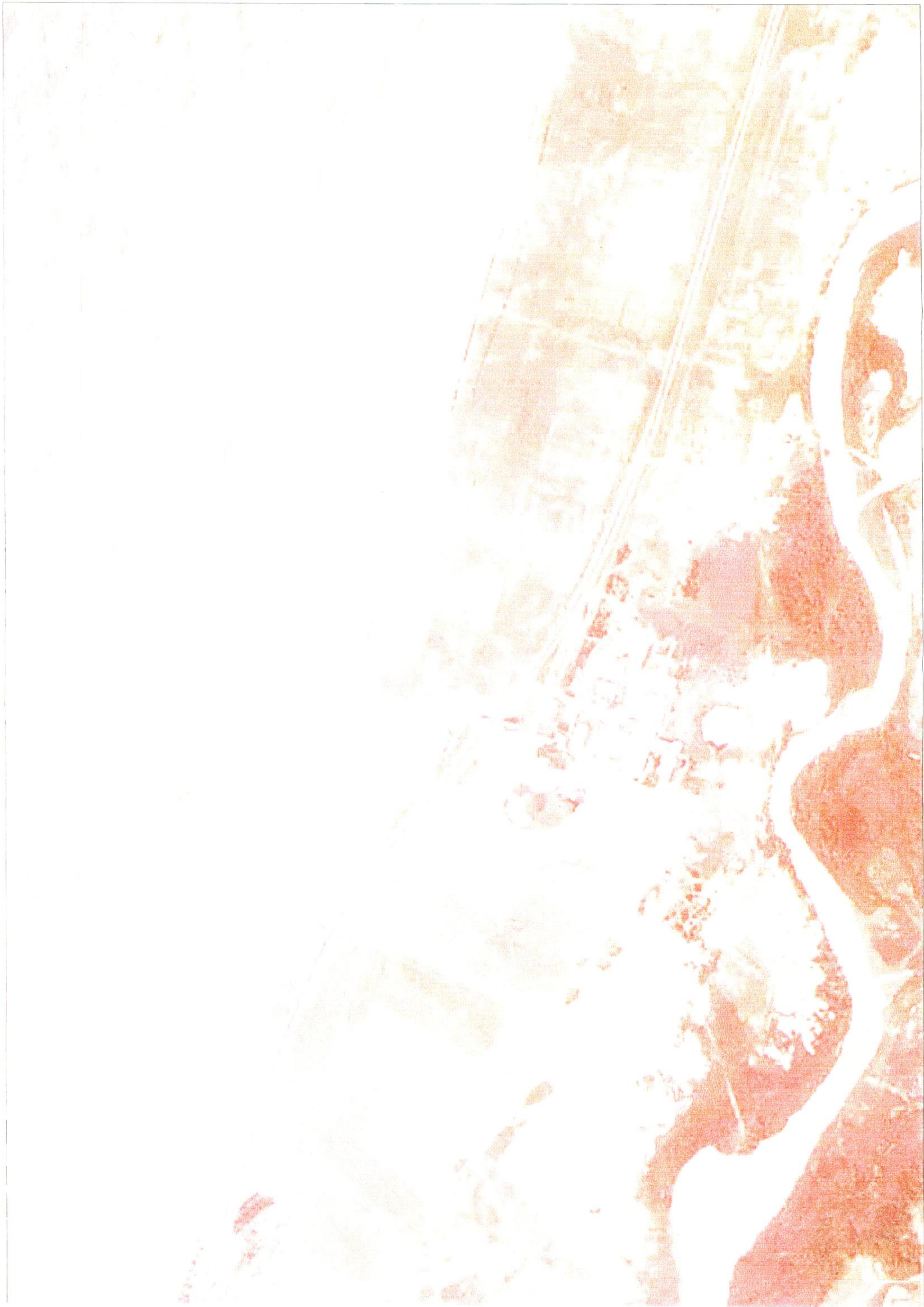
CLIENT SALT	SCALE - 1:1000 A1
DESCRIPTION KINGSCLIFF SOUTH PROJECT CONTAMINATION INVESTIGATION	DATE - June 2002 Rev 0
JOB No. 7083/1-5	

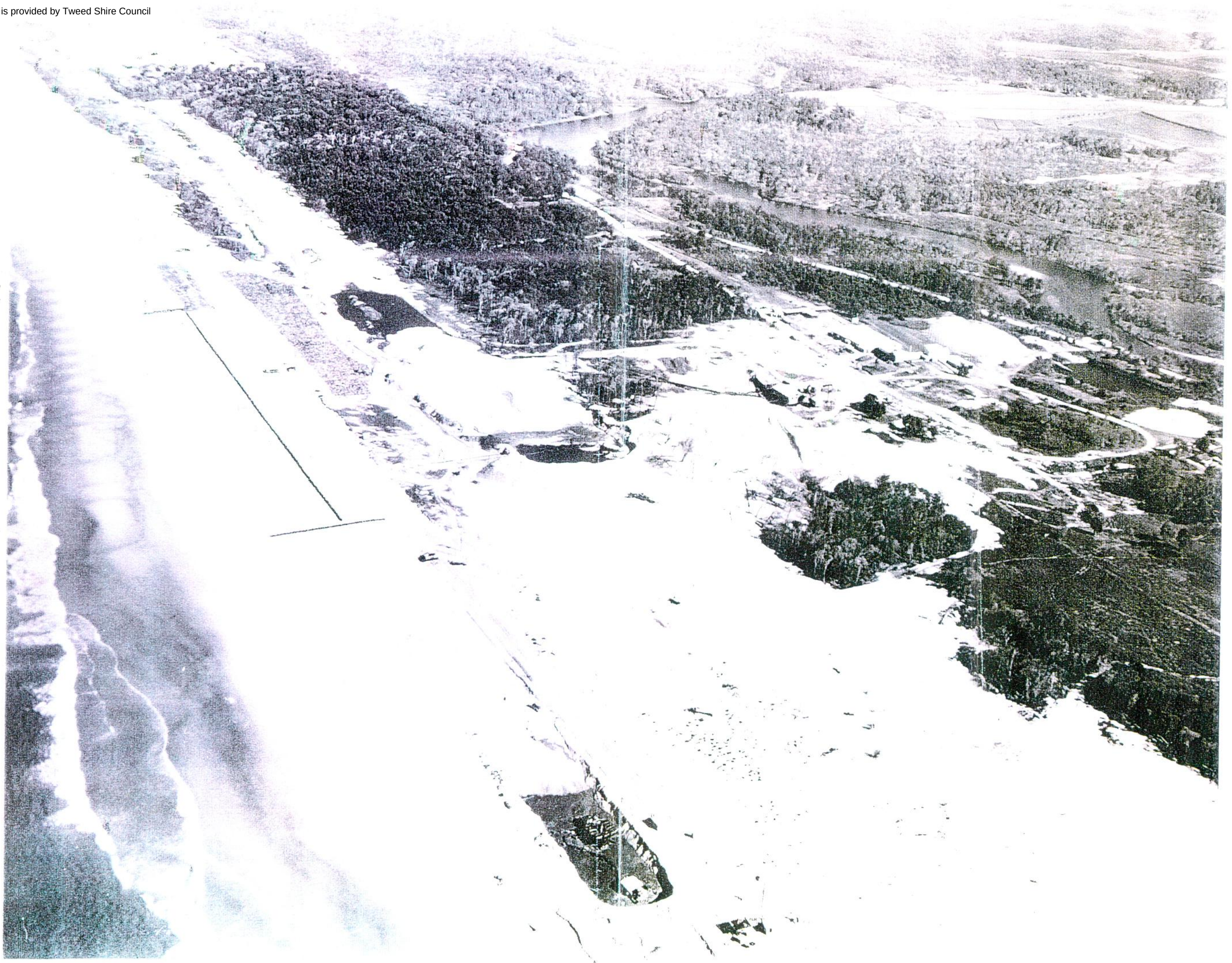
SK No. 9 (22/07/02)
DETAILED DEPTH ASSESMENT

South Kingscliff Developments Pty Ltd
7083/1-5

APPENDIX 3

PAST AERIAL PHOTOGRAPHS





South Kingscliff Developments Pty Ltd
7083/1-5

APPENDIX 4

QUEENSLAND DEPARTMENT OF HEALTH RADIATION INVESTIGATION REPORTS

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

Reference: Kingscliff South Development

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

SUBSURFACE RADIATION INVESTIGATION REPORT No. 01PQ385

Kingscliff South Development
TWEED SHIRE NSW

Date Request Received: 25 January 2002

Report Description: Subsurface Radiation Investigation, Kingscliff South Development,
Kingscliff, NSW.

1.0 SCOPE OF WORK

A subsurface radiation investigation of the Kingscliff South development was conducted to assist in characterisation of the extent of radiological contaminants.

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 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.

2.1.1 Land Use Application - Residential

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.

2.1.2 Site works

Where radiologically enhanced materials are to be excavated and redistributed or removed, all exposure pathways should be considered as contributing to the potential radiation exposure. A workplace occupational health and safety plan should be developed to minimise radiation exposure from these activities.

An occupational health and safety guideline document is appended to this report to assist in minimising radiation exposure during site works.

a) Inhalation

Dust raising activities experienced during excavation and remediation works may provide a radiation exposure pathway.

In addition to particulate inhalation, the release of significant quantities of radon 222 gas trapped in soil pore space may occur during excavation operations. Typical soil gas radon 222 concentrations of 30 - 100 kBq.m⁻³ can be expected from crustal rock and soil with a uranium 238 concentration of 40 Bq.kg⁻¹. Mineral sand materials present at the subject site have uranium 238 concentrations of at least 1000Bq.kg⁻¹ suggesting soil gas radon 222 concentrations of up to 1000kBq.m⁻³. Release of soil gas by disturbing buried material may elevate radon concentrations considerably. In a dusty environment, radioactive decay progeny from the radioactive gas radon, will generally attach to particulates in the air.

b) Ingestion

Radioactive materials may be ingested via the accumulation of particulate material on surfaces. The particulates may then be ingested when eating, smoking or performing other hand to mouth type activities.

c) External exposure

External exposure may result from being in close proximity, for prolonged periods in time, with bulk mineral sand materials. External radiation fields may be increased if excavated material is stockpiled or distributed on the ground surface.

2.2 Subject Area

Mr Allan Burton and Mr Gordon Gee, Queensland Health Scientific Services performed the subsurface logging investigations on 6th, 7th & 13th June 2002.

<i>Description:</i>	Subject Area, Figure 1(as supplied by Cardno MBK)
<i>Assessment Method:</i>	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 5m (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

Bore hole locations were identified by Cardno MBK using the Australian Geolog Data 66 system. All data presented is based on the client supplied location data. Additionally, each borehole location was mapped by QHSS using a handheld GPS (Australian 1966 map datum). Some discrepancy between the two systems was observed, variations are shown in Figure 2a. Figure 2b shows raw data contours (counts per minute) for various depth profiles between ground surface and 5500 mm. Figure 2c shows the bore hole log profiles for activity with depth.

Figure 3 indicates the derived gamma exposure contours for material excavated and deposited in a semi-infinite plane on the ground surface. Material buried at depth that, if distributed on the surface, may give rise to surface gamma radiation activities in the range of $0.2\mu\text{Gy}\cdot\text{h}^{-1}$ to $2.4\mu\text{Gy}\cdot\text{h}^{-1}$. Large quantities of material are present at depth and the extent of the bulk material has not been fully mapped. Surface gamma radiation surveys (Figure 3) have not detected the presence of this buried material indicating that surface survey methods are inadequate in determining the extent of buried deposits.

4.0 CONCLUSIONS

The downhole logging of a number of bores in the subject area, in addition to surface gamma radiation surveys (Cardno MBK) has defined the extent of radiologically enhanced mineral sand material at depths to at least the water table (approx. 6m) for the subject area.

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.

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.

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.

Contour mapping used in generating this report is limited by the frequency and location of boreholes. Spatial anomalies and artifacts may be generated when optimum data sets are not available.

Conversion of raw activity in counts per minute to derived gamma exposure rates on the ground surface may overestimate actual surface exposure rates. Conversion factors are based on homogenous deposits of uranium and thorium based over an infinite volume.

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.

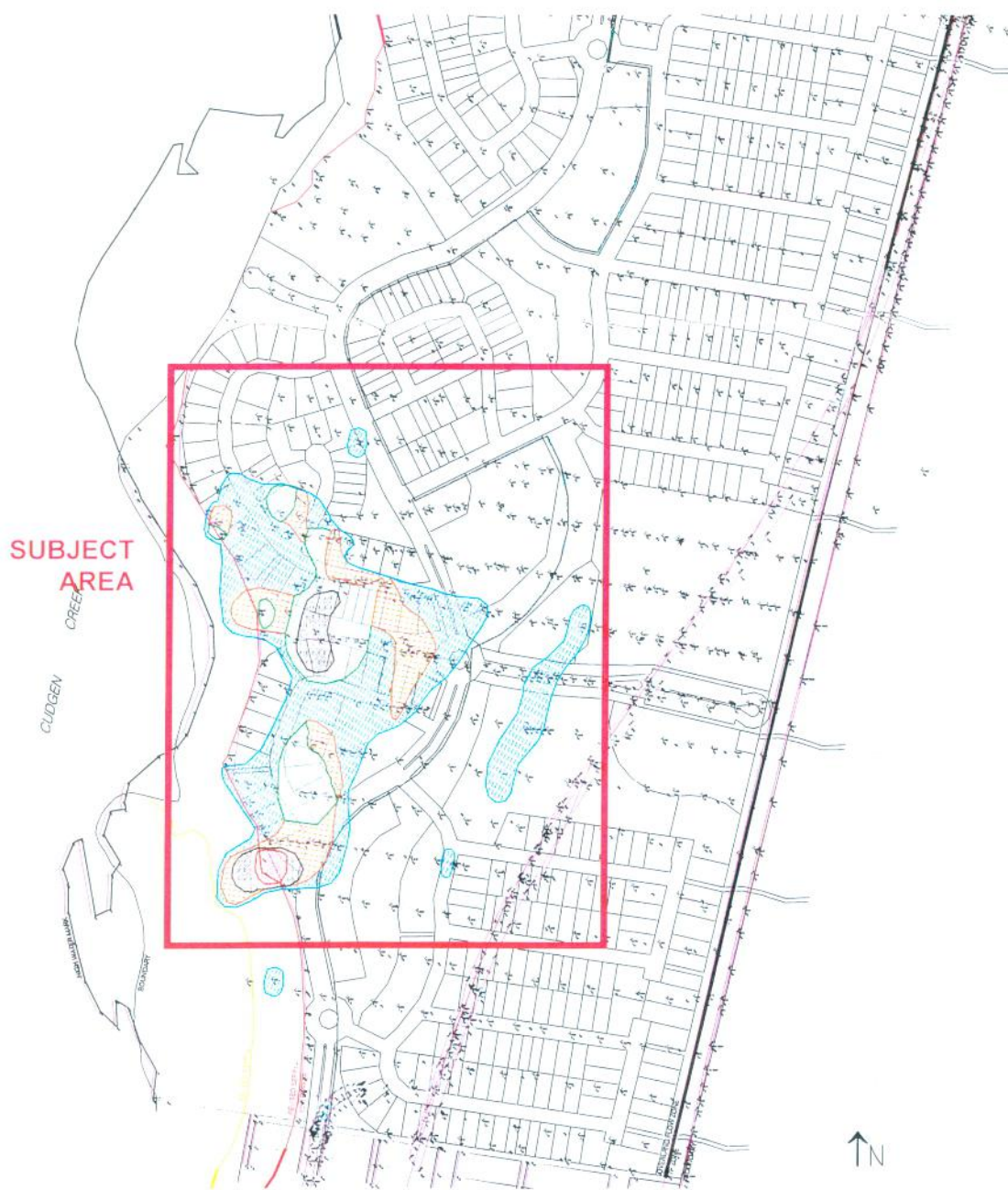
6.0 REFERENCES

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

21 June 2002



COPYRIGHT his drawing shall not e copied or sproduced by any reans without the ritten consent of ueensland Health.	Drawn RK 	Scale A4	 Queensland Government Queensland Health Scientific Services PO Box 594 ARCHERFIELD Q 4108 Phone: 07 3274 9124 Fax: 07 3274 9123 e-mail: Ross_Kleinschmidt@health.qld.gov.au	Project KINGSCLIFF SOUTH PROJECT	Title LOCATION PLAN - RADIATION SURVEY (adapted from DWG 7083/1-5, Cardno MBK)	
	Job/Lab No. 01PQ385	Date 19/06/02		Client CARDNO MBK (GOLD COAST)	Drawing No. FIGURE 1	Rev 1.0
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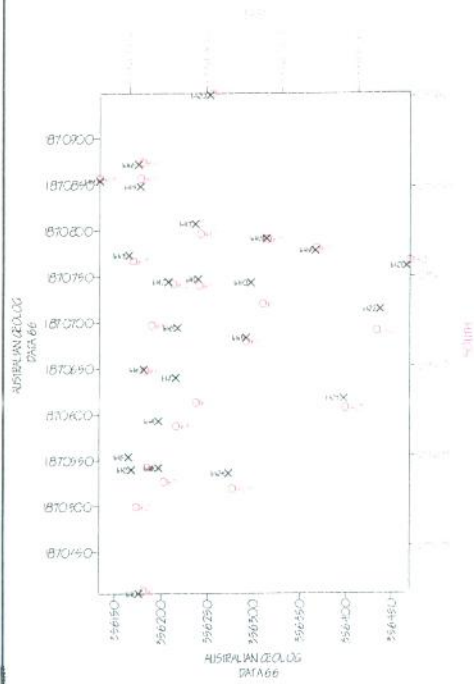


Figure 2a: Discrepancy between Cardno MBK supplied log positions and QHSS GPS log positions.

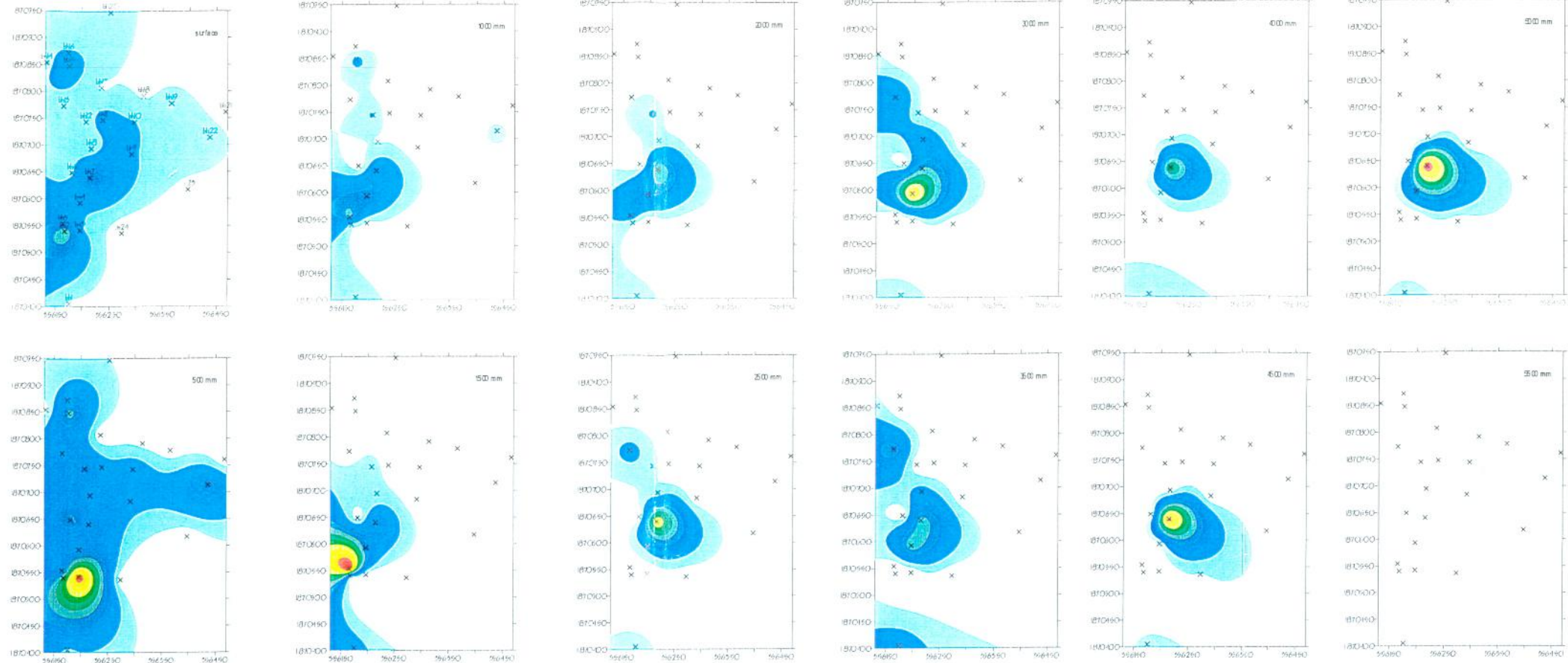


Figure 2b: Raw data contours (counts per minute) for various depth profiles between ground surface and 5500mm.

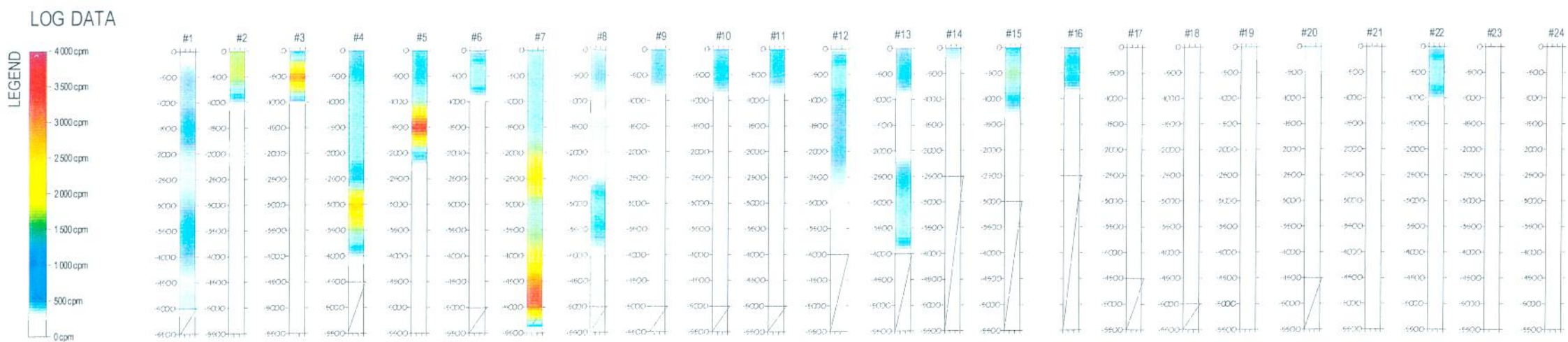
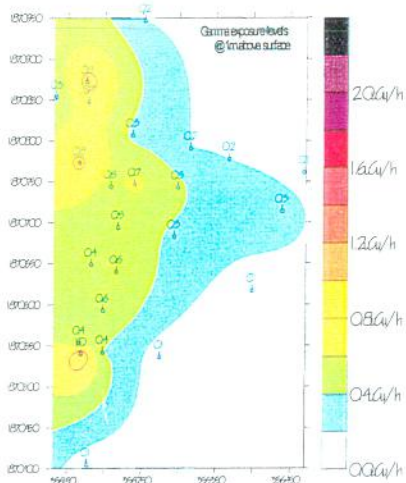
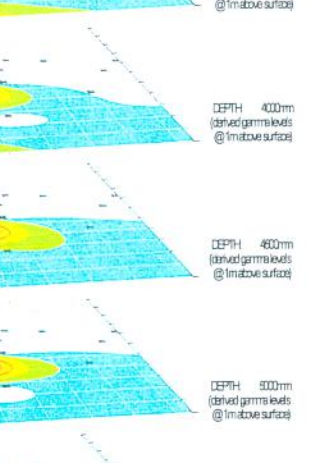
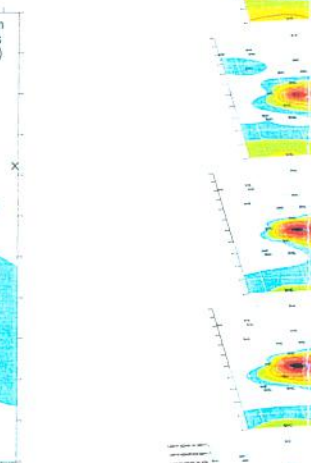
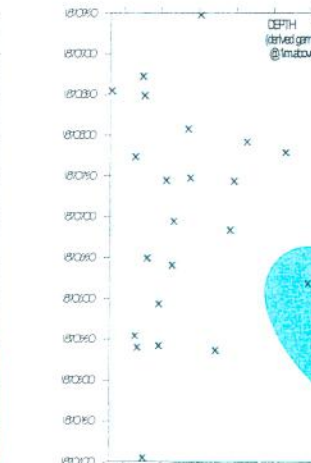
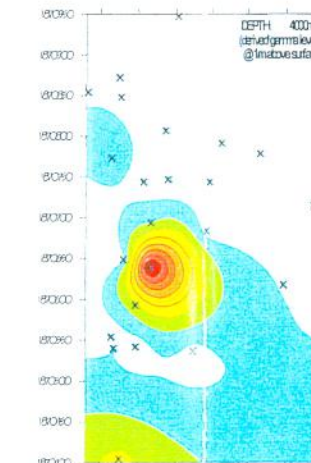
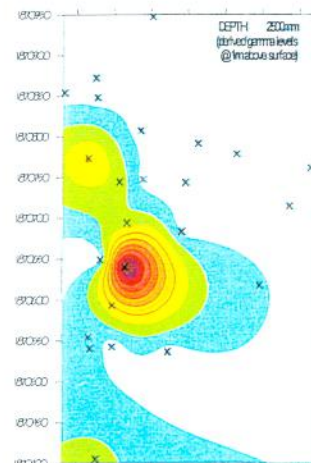
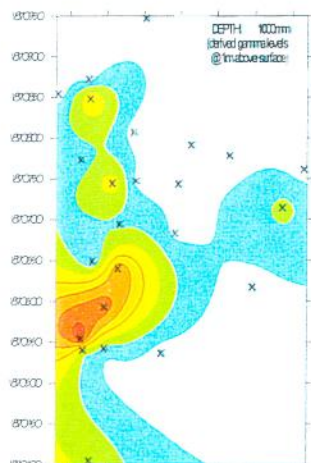
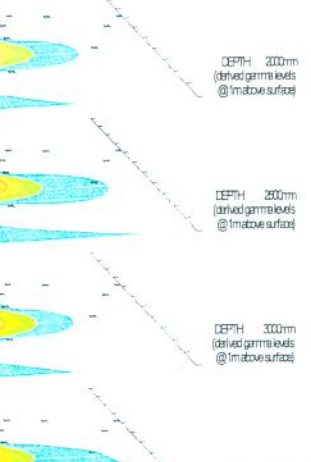
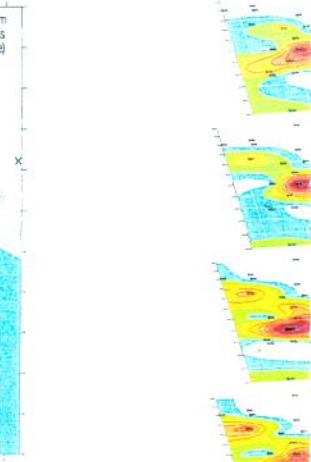
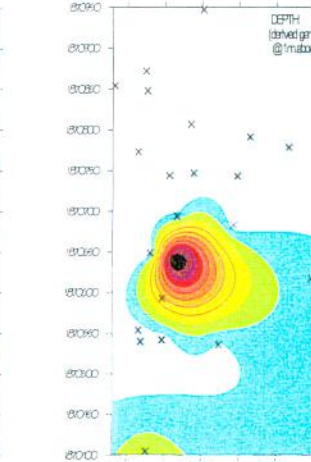
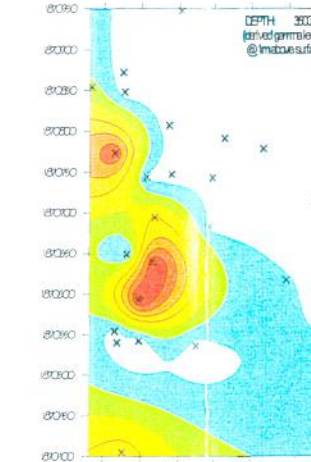
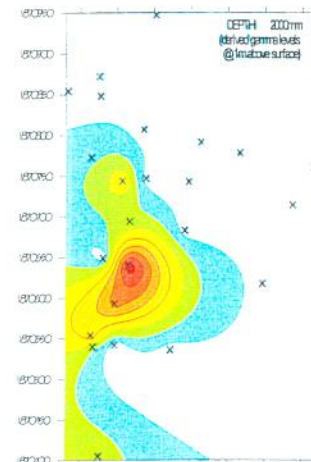
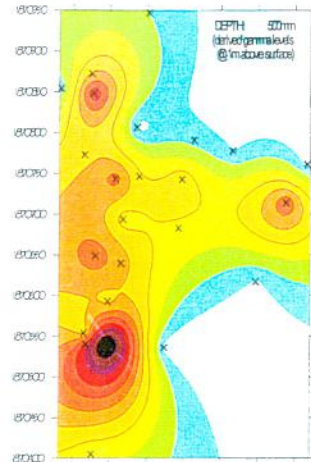
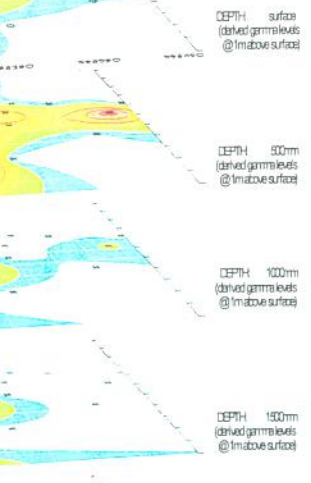
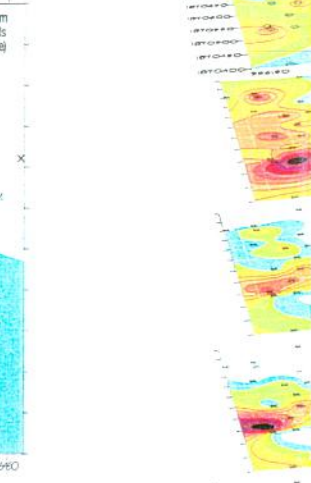
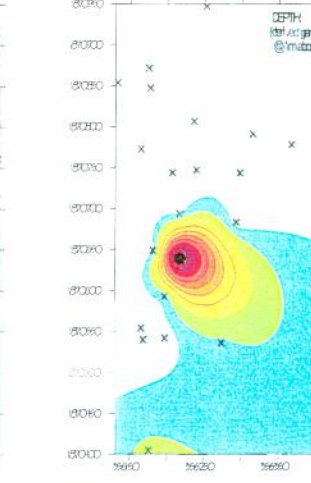
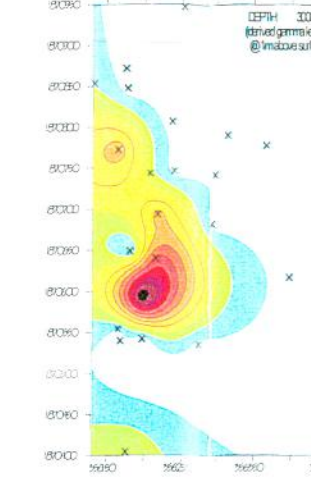
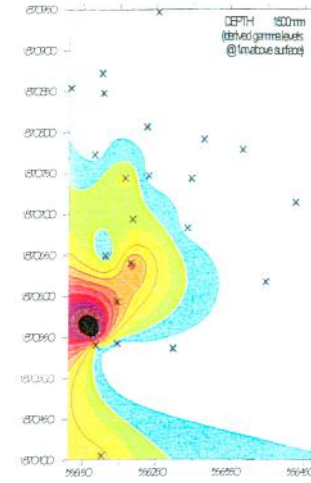
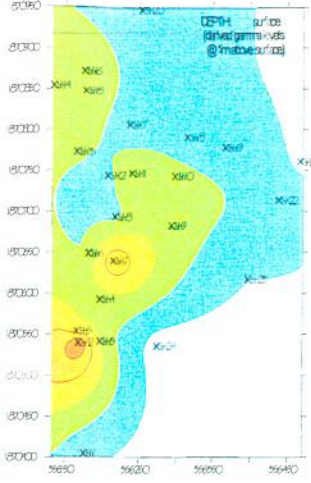


Figure 2c: Bore hole log profiles (counts per minute).

GENERAL NOTES		COPYRIGHT		Drawn	Scale	ABN: 66 329 169 412	Project	Title	
All measurements are in counts per minute unless otherwise indicated. Survey points as supplied by Cardno MBK (Australian Geolog data 66)		This drawing shall not be copied or reproduced by any means without the written consent of Queensland Health.		RK	A3 Do not scale	 Queensland Government Queensland Health Scientific Services PO Box 594 ARCHERFIELD Q 4108 Phone: 07 3274 9124 Fax: 07 3274 9123 e-mail: Ross_Kleinschmidt@health.qld.gov.au	KINGSCLIFF SOUTH PROJECT	DOWNHOLE LOG RESULTS - RAW LOGGING DATA	
Survey conducted by: Allan Burton & Gordon Gee, QHSS Date of survey: 6 th , 7 th & 13 th June 2002 Survey instrument: Downhole log system, Bicon Analyst + 1" dia. NaI detector				Job/Lab No. 01PQ385	Date 19 June 2002			Client CARDNO MBK (GOLD COAST)	
				File C:\01pq385_figure2.doc				Drawing No. FIGURE 2	Rev 1.0



QHSS surface gamma exposure levels measured @ 1m above the ground surface using Bicon microSievert extended range survey meter.



GENERAL NOTES
All measurements are in $\mu\text{Gy}\cdot\text{h}^{-1}$ unless otherwise indicated.
Survey points as supplied by Cardno MBK (Australian Geolog data 66)

Survey conducted by: Allan Burton & Gordon Gee, QHSS
Date of survey: 6th, 7th & 13th June 2002
Survey instrument: Downhole log system, Bicon Analyst + 1" dia. NaI detector

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ABN: 66 329 169 412

**Queensland Government**
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Project KINGSCLIFF SOUTH PROJECT
Client CARDNO MBK (GOLD COAST)

Title DERIVED GAMMA EXPOSURE CONTOURS FOR EXCAVATED MATERIAL	
Drawing No. FIGURE 3	Rev 1.1



Enquiries: Ross Kleinschmidt

Telephone: 07 3274 9124

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

Reference: Kingscliff South Development
Extended data

SUBSURFACE RADIATION INVESTIGATION REPORT No. 02PQ14

Kingscliff South Development
TWEED SHIRE NSW

Date Request Received: 09 July 2002

Report Description: Extended Subsurface Radiation Investigation, Kingscliff South Development, Kingscliff, NSW.

1.0 SCOPE OF WORK

An extended subsurface radiation investigation of the Kingscliff South development was conducted to further define the extent of radiological contaminants present.

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 report 01PQ385.

Queensland Health Scientific Services was commissioned by Cardno MBK (Qld) to perform the extended 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.

2.1.1 Land Use Application - Residential

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.

2.1.2 Site works

Where radiologically enhanced materials are to be excavated and redistributed or removed, all exposure pathways should be considered as contributing to the potential radiation exposure. A workplace occupational health and safety plan should be developed to minimise radiation exposure from these activities.

a) Inhalation

Dust raising activities experienced during excavation and remediation works may provide a radiation exposure pathway.

In addition to particulate inhalation, the release of significant quantities of radon 222 gas trapped in soil pore space may occur during excavation operations. Typical soil gas radon 222 concentrations of 30 - 100 kBq.m⁻³ can be expected from crustal rock and soil with a uranium 238 concentration of 40 Bq.kg⁻¹. Mineral sand materials present at the subject site have uranium 238 concentrations of at least 1000Bq.kg⁻¹ suggesting soil gas radon 222 concentrations of up to 1000kBq.m⁻³. Release of soil gas by disturbing buried material may elevate radon concentrations considerably. In a dusty environment, radioactive decay progeny from the radioactive gas radon, will generally attach to particulates in the air.

b) Ingestion

Radioactive materials may be ingested via the accumulation of particulate material on surfaces. The particulates may then be ingested when eating, smoking or performing other hand to mouth type activities.

c) External exposure

External exposure may result from being in close proximity, for prolonged periods in time, with bulk mineral sand materials. External radiation fields may be increased if excavated material is stock piled or distributed on the ground surface.

2.2 Subject Area

Mr Allan Burton and Mr Gordon Gee, Queensland Health Scientific Services performed the additional subsurface logging investigations on 12th July 2002.

Description: Subject Area, Report 01PQ385, Figure 1(as supplied by Cardno MBK)

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 5m (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

Bore hole locations were identified by Cardno MBK using the Australian Geolog Data 66 system. All data presented is based on the client supplied location data. Figure 1a shows the bore hole log profiles for activity with depth.

Figure 1b indicates the derived gamma exposure contours for material excavated and deposited in a semi-infinite plane on the ground surface. Material buried at depth that, if distributed on the surface, may give rise to surface gamma radiation activities in the range of 0.2μGy.h⁻¹ to 2.4μGy.h⁻¹. Large quantities of material are present at depth and the extent of the bulk material has not been fully mapped.

4.0 CONCLUSIONS

The addition downhole logging of bores in the subject area, in addition to previous data (QHSS 2002) and surface gamma radiation surveys (Cardno MBK) has further defined the extent of radiologically enhanced mineral sand material at depths to at least the water table (approx. 6m) for the subject area.

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.

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.

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.

Contour mapping accuracy for this report is limited by the frequency and location of boreholes. Spatial anomalies and artifacts may be generated when optimum data sets are not available.

Conversion of raw activity in counts per minute to derived gamma exposure rates on the ground surface may overestimate actual surface exposure rates. Conversion factors are based on homogenous deposits of uranium and thorium based over an infinite volume.

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 (2002). *Subsurface Radiation Investigation Report No. 01PQ385. Kingscliff South Development*. Queensland Health Scientific Services. Queensland Health. Brisbane. Australia.



R Kleinschmidt
Senior Health Physicist
MARPS, SPERA

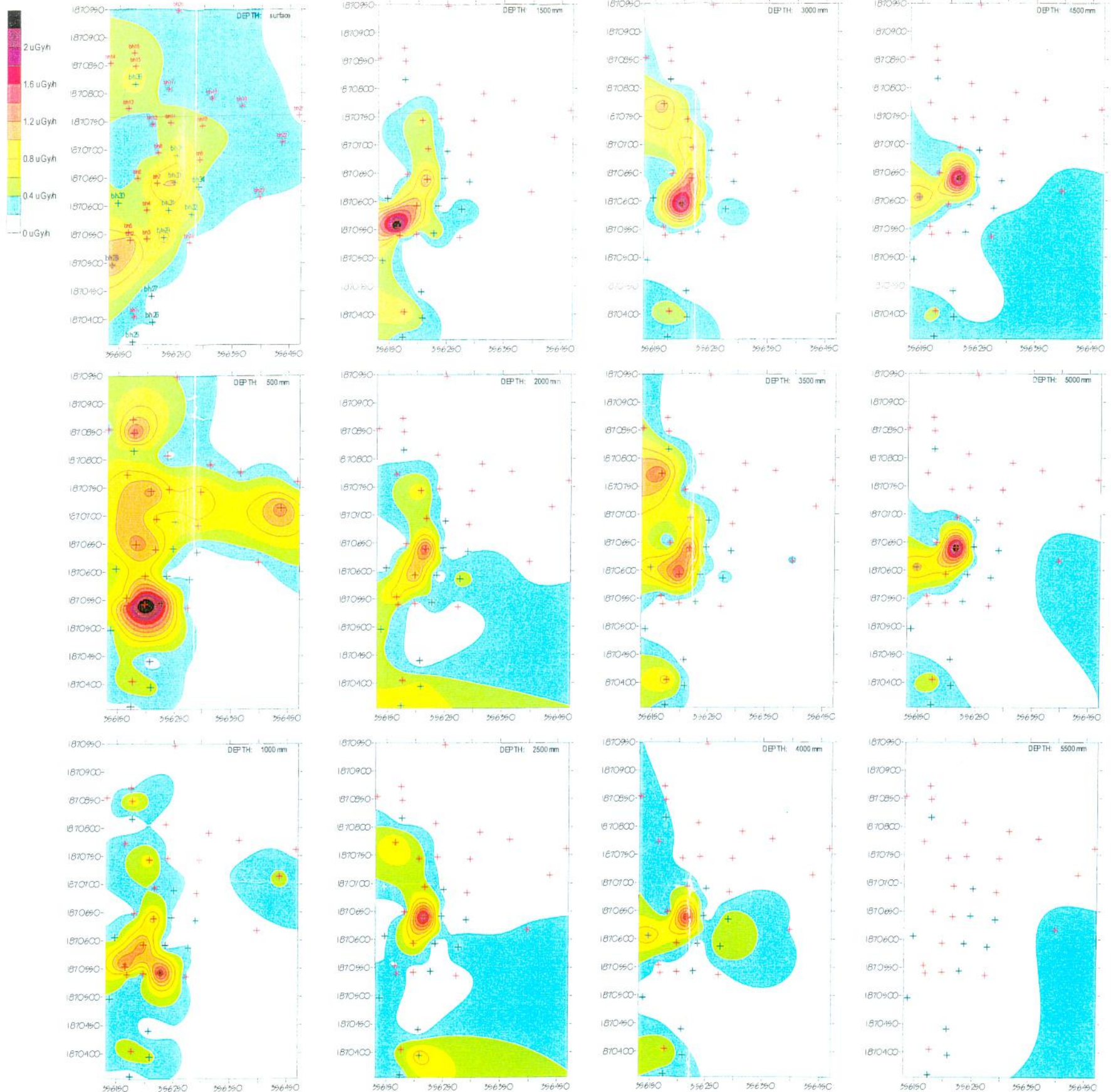
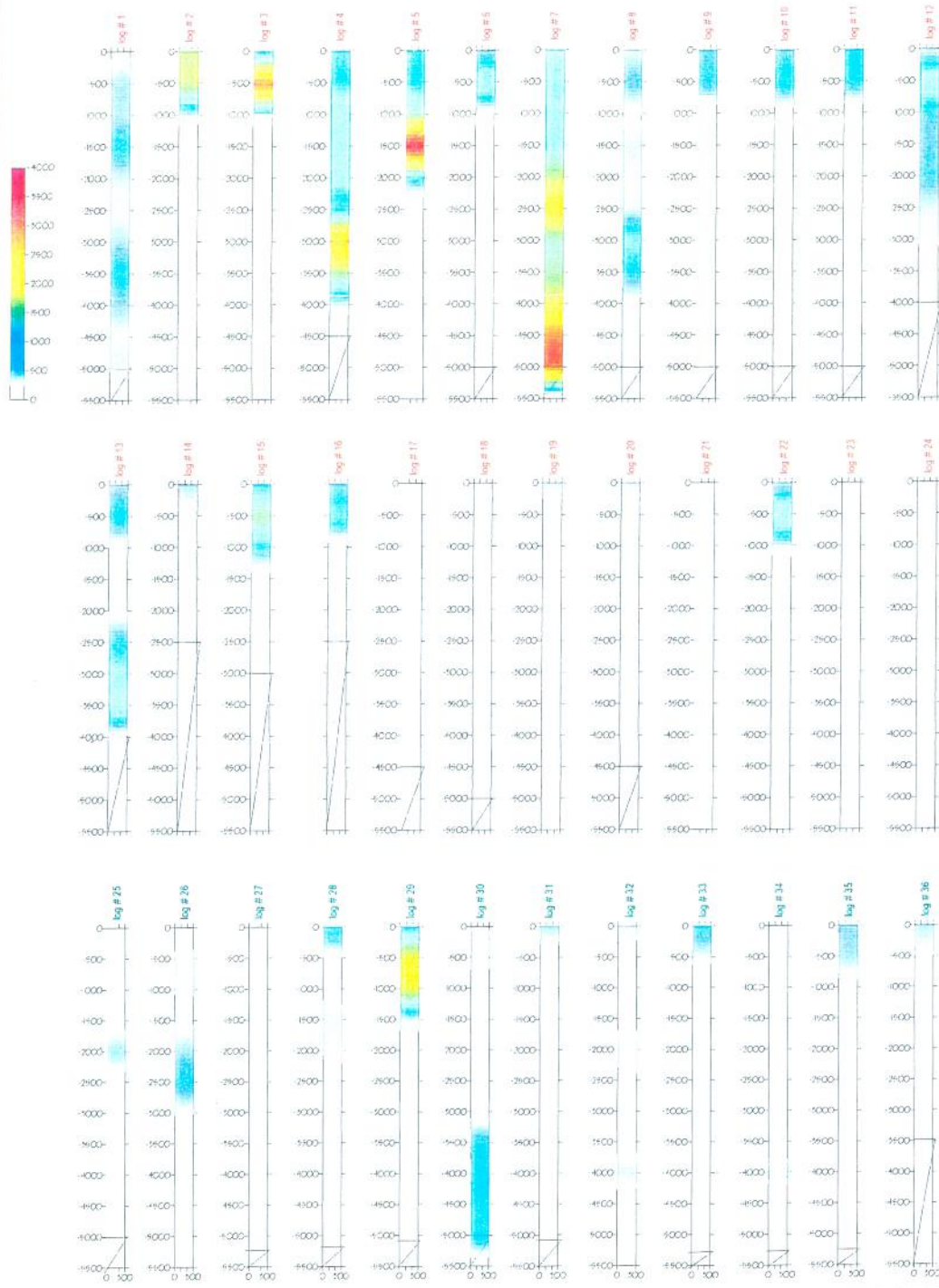
17 July 2002

Figure 1b: Derived gamma exposure contours for excavated material

bh 1
+ previous borehole (06th/07th/13th June 2002)

bh25
+ extended survey borehole (12th July 2002)

Figure 1a: Bore hole log profiles (counts per minute)



GENERAL NOTES

All measurements are in $\mu\text{Gy}\cdot\text{h}^{-1}$ unless otherwise indicated.
Survey points as supplied by Cardno MBK (Australia Geolog data 66)

Survey conducted by: Allan Burton & Gordon Gee, QHSS
Date of survey: 12 July 2002
Survey instrument: Downhole log system, Bicon Analyst + 1" dia. NaI detector

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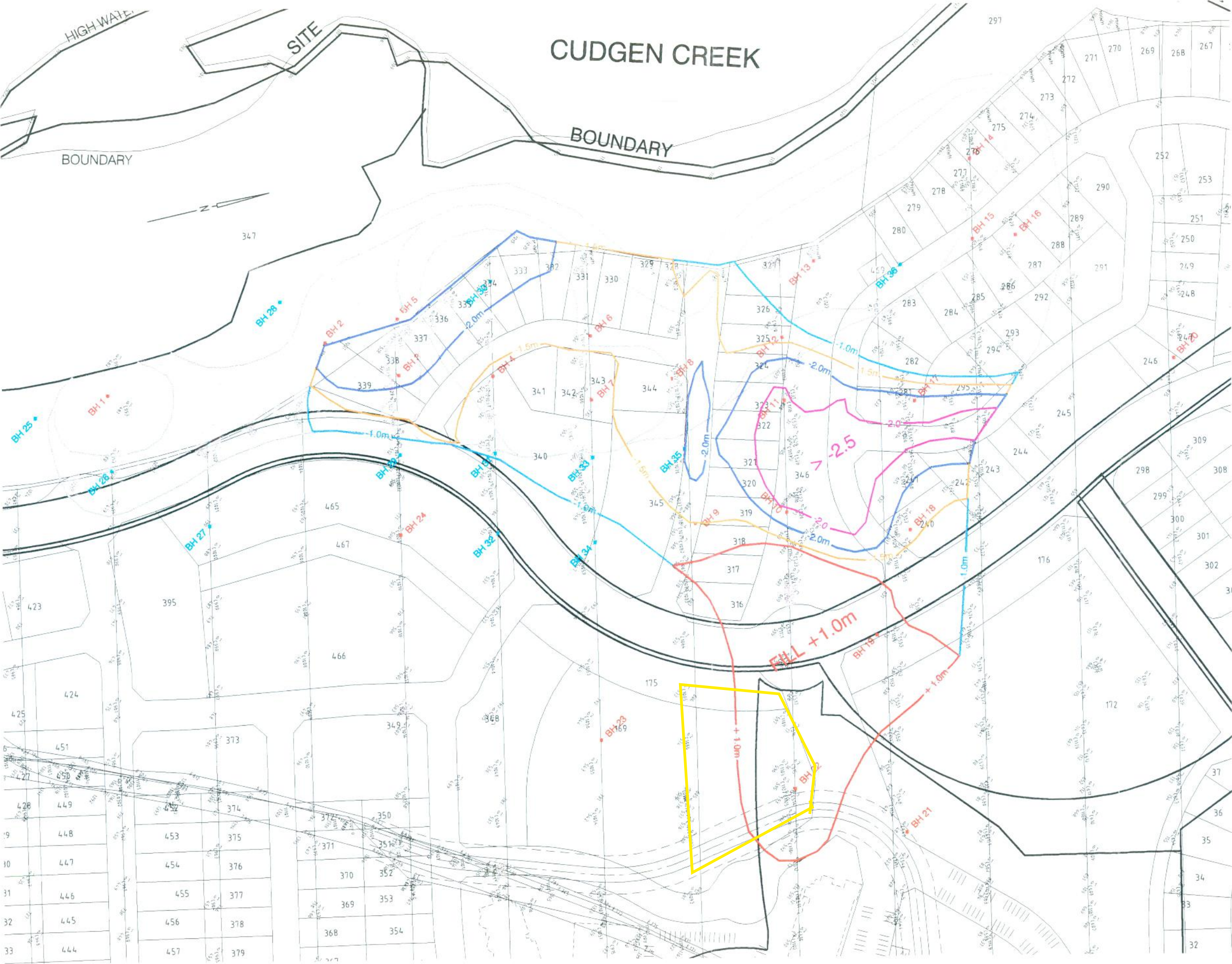
Queensland Government
Queensland Health
Scientific Services
PO Box 594 ARCHERFIELD Q 4108
Phone: 07 3274 9124 Fax: 07 3274 9123
e-mail: Ross_Kleinschmidt@health.qld.gov.au

Project: KINGSCLIFF SOUTH PROJECT

Client: CARDNO MBK (GOLD COAST)

Title: DERIVED GAMMA EXPOSURE CONTOURS FOR EXCAVATED MATERIAL - EXTENDED DATA SET

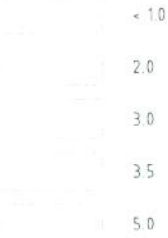
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Rev: 1.0



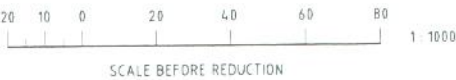
LEGEND

- BH 23 EXISTING BORE HOLE
- BH 33 BORE HOLE

CONTAMINATION DEPTH AT EXISTING GROUND LEVELS



DEPTH	SURFACE AREA	VOLUME
CUT		
CUT -1.0m	12,523m ²	12,523m ³
CUT -1.50m	14,173m ²	21,260m ³
CUT -2.0m	8,326m ²	16,652m ³
CUT -2.5m	4,297m ²	10,743m ³
TOTAL CUT	39,319m ²	61,178m ³
FILL		
FILL +1.0m	12,496m ²	12,496m ³
TOTAL FILL	12,496m ²	12,496m ³



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CLIENT
SOUTH KINGSCLIFF DEVELOPMENTS PTY. LTD.
C/O RAY GROUP PTY. LTD.

DESCRIPTION
KINGSCLIFF SOUTH PROJECT
CONTAMINATION INVESTIGATION

SCALE - 1:1000 A1
DATE - August 2002 Rev A
JOB No 7083/1-5

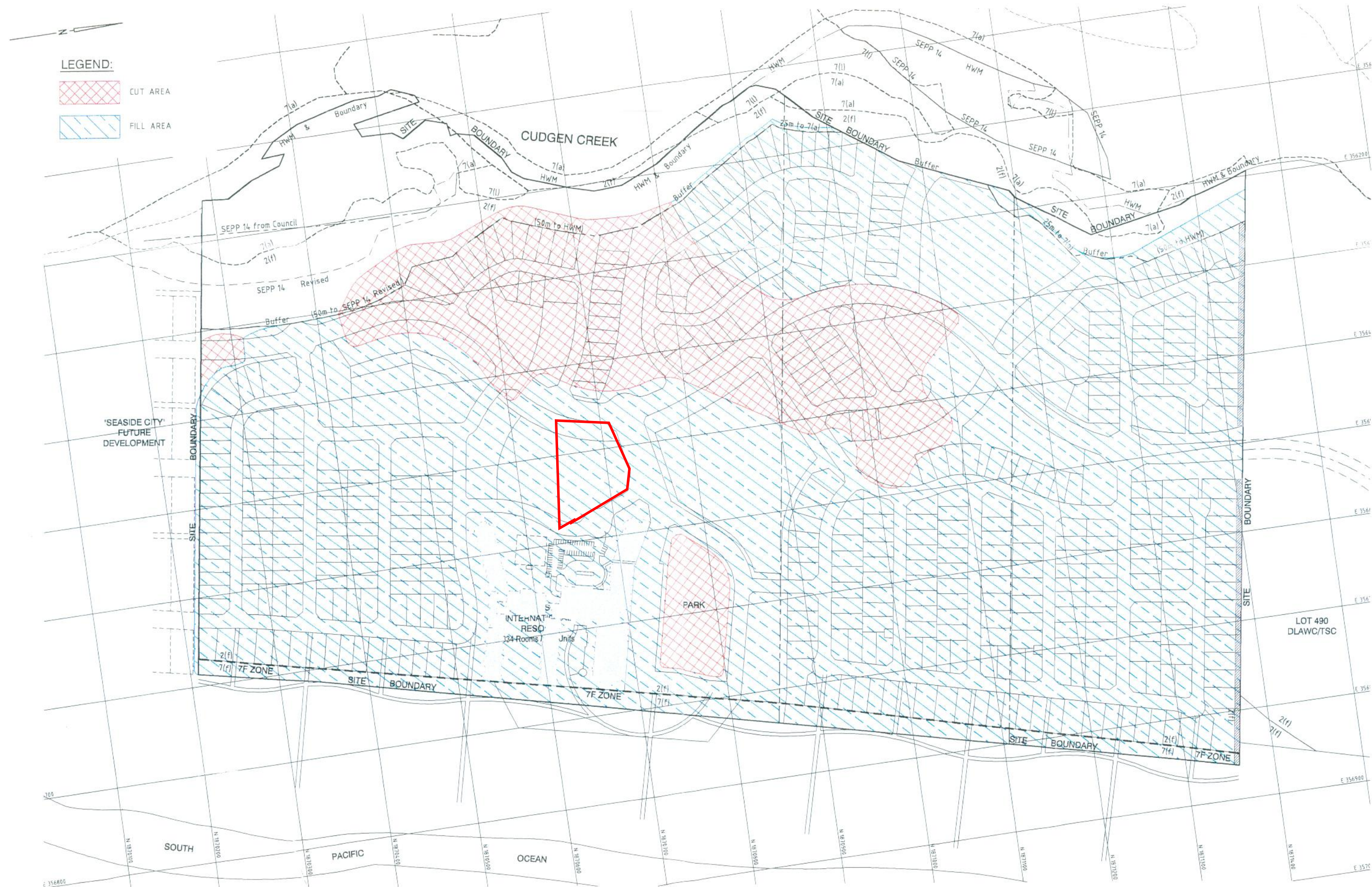
SK No. 12 (23/08/02)

**FINAL DESIGN CUT/FILL
OVER CONTAMINATED AREA**

South Kingscliff Developments Pty Ltd
7083/1-5

APPENDIX 5

REMEDIATION EXCAVATION PLAN



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C/O RAY GROUP PTY. LTD.	<table border="1"> <tr> <td>SCALE - 1:2000</td> <td>A1</td> </tr> <tr> <td>DATE - AUGUST 2002</td> <td>Rev. 02</td> </tr> </table>	SCALE - 1:2000	A1	DATE - AUGUST 2002	Rev. 02
SCALE - 1:2000	A1				
DATE - AUGUST 2002	Rev. 02				
SALT - SOUTH KINGSCLIFF	JOB No. 7083/1-1				
DA SUBMISSION					

FIGURE No. DA15
CUT \ FILL SURFACE
LAYOUT PLAN

South Kingscliff Developments Pty Ltd
7083/1-5

APPENDIX 6

OCCUPATIONAL HEALTH & SAFETY GUIDELINE

OCCUPATIONAL HEALTH & SAFETY GUIDELINE

SITES CONTAMINATED WITH RADIOLOGICALLY ENHANCED MINERAL SAND PRODUCTS

This guideline document workplace health and safety requirements for the remediation of a site contaminated with bulk quantities of radiologically enhanced mineral sand products. The document covers the following generally accepted issues but is not limited to them.

This document relates only to health and safety issues relating to radioactive materials. The presence of other hazards should be identified and dealt with by the client.

A1 SITE INDUCTION

All site workers are to be briefed on the nature of the contaminants, exposure pathways and risk factors, and the nature of safety measures to be employed before commencement of work.

A2 NATURE OF CONTAMINANTS AND RISK ASSESSMENT

A2.1 Radioactivity

The radioactive material contaminating the site consists mainly of a thorium and uranium bearing mineral sand products, typically monazite and ilmenite. These products have been concentrated as a result of physical separation processes associated with the mineral sand extraction industry.

Uranium and thorium decay via natural radioactive decay processes to several decay progeny. The uranium 238 decay chain contains 14 progeny, all radioactive and effectively contributing to the total activity available for exposure (figure A1).

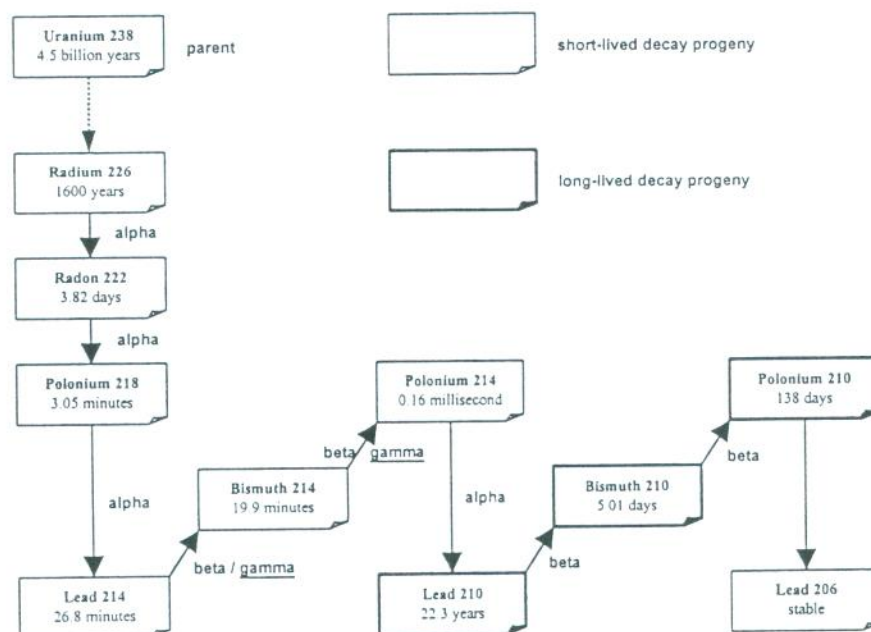


Figure A1: Uranium 238 decay series showing radionuclide half-lives and decay radiation emissions.

A2.2 Exposure Risk

The radioactive components of the material to be excavated or remediated may pose a risk via dust inhalation, radon (and progeny) inhalation and external gamma and beta irradiation from prolonged and close proximity exposure to the radiologically enhance materials. Ingestion is not considered a significant exposure risk if general hygiene procedures are observed (e.g. washing hands before eating).

It has recently been confirmed that smoking in proximity to elevated radon sources may increase the risk of induction of effects from radiation exposure. The decay progeny from radon 222 are preferentially attached to smoke particles which are then trapped in the lung providing a significant exposure pathway. It is strongly recommended that smoking not be permitted in the remediation area.

A3 RADIATION SAFETY PLAN

Radiological health and safety issues in relation to any remediation operation include:

- On-site workers and supervisory staff
- Off-site individuals on adjacent properties to the remediation area
- Transportation routes and vehicles involved in the operations.

The safety of on-site individuals should be protected by adoption of work practices that control airbourne movement of contaminated material.

The risk of contamination of vehicles and equipment involved in the operation should be minimised by adoption of work practices which provide effective decontamination.

The safety of off-site individuals should be controlled by ensuring on-site operations provide effective controls and minimisation of exposure.

The Radiation Safety Plan should:

- Delineate and mark the remediation and disposal areas and decontamination areas
- Control access into the delineated areas by signage and temporary fencing. Prevent unauthorised access after hours with passive security measures.
- Ensure site induction briefings for all workers and visitors
- Require workers to wear coveralls and not smoke on-site during work periods
- Issue face masks and passive dosimeters to all site workers
- Issue electronic dosimeters to critical group workers – normally excavator operators – to monitor gamma radiation levels at the remediation and disposal areas
- Contain excavated material in a controlled stockpile with dust suppression and erosion control devices
- Stop work during windy conditions and heavy rain
- Decontaminate worker's clothing and footwear at the designated decontamination area
- Decontaminate equipment and vehicles on a daily basis at the designated wash down area
- Fully clean and restore the remediation and stockpile areas
- Minimise dust creation at work site using appropriate practices (e.g. wetting down excavation areas)
- Supervise work sites to control and correct unsafe work practices
- Maintain a log of the operations for management and reporting purposes
- Validate remediation process to ensure compliance with target values.

APPENDIX 9 - BORELOGS

UTM : 56J	Drill Rig :	Job Number : GI 3624-f
Easting (m) : 556495.36	Driller Supplier : GeoTech Investigations	Client : Podia
Northing (m) : 6871811.18	Logged By : JW	Project : Proposed 2 Lot Subdivision
Ground Elevation : Not Surveyed	Reviewed By : JW	Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Total Depth : 3 m BGL	Date : 04/03/2025	Loc Comment :

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.5	Fill		SW	Fill- SAND SW: pale brown, dense, well compacted, fine to medium grained.	M	D-WC	2	
									2	
									5	
									6	
									7	
		1			SW	Fill- SAND SW: pale brown, dense, well compacted, fine to medium grained.	M	D-WC	7	
									10	
									10	
									11	

BH 1 Terminated at 3m

Method	Water		Consistency	Moisture	In Situ Testing	Laboratory Results
EX excavator	complete water less	Level during drilling	VS Very soft	D Dry	PP pen penetrometer	UC undrained unconsol cohesion
BH backhoe bucket	Water inflow	P partial water loss	S Soft	M Moist	VS vane shear	UF undrained unconsol friction angle
NE natural exposure	water level	N none encountered	F Firm	W Wet		MC moisture content
EE existing xcavation	USC Classification		St Stiff	PL plastic limit	DCP dynamic cone penetrometer	DD dry density
RP ripper			VSt Very stiff	LL liquid limit		LL liquid limit
	GW well graded gravels	SW well graded sands	H Hard	Soil Samples		PL plastic limit
	GP poorly graded gravels	SP poorly graded sands				LS linear shrinkage
	GM silty gravel	SM silty sands	Density	B bulk	CC undrained console cohesion	
	GC clayey gravel	SC clayey sands	VL Very loose	D disturbed	CF undrained console friction angle	
	ML inorg silts low plastic	CL inorg clay low plastic	L Loose	U(63) U(63) push tube	FH falling head permeability	
	MH inorg clay high plastic	CI inorg clay med plastic	MD Medium dense	U(50) U(50) push tube	CH constan head permeability	
	OL org silts low plastic	CH inorg clay high plastic	D Dense	WS water	CBR californian bearing ratio	
	OH org sils high plastic	Pt peat of high org soils	VD Very dense			

Job Number : GI 3624-f
Client : Podia
Project : Proposed 2 Lot Subdivision
Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Loc Comment :

BH 2 Terminated at 3m

Page 1 of 1

UTM : 56J	Drill Rig :	Job Number : GI 3624-f
Easting (m) : 556433.53	Driller Supplier : GeoTech Investigations	Client : Podia
Northing (m) : 6871837.76	Logged By : JW	Project : Proposed 2 Lot Subdivision
Ground Elevation : Not Surveyed	Reviewed By : JW	Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Total Depth : 3 m BGL	Date : 05/03/2025	Loc Comment :

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.7 1 1.2 2	Fill		SW	Fill- SAND SW: pale brown, dense, well compacted, fine to medium grained.	M	D-WC		
BH 3 Terminated at 3m										

Method	Water	Consistency	Moisture	In Situ Testing	Laboratory Results
EX excavator	complete water less Water inflow water level Level during drilling partial water loss none encountered	VS Very soft S Soft F Firm St Stiff VSt Very stiff H Hard	D Dry M Moist W Wet PL plastic limit LL liquid limit	PP pen penetrometer VS vane shear dynamic cone penetrometer	UC undrained unconsol cohesion UF undrained unconsol friction angle MC moisture content DD dry density LL liquid limit PL plastic limit LS linear shrinkage CC undrained console cohesion CF undrained console friction angle FH falling head permeability CH constan head permeability CBR californian bearing ratio
BH backhoe bucket	USC Classification GW well graded gravels SW well graded sands GP poorly graded gravels SP poorly graded sands GM silty gravel SM silty sands GC clayey gravel SC clayey sands ML inorg silts low plastic CL inorg clay low plastic MH inorg clay high plastic CI inorg clay med plastic OL org silts low plastic CH inorg clay high plastic OH org silts high plastic Pt peat of high org soils	Density VL Very loose L Loose MD Medium dense D Dense VD Very dense	Soil Samples B bulk D disturbed U(63) U(63) push tube U(50) U(50) push tube WS water		
NE natural exposure					
EE existing xcavation					
RP ripper					

Job Number : GI 3624-f
Client : Podia
Project : Proposed 2 Lot Subdivision
Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Loc Comment :

BH 4 Terminated at 3m

Page 1 of 1

Job Number : GI 3624-f
Client : Podia
Project : Proposed 2 Lot Subdivision
Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Loc Comment :

BH 5 Terminated at 3m

Page 1 of 1

UTM : 56J Easting (m) : 556469.25 Northing (m) : 6871839.67 Ground Elevation : Not Surveyed Total Depth : 3 m BGL	Drill Rig : Driller Supplier : GeoTech Investigations Logged By : JW Reviewed By : JW Date : 06/03/2025	Job Number : GI 3624-f Client : Podia Project : Proposed 2 Lot Subdivision Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia Loc Comment :
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Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		<								

Job Number : GI 3624-f
Client : Podia
Project : Proposed 2 Lot Subdivision
Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Loc Comment :

BH 7 Terminated at 3m

Page 1 of 1

UTM : 56S	Drill Rig :	Job Number : GI 3624-f
Easting (m) : 556505.00	Driller Supplier : GeoTech Investigations	Client : Podia
Northing (m) : 6871851.00	Logged By : JW	Project : Proposed 2 Lot Subdivision
Ground Elevation : Not Surveyed	Reviewed By : JW	Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Total Depth : 3 m BGL	Date : 06/03/2025	Loc Comment :

Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
						Fill- SAND SW: pale brown, dense, well compacted, fine to medium grained.				
		1							10	
									18	

Method	Water	Consistency	Moisture	In Situ Testing	Laboratory Results
EX excavator	complete water less Water inflow water level	Level during drilling partial water loss none encountered	D Dry M Moist W Wet PL plastic limit LL liquid limit B bulk D disturbed U(63) U(63) push tube U(50) U(50) push tube WS water	PP pen penetrometer VS vane shear DCP dynamic cone penetrometer	UC undrained unconsol cohesion UF undrained unconsol friction angle MC moisture content DD dry density LL liquid limit PL plastic limit LS linear shrinkage CC undrained console cohesion CF undrained console friction angle FH falling head permeability CH constan head permeability CBR californian bearing ratio
BH backhoe bucket	USC Classification GW well graded gravels GP poorly graded gravels GM silty gravel GC clayey gravel ML inorg silts low plastic MH inorg clay high plastic OL org silts low plastic OH org silts high plastic SW well graded sands SP poorly graded sands SM silty sands SC clayey sands CL inorg clay low plastic CI inorg clay med plastic CH inorg clay high plastic Pt peat of high org soils		VS Very soft S Soft F Firm St Stiff VSt Very stiff H Hard		
NE natural exposure					
EE existing xcavation					
RP ripper					

UTM : 56S Easting (m) : 556505.00 Northing (m) : 6871851.00 Ground Elevation : Not Surveyed Total Depth : 3 m BGL	Drill Rig : Driller Supplier : GeoTech Investigations Logged By : JW Reviewed By : JW Date : 06/03/2025	Job Number : GI 3624-f Client : Podia Project : Proposed 2 Lot Subdivision Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia Loc Comment :
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Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		2	Fill		SW	Fill- SAND SW: pale brown, dense, well compacted, fine to medium grained.	M	D-WC		
BH 8 Terminated at 3m										

Method	Water		Consistency	Moisture	In Situ Testing	Laboratory Results
EX excavator	 complete water less	 Level during drilling	VS Very soft	D Dry	PP pen penetrometer	UC undrained unconsol cohesion
BH backhoe bucket	 Water inflow	P partial water loss	S Soft	M Moist	VS vane shear	UF undrained unconsol friction angle
NE natural exposure	 water level	N none encountered	F Firm	W Wet		DD dry density
EE existing xcavation	USC Classification		St Stiff	PL plastic limit	DCP dynamic cone penetrometer	MC moisture content
VSt Very stiff			LL liquid limit	DD dry density		
RP ripper	GW well graded gravels SW well graded sands GP poorly graded gravels SP poorly graded sands GM silty gravel SM silty sands GC clayey gravel SC clayey sands ML inorg silts low plastic CL inorg clay low plastic MH inorg clay high plastic CI inorg clay med plastic OL org silts low plastic CH inorg clay high plastic OH org sils high plastic Pt peat of high org soils		H Hard	Soil Samples	LL liquid limit	PL plastic limit
			Density			B bulk
			VL Very loose	D disturbed		CC undrained console cohesion
			L Loose	U(63) U(63) push tube		CF undrained console friction angle
			MD Medium dense	U(50) U(50) push tube		FH falling head permeability
			D Dense	WS water		CH constan head permeability
			VD Very dense			CBR californian bearing ratio

UTM : 56J Easting (m) : 556531.46 Northing (m) : 6871899.36 Ground Elevation : Not Surveyed Total Depth : 3 m BGL	Drill Rig : Driller Supplier : GeoTech Investigations Logged By : JW Reviewed By : JW Date : 04/03/2025	Job Number : GI 3624-f Client : Podia Project : Proposed 2 Lot Subdivision Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia Loc Comment :
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Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		0.9 1 2	Fill		SW	Fill- SAND SW: brown to pale brown and grey, dense, well compacted, fine to medium grained, trace fine sized gravel.	M	D-WC	1	
								2		
								8		
								8		
								12		
								14		
BH 9 Terminated at 3m										

Method	Water	Consistency	Moisture	In Situ Testing	Laboratory Results
EX excavator	 complete water less  Level during drilling	VS Very soft	D Dry	PP pen penetrometer	UC undrained unconsol cohesion
BH backhoe bucket	 Water inflow  partial water loss	S Soft	M Moist	VS vane shear	UF undrained unconsol friction angle
NE natural exposure	 water level  none encountered	F Firm	W Wet	DCP dynamic cone penetrometer	MC moisture content
EE existing xcavation	USC Classification GW well graded gravels SW well graded sands GP poorly graded gravels SP poorly graded sands GM silty gravel SM silty sands GC clayey gravel SC clayey sands ML inorg silts low plastic CL inorg clay low plastic MH inorg clay high plastic CI inorg clay med plastic OL org silts low plastic CH inorg clay high plastic OH org silts high plastic Pt peat of high org soils	St Stiff	PL plastic limit		DD dry density
RP ripper		VSt Very stiff	LL liquid limit		LL liquid limit
		H Hard			PL plastic limit
		Density VL Very loose L Loose MD Medium dense D Dense VD Very dense	Soil Samples B bulk D disturbed U(63) U(63) push tube U(50) U(50) push tube WS water		LS linear shrinkage
					CC undrained console cohesion
					CF undrained console friction angle
					FH falling head permeability
					CH constan head permeability
					CBR californian bearing ratio

UTM : 56J Easting (m) : 556483.06 Northing (m) : 6871912.35 Ground Elevation : Not Surveyed Total Depth : 3 m BGL	Drill Rig : Driller Supplier : GeoTech Investigations Logged By : JW Reviewed By : JW Date : 04/03/2025	Job Number : GI 3624-f Client : Podia Project : Proposed 2 Lot Subdivision Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia Loc Comment :
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Drilling Method	Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP	Testing
		<								

Method	Water	Consistency	Moisture	In Situ Testing	Laboratory Results
EX excavator	complete water less Level during drilling	VS Very soft	D Dry	PP pen penetrometer	UC undrained unconsol cohesion
BH backhoe bucket	Water inflow partial water loss	S Soft	M Moist	VS vane shear	UF undrained unconsol friction angle
NE natural exposure	water level none encountered	F Firm	W Wet	dynamic cone penetrometer	MC moisture content
EE existing xcavation	USC Classification GW well graded gravels SW well graded sands GP poorly graded gravels SP poorly graded sands GM silty gravel SM silty sands GC clayey gravel SC clayey sands ML inorg silts low plastic CL inorg clay low plastic MH inorg clay high plastic CI inorg clay med plastic OL org silts low plastic CH inorg clay high plastic OH org silts high plastic Pt peat of high org soils		PL plastic limit	DCP	DD dry density
RP ripper		St Stiff	LL liquid limit		LL liquid limit
		H Hard	Soil Samples B bulk D disturbed U(63) U(63) push tube U(50) U(50) push tube WS water		PL plastic limit
		Density			LS linear shrinkage
		VL Very loose			CC undrained console cohesion
		L Loose			CF undrained console friction angle
		MD Medium dense			FH falling head permeability
		D Dense			CH constan head permeability
		VD Very dense			CBR californian bearing ratio

GEOTECH INVESTIGATIONS PTY LTD

Unit 3/42 Machinery Drive, Tweed Heads South NSW 2486

Ph: 0755 233 979

Fax: 0755 233 981

ENGINEERING LOG – BOREHOLE PROFILE

GPS:		N:		E:				
CLIENT: GTDP INVESTMENTS PTY LTD						BOREHOLE I.D.: BH 11		
PROJECT: Nos.4-8 BELLS BOULEVARD, KINGSCLIFF – ‘SALT’ STAGE 1A3						JOB No.: GI 3624-a		
EQUIPMENT TYPE: EXPLORA85				HOLE DIAMETER: 110mm		PAGE: 1 of 3		
Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
AD		0.5		(SP) SAND: Fine to medium sand, Moist, Pale brown and orange mottled		SPT 6,7,20 N = 27		FILL?
		1.0		(SP) SAND: Fine to medium sand, Trace of silt, Moist, Pale brown, grey and black mottled	L			
		1.5		(SP) SAND: Fine to medium sand, Moist, Pale brown and orange mottled	MD			
WB/MS		2.0		(SP) SAND: Fine to medium sand, Moist, Pale brown and orange mottled		SPT 5,6,7 N = 13		AEOLIAN?
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						
		5.0						
		5.5						
				L/ MD	SPT 2,3,6 N = 9	Some shell fragments		

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ENGINEERING LOG – BOREHOLE PROFILE

CLIENT: GTDP INVESTMENTS PTY LTD						BOREHOLE I.D.: BH 11		
PROJECT: Nos.4-8 BELLS BOULEVARD, KINGSCLIFF – ‘SALT’ STAGE 1A3						JOB No.: GI 3624-a		
EQUIPMENT TYPE: EXPLORA85				HOLE DIAMETER: 110mm		PAGE: 2 of 3		
Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
WB/MS	▶	6.0_		(SP) SAND: Fine to medium sand, Moist, Pale brown and orange mottled - becoming wet	L/ MD	SPT 7,9,11 N = 20		AEOLIAN?
					MD			
		6.5_				SPT 7,8,10 N = 18		
		7.0_						
		7.5_						
		8.0_						
		8.5_						
		9.0_				SPT 6,10,12 N = 22		Lenses of black sand, possibly mineral sand
		9.5_						
		10.0_						
		10.5_						
		11.0_		(SP) SAND: Fine to medium sand, Wet, Pale brown	VD	SPT 11,19,30 /130mm N > 50		ALLUVIUM?
		11.5						

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ENGINEERING LOG – BOREHOLE PROFILE

CLIENT: GTDP INVESTMENTS PTY LTD						BOREHOLE I.D.: BH 11	
PROJECT: Nos.4-8 BELLS BOULEVARD, KINGSCLIFF – ‘SALT’ STAGE 1A3						JOB No.: GI 3624-a	
EQUIPMENT TYPE: EXPLORA 85				HOLE DIAMETER: 110mm		PAGE: 3 of 3	

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
WB/MS		12.0		(SP) SAND: Fine to medium sand, Wet, Pale brown	VD	SPT 30/120mm N > 50		ALLUVIUM?
		12.5				SPT 30/140mm N > 50		
		13.0						
		13.5						
		14.0						
		14.5						
		15.0				SPT 30/100mm N > 50		
		15.5						
		16.0						

BH 11 TERMINATED AT 15.1m – LIMIT OF INVESTIGATION									
METHOD		WEATHERING		CONSISTENCY / DENSITY / ROCK STRENGTH				SAMPLES / TESTS	
AD	Auger Drilling	EW	Extremely	VS	Very Soft	D	Dense	U ()	Undisturbed (size in mm)
RR	Rock Roller	HW	Highly	S	Soft	VD	Very Dense	D	Disturbed
MS	Mud Support	DW	Distinctly	F	Firm	Fb	Friable	BS	Bulk Sample
NMLC	Rock Coring	MW	Moderately	St	Stiff	ELw	Extremely Low	DCP	Dynamic Cone Penetrometer
WB	Wash Bore	SW	Slightly	VSt	Very Stiff	VLw	Very Low	SPT	Standard Penetrometer Test
		F	Fresh	Hd	Hard	Lw	Low	N	Number of blows for SPT / 300mm
▼	Water Level			VL	Very Loose	M	Medium	VS	Vane Shear
►	Water Seepage			L	Loose	H	High	A	Acid Sulfate Sample
»–	Partial Loss			MD	Medium Dense	VH	Very High	PP	Pocket Penetrometer (kPa)
–«	Complete Loss								
Logged By: MM/AO'D		Date: 09/10/17		Checked By: HT		Date: 13/10/17			