



REMEDIAL ACTION PLAN

SSD-83069459

Kingscliff Mixed Use Development

July 2026

Prepared For: Bells Boulevard Pty Ltd

Lot 2 DP 1310938
4–8 Bells Boulevard
Kingscliff NSW

HMC2025.1646.05

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

HMC Environmental Consulting Pty Ltd is pleased to present our Remedial Action Plan for the abovementioned site.

This plan has been prepared to accompany the Detailed Site Investigation (Report No. HMC2025.1646.04) and the Radiation Assessment Report (Report No. Q2026.4049, Radiation Safety Support Services Aus), in support of State Significant Development SSD-83069459. We trust this report meets with your requirements. If you require further information, please contact HMC Environmental Consulting directly on the numbers provided.

HMC Environmental Consulting
Suite 29, Level 2, 75–77 Wharf Street
PO Box 311
Tweed Heads NSW 2485

PH: 07 5536 8863
Email: admin@hmcenvironment.com.au
Web: www.hmcenvironment.com.au
ABN: 60 108 085 614

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1 SITE INFORMATION

1.1 SITE IDENTIFICATION

Table 1- Site Identification Summary

Street Address	4–8 Bells Boulevard, Kingscliff NSW 2487
Allotment Description	Lot 2 DP 1310938
Allotment Size	4,450 m ²
Local Government Area	Tweed Shire Council (Parish Cudgen, County Rous)
Zoning	SP3 – Tourist
Proposed Development	State Significant Development (SSD-83069459) – five-storey mixed-use building with two-level basement carpark (193 spaces) and 71 residential units, requiring bulk excavation to approximately 7–8 m below ground level.
Existing Land Use	Vacant; informal car parking in the north-east
Proposed Land Use	Mixed-use (residential, retail and wellness)
Contaminant of Concern	Naturally Occurring Radioactive Material (NORM) – monazite-bearing heavy-mineral-sand residues (thorium and uranium series) from historic sand mining

1.2 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 up to approximately 7 m below ground level (BGL). The site is currently vacant and zoned SP3 (Tourist).

In response to the Development Application, Tweed Shire Council issued a Request for Further Information (RFI) dated 17 February 2026 (Item 7 – Contaminated Land). The RFI noted that the contamination status of the site had only been validated to approximately 1 m BGL, that historic sand mining and the later placement of uncontrolled fill had been identified as potential contamination sources, and that the proposed basement excavation to 7m BGL extends well beyond the previously validated material. In particular, development consent DA05/0876 had required a final radiation survey for any basement excavation in accordance with the relevant RAP/DSI, but those works were never undertaken and the site remains unvalidated below 1 m BGL. The RFI required a Detailed Site Investigation (DSI) characterising soil from 1 m to the full excavation depth, a radiation assessment consistent with prior consent conditions, and appropriate remediation or management recommendations.

The site and its surrounds were subject to extensive heavy-mineral-sand mining and on-site processing between approximately 1954 and 1976. Mineral sands were dredged and partially processed on site for rutile and zircon, with residual material pumped back into the dredge pits. The principal residue mineral, ilmenite, is only weakly radioactive; however it is contaminated with small amounts of monazite — a thorium- and uranium-bearing phosphate mineral that is the principal source of elevated radioactivity on these sites. The earlier Cardno MBK (2002) *Detailed Site Radiation Investigation Report & Remediation Action Plan* for the Salt, South Kingscliff land identified approximately 178,000 m³ of material requiring remediation or management across the broader site, 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. All residues were measured below 100 Bq/g and were

therefore not classified as hazardous waste. The principal remediation areas were in the south-west of the Salt Village site near Cudgen Creek.

To address the RFI, HMC engaged Radiation Safety Support Services Aus (RsssA) — Simon Turner, Senior Health Physicist — to undertake a radiation and soil characterisation comprising a soil-profile radiation survey of three boreholes (Holes 1–3) advanced to the base of the proposed excavation, with laboratory analysis by high-resolution gamma spectrometry (Queensland Health Radiation Sciences, traceable to NIST (USA), Certificates 25PQ904–25PQ916). The findings are reported in RsssA Report No. Q2026.4049 (site operations 20 May 2026, report dated 29 June 2026) and are summarised in this RAP.

The activity results are summarised in Table 2. Eleven (11) of the thirteen samples returned total activity concentrations below the 1 Bq/g NORM screening threshold and are consistent with the normal range for NSW mineral-rich coastal sands (approximately 0.02–0.30 Bq/g). Two samples exceeded the screening threshold:

- **Sample 3 – Hole 1 at 7.2 m:** 1.67 Bq/g (field dose rate 0.84 µSv/hr); and
- **Sample 8 – Hole 3 at 1.5 m:** 1.02 Bq/g (field dose rate 0.53 µSv/hr).

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. All measured values remain well below the 100 Bq/g hazardous-waste threshold and well below the levels associated with the 1 mSv/year public dose constraint. No sample indicates a radiological hazard requiring off-site disposal as radioactive waste.

Table 2 Summary of Laboratory 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

Note: U, Th and K-series activity concentrations and measurement uncertainties are reported in full in the RsssA report and the QLD Health Certificate of Analysis. Run-off samples were collected from surface drainage in the lower drain area and are not within the excavation profile.

1.3 CONCEPTUAL SITE MODEL

The conceptual site model adopted in the DSI is summarised in Table 3. The dominant radiological exposure pathways during the works are direct gamma from, and inhalation of dust derived from, any elevated material exposed during excavation. Because measured field dose rates remain at background, the external gamma pathway is minor; dust suppression and surface-water control are therefore the principal management measures. Groundwater lies deeper than 8 m BGL (confirmed by boreholes to 8.2 m), and surface run-off ultimately discharges towards Cudgen Creek, approximately 260 m west.

Table 3 Conceptual Site Model

Source	Pathway	Exposure Route	Receptor
NORM (monazite-bearing residues) from historic sand mining	Exposed surface soil during earthworks	Direct gamma / dermal contact	Site workers, occupiers, visitors
	Atmospheric dispersion	Inhalation of NORM-bearing dust	Site workers, community
	Surface-water run-off	Sediment entering waterways (Cudgen Creek ~260 m W)	Ecological receptors
	Leaching to groundwater (>8 m BGL)	Groundwater movement off-site	Beneficial users, ecological receptors

On the basis of the DSI and the RsssA assessment, the site is considered suitable for the proposed development subject to the implementation of this RAP for the identification and management of soil exceeding the 1 Bq/g screening threshold, and the completion of a final radiation clearance survey of the basement excavation, to the satisfaction of the NSW EPA (Radiation Control) and the General Manager of Tweed Shire Council or delegate.

2 REMEDIATION APPROACHES

Because the elevated material is localised, dispersed and not detectable as an external radiation hazard in the field, the site can be managed using practical, low-cost controls during excavation. The following approaches are carried forward from the RsssA assessment, and are consistent with the dilution-and-capping strategy previously approved for the broader Salt Village site (Cardno MBK, 2002). The recommended approach combines **B** (specialist oversight) and **C** (over-excavation and clean-sand backfill), with **A** (blending/dilution) applied to any segregated elevated material. The objective is management to below the 1 Bq/g screening threshold, not disposal as radioactive waste.

2.1 OPTION A – STOCKPILING AND ON-SITE BLENDING (DILUTION)

Where elevated material is encountered during excavation, it is stockpiled in a controlled, lined and bunded on-site location, monitored with handheld gamma instruments, and blended with clean sand or low-activity soil using an excavator. Blending reduces the average activity concentration to below 1 Bq/g — the same dilution principle applied and approved under the Cardno MBK (2002) strategy.

2.1.1 Advantages

- Very low treatment cost; no off-site disposal as radiological material required; rapid compliance and suitable for large-volume earthworks.

2.1.2 Disadvantages

- The lateral extent of elevated material is not fully defined by the three-borehole scoping investigation.

- Potential to create a hard-to-manage stockpile of elevated material, with additional plant-hire days and double handling.

2.2 APPROACH B – RADIATION SPECIALIST OVERSIGHT (RECOMMENDED)

A qualified radiation specialist (RsssA or equivalent) supervises excavation in real time to identify and segregate small pockets of elevated soil, minimise the volume requiring blending, confirm compliance with the 1 Bq/g threshold, and provide regulatory assurance and documentation to the NSW EPA and Tweed Shire Council.

2.2.1 Advantages

- Efficient and cost-effective; minimises unnecessary soil movement and blending volume.
- Ensures accurate, real-time identification of elevated NORM pockets and a defensible compliance record.

2.3 APPROACH C – OVER-EXCAVATION AND CLEAN-SAND BACKFILL

Within the basement footprint, the excavation is over-excavated by approximately 1,200 mm **where elevated material is encountered**, the elevated soil is removed or blended, and the zone is backfilled with clean pore-silicate sand. This is consistent with the 1.0 m clean-sand capping approach adopted under the Cardno MBK (2002) strategy for areas left in situ.

2.3.1 Advantages

- Creates a clean, low-activity zone with increased shielding and separation; reduces exposure pathways.
- Supports long-term compliance with the 1 mSv/year public dose constraint; simple to implement during construction.

2.4 APPROACH D – EXCAVATION AND TRANSPORT TO MINERAL SANDS PTY LTD PROCESSING PLANT

Material is excavated including contained NORM and transported to the local Mineral Sands plant at Currumbin Qld. Operator advises this process is commonly used on the Gold Coast Qld and has been used for cleanup in Byron Bay and other locations in NSW.

2.4.1 Advantages

- Efficient and cost-effective; minimises unnecessary soil movement and blending.
- Recognised treatment option with both resource recovery and beneficial reuse.
- Supports long-term compliance with the 1 mSv/year public dose constraint; simple to implement during construction.

2.5 RECOMMENDED OPTION

The recommended strategy is to

1. **Combine Approaches B, C and D.**

This approach would include a limited investigation and oversight by an approved radiation consultant including validation of the excavation following earthworks. The transport of material to the licensed Currumbin Minerals site appears to be the efficient and effective option to meet scheduling requirements, and also provide both resource recovery (minerals) and beneficial reuse (sand resource).

2. If 1 above is not available, Combine Approaches **B, and C**, with Approach **A** applied to segregated material:

Specialist-supervised excavation to identify and segregate the localised elevated material as it is encountered (notably in the vicinity of Hole 1 at ~7.2 m and Hole 3 at ~1.5 m), blending of any elevated soil to below 1 Bq/g, and over-excavation with clean-sand backfill within the basement footprint.

The final option will be confirmed in consultation with the client, the NSW EPA (Radiation Control) and Tweed Shire Council, having regard to the volume, cost and long-term management implications of each option.

2.6 LEGISLATION

This RAP has been prepared with regard to the following instruments Reference within the Radiation Assessment (RsssA, 2026):

- Protection from Harmful Radiation Act 1990 No 13 (NSW) and Protection from Harmful Radiation Regulation 2025 (NSW) – 1 Bq/g NORM screening threshold;
- EPA NORM Management Framework (1 Bq/g screening threshold);
- ARPANSA Radiation Protection Series (RPS) dose constraints – public exposure limit 1 mSv/year;
- Guidance Note QGN12 (QLD Health Radiation Health) – radiation protection from NORM;
- Contaminated Land Management Act 1997 (NSW);
- State Environmental Planning Policy (Resilience and Hazards) 2021 (SEPP 2021) and the Secretary's Environmental Assessment Requirements (SEAR Item 13 – Contamination and Remediation); and
- NSW EPA Waste Classification Guidelines, Part 3: Waste containing radioactive material (2014), together with the Radiation Control Act 1990 and Radiation Control Regulation 2013, governing the classification of any material removed from the site for disposal.

Clause 4.6(1)(a–c) of SEPP 2021 requires that a consent authority must not consent to development unless it has considered whether the land is contaminated and is satisfied that the land is suitable (or will be suitable after remediation) for the proposed purpose, and that any required remediation will be carried out before the land is used. This RAP also gives effect to the outstanding DA05/0876 condition requiring a final radiation survey of basement excavations.

3 INTRODUCTION

Site safety, health and environmental protection are central components of the remediation strategy. The objective is to ensure that the remedial works are completed in a safe and radiologically sound manner, that the relevant NSW EPA (Radiation Control), ARPANSA and Tweed Shire Council requirements are complied with, and that the interests of stakeholders and the community are protected.

The proposed two-level basement requires bulk excavation to approximately 7m BGL, below the depth of previously validated material and potentially, below the level at which remediated mineral-sand residues were reburied during the historic rehabilitation. There is therefore potential for excavation to intercept residual or relocated material exceeding the screening threshold, as confirmed at two locations by the RsssA assessment. Soil disturbance is anticipated during the following operations:

- Site stripping and removal of dumped waste material (classified under the NSW EPA Waste Classification Guidelines 2014);
- Bulk excavation and benching of the two-level basement;
- Installation of footings, retention systems and services; and

- Landscaping, driveways and car parking.

3.1 PURPOSE

To provide a clear, practical and compliant methodology for the management of NORM-impacted soil encountered during the basement excavation, and for the final radiation clearance of the excavation, so that the site is suitable for the proposed mixed-use development under NSW radiation legislation and SEPP 2021.

3.2 HOURS OF OPERATION

It is anticipated that the remediation works would be undertaken between 7:00 am and 5:00 pm Monday to Saturday. No remediation works would be undertaken on Sundays or public holidays, subject to the conditions of development consent.

4 REMEDIATION

Two remediation approaches are included. Remediation works are common to all options however the preferred **Option 1** implements resource recovery and beneficial reuse, minimises the ongoing oversight of the radiation monitoring during excavation and does not require blending of material prior to removal to a licensed facility for processing.

Option 2, up to the point of excavation and differ only in how the segregated elevated material is finally managed (blended/diluted, or placed beneath clean-sand backfill). The combined approach (Options B + C, with A for segregated material) is described below.

4.1 REMEDIATION GOAL

The remediation goal is for the total activity concentration of soil remaining within, or re-used on, the site to be less than the 1 Bq/g NORM screening threshold, with the residual condition consistent with a public dose of less than 1 mSv/year and a final basement clearance dose rate consistent with site background. Where more than eight (8) primary validation samples are collected, the 95% upper confidence limit (95% UCL) of the mean would be used in place of the maximum concentration for the assessment of compliance.

4.2 SCOPE

Management strategies and verification procedures during and following excavation of NORM-impacted soil, including either

1. Excavation and transport to a licensed processing facility, and over-excavation with clean sand backfill, and validation of the residual material and the basement excavation against the clean-up criteria;

and/or

2. segregation, blending/dilution, controlled placement and/or over-excavation with clean-sand backfill, and validation of the residual material and the basement excavation against the clean-up criteria.

4.3 REMEDIATION STRATEGY

Under Option 1, the recommended approach, a qualified radiation specialist provides general oversight for the basement carpark excavation. Soil is excavated and transported to a Qld-licensed facility and processed to remove NORM (resource recovery) provide beneficial reuse for the residual material. NORM remaining within the basement footprint would be excavated (over-excavation), and capped beneath clean pore-silicate backfill.

Under Option 2, a qualified radiation specialist provides real-time monitoring during excavation. Soil returning handheld gamma readings above site background is segregated and confirmed by laboratory gamma spectrometry where required. Segregated material exceeding 1 Bq/g is either blended with clean low-activity sand to below the threshold, or placed in a controlled location beneath clean pore-silicate backfill within the basement footprint.

Because field dose rates remain at background, the dominant exposure pathways during works are inhalation of NORM-bearing dust and waterborne dispersal of fines, rather than external gamma radiation. Dust suppression, surface-water control, segregation and controlled placement therefore form the core of the strategy.

The proposed remediation (Option 1) comprises the following primary actions:

- Mark out the excavation/remediation area and identify controlled stockpile locations;
- Install erosion and sediment control measures around the downgradient perimeter (towards Cudgen Creek);
- Implement dust suppression measures;
- Excavate under radiation-specialist supervision;
- Transport off site to a licensed facility (Currumbin Minerals Pty Ltd) in accordance with NSW EPA Waste Classification Guidelines 2014;
- Maintain a soil-movement log for all material tracked above 1 Bq/g;
- Backfill the over-excavated basement zone with minimum 1.2m depth clean sand; and
- Undertake validation sampling and a final basement radiation clearance survey, and reporting.

Option 2

- Mark out the excavation/remediation area and identify controlled stockpile/blending locations;
- Install erosion and sediment control measures around the downgradient perimeter (towards Cudgen Creek);
- Implement dust suppression measures;
- Excavate under radiation-specialist supervision, segregating elevated material identified by handheld gamma monitoring;
- Blend/dilute elevated soil with clean sand to below 1 Bq/g, or place it under controlled conditions beneath clean-sand backfill, or dispose off site in accordance with NSW EPA Waste Classification Guidelines 2014;
- Maintain a soil-movement log for all material tracked above 1 Bq/g;
- Backfill the over-excavated basement zone with minimum 1.2m depth clean sand; and
- Undertake validation sampling and a final basement radiation clearance survey, and reporting.

4.4 OFF-SITE DISPOSAL AND WASTE CLASSIFICATION

The recommended strategy (**Option 1**) manages the NORM-impacted through removal to an approved facility for processing to recover valuable minerals and recover the residual sand resource for beneficial reuse. The material would be processed in a Qld- licensed facility that regularly processes similar material with final reuse options including Gold coast City Council beach replenishment.

Option 2 manages the NORM-impacted soil on site through segregation, blending/dilution and controlled placement, and does not rely on off-site disposal. Where, however, any remediated (blended) or surplus excavated material is to leave the site — for example, spoil taken to 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.

The radioactivity of the material is assessed under the Radiation Control Act 1990 and Radiation Control Regulation 2013. Non-liquid waste with a specific activity greater than 100 Bq/g that also contains more than the prescribed activity of a Schedule 1 radionuclide must be classified as hazardous waste. All material characterised in the RsssA assessment is far below 100 Bq/g (the maximum recorded result was 1.67 Bq/g), so none of the site material is radioactive hazardous waste, and blending further lowers the specific activity.

For non-liquid waste of 100 Bq/g or less, two ratios must be calculated for each consignment from the Group 1–4 radionuclide activities listed in Schedule 1 of the Radiation Control Regulation 2013:

- the **total activity ratio** = $(A_1 \times 10^{-3}) + (A_2 \times 10^{-4}) + (A_3 \times 10^{-5}) + (A_4 \times 10^{-6})$, where A_1 – A_4 are the total activities (Bq) of the Group 1–4 radionuclides in the whole consignment; and
- the **specific activity ratio** = $SA_1 + (SA_2 \times 10^{-1}) + (SA_3 \times 10^{-2}) + (SA_4 \times 10^{-3})$, where SA_1 – SA_4 are the specific activities (Bq/g) of the Group 1–4 radionuclides.

Where either ratio exceeds one, the non-liquid waste is classified as restricted solid waste (unless other characteristics make it hazardous) and may only be received by a facility licensed to accept that classification. Where both ratios are one or less, the radioactivity is regarded as 'below regulatory concern' for classification purposes and the material is classified solely on its other characteristics under Part 1 of the Guidelines — typically general solid waste for clean coastal sand.

Accordingly, in **Option 2**, before any material leaves the site: representative samples of the blended/remediated material will be analysed by gamma spectrometry; the total activity ratio and specific activity ratio will be calculated and the classification documented; the receiving facility's licence to accept the resulting classification (general solid waste or restricted solid waste) will be confirmed in writing; and the material will be transported under the relevant NSW EPA waste-tracking requirements, with facility receipts (dockets) retained. Disposal of any low-level radioactive waste is managed through licence conditions and a 'consent to dispose' under the Radiation Control Act 1990 or the Protection of the Environment Operations Act 1997, and any such consent, if required, would be obtained before disposal.

4.5 IMPLEMENTATION

1. Review this RAP and confirm the selected management option with the client, the NSW EPA (Radiation Control) and Tweed Shire Council.
2. Confirm a suitably qualified radiation specialist is engaged to supervise the works and that monitoring instruments are within calibration.
3. The Site Manager establishes a contaminant control zone, comprising an exclusion zone (excavation, segregation, blending and loading) and a contaminant reduction zone (decontamination).
4. Site induction is completed prior to entry; the control zone is fenced and signed, and access is restricted to briefed personnel.
5. The contaminant reduction zone includes a personnel decontamination area and a plant/vehicle cleaning area; plant is cleaned of loose soil and washed, where necessary, prior to leaving the control zone.

4.6 EXCAVATION

Option 1

- Delineate the perimeter of the remediation area with stakes/marketing paint prior to any soil disturbance.
- Install erosion and sediment control devices around the downgradient perimeter to retain loose or eroded soil on site.
- Implement dust suppression measures.
- Excavate under radiation-specialist supervision
- Transport excavated material to Currumbin Minerals Pty Ltd processing facility.
- Over-excavate the basement zone by approximately 1,200 mm where elevated material is encountered and backfill with clean sand.
- Capture any soil washings within a bunded area with a low-permeability base to prevent infiltration to groundwater.

Option 2

- Stockpile segregated elevated material in a controlled, lined and bunded location; keep damp or covered with LDPE plastic sheeting.
- Blend/dilute segregated material with clean sand and re-monitor to confirm < 1 Bq/g prior to re-use, placement or disposal off-site in accordance with Waste Classification.
- Over-excavate the basement zone by approximately 1,200 mm where elevated material is encountered and backfill with clean sand.
- Capture any soil washings within a bunded area with a low-permeability base to prevent infiltration to groundwater.

4.7 SEQUENCE

The sequence of excavation and material handling will depend on scheduling and weather:

Option 1

- Remediation area marked and controlled stockpile/blending area identified; adequate clean water supply and LDPE sheeting available.
- Implement dust suppression measures.
- Excavate to design level under specialist supervision,
- Transport to Qld-licensed processing facility
- Maintain photographic evidence of staging and a soil-movement log.
- On reaching the design (and any over-excavation) depth, undertake validation sampling and a final radiation clearance survey of the exposed excavation.
- If validation confirms the criteria are met, backfill with clean sand and complete construction in accordance with the approval; if not, undertake further excavation/blending and re-validate until the criteria are met.

Option 2

- Remediation area marked and controlled stockpile/blending area identified; adequate clean water supply and LDPE sheeting available.

- Implement dust suppression measures.
- Excavate to design level under specialist supervision, segregating elevated soil as identified by gamma monitoring.
- Blend/dilute or place segregated material; re-monitor to confirm compliance.
- Maintain photographic evidence of staging and a soil-movement log.
- On reaching the design (and any over-excavation) depth, undertake validation sampling and a final radiation clearance survey of the exposed excavation.
- If validation confirms the criteria are met, backfill with clean sand and complete construction in accordance with the approval; if not, undertake further excavation/blending and re-validate until the criteria are met.

4.8 OCCUPATIONAL HEALTH & SAFETY

- Safety fencing installed around the contaminant control zone; exclusion and contaminant reduction zones delineated.
- Site induction completed prior to entry to the remediation area.
- Personal protective equipment (disposable overalls, gloves, P2 dust masks/respirators) provided to workers in direct contact with NORM-impacted soil exceeding threshold criteria, or as directed by Radiation Consultant. The primary radiological control is suppression of inhalable dust, given external dose rates remain at background.
- Works undertaken during dry, still conditions wherever practicable, with the area wetted immediately prior to any soil disturbance.
- Personal and area gamma/dust monitoring maintained under the direction of the radiation specialist; results recorded.

4.9 IDENTIFICATION OF INCIDENT OR FAILURE

- Failure to install adequate erosion and sediment control prior to commencement.
- Movement of elevated soil across or off site.
- Failure to protect stockpiles from erosion, dust generation or leaching.
- Conducting works in high-wind conditions with dust generation.

4.10 CORRECTIVE ACTION

- Confirm approvals and contacts are held on site; provide clear site delineation.
- Install/replace erosion and sediment controls in a timely manner;
- **Option 2 only** - Limit blending operation work in high wind; re-monitor and re-blend any material not confirmed below 1 Bq/g prior to placement.

4.11 ENVIRONMENTAL SAFEGUARDS

- Erosion and sediment control devices installed prior to any excavation; adequate clean water supply available.
- Contractor to carry appropriate spill-response materials.
- Surface drainage protected; run-off captured and managed within the bunded remediation area to prevent discharge towards Cudgen Creek.

4.12 IDENTIFICATION OF INCIDENT OR FAILURE

- Spillage or dust generation of elevated material during excavation, stockpiling, loading or placement/transportation.
- Failure to use the vehicle wash/decontamination facility.

4.13 CORRECTIVE ACTION

- Any spillage of soil in transit within or off site to be cleaned up immediately.
- Ensure stockpiles of elevated material are wetted and covered with LDPE plastic;
- Repair or replace damaged bund/sediment fencing.

5 VALIDATION

Following excavation and any blending/placement, the exposed surfaces, any re-used material, and the completed basement excavation would be subject a final radiation clearance survey to confirm that the residual condition meets the adopted criteria, satisfying the outstanding DA05/0876 condition.

5.1 FINAL CLEARANCE SURVEY

Table 4 Validation Clean-up / Acceptance Criteria

Parameter	Clean-up / Acceptance Criteria
Soil total activity concentration	< 1 Bq/g (NORM screening threshold)
Estimated annual public dose	< 1 mSv/year (1,000 μ Sv/year)
Final basement clearance dose rate	Consistent with site background ($\approx$ 0.15–0.25 μ Sv/hr)
Hazardous-waste classification	$\ll$ 100 Bq/g – not classified as hazardous waste

5.2 VALIDATION REPORT

Within 60 days of completion of the validation works, a Validation Report would be submitted to the NSW EPA (Radiation Control) and Tweed Shire Council reporting on all works conducted and detailing compliance with this RAP and the DA05/0876 radiation-survey condition, to the satisfaction of the General Manager or delegate.

6 LIMITATIONS

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

This RAP relies upon the findings of the Detailed Site Investigation (HMC2025.1646.04), the Preliminary Site Investigation (HMC2025.1646.02), the Cardno MBK (2002) Detailed Site Radiation Investigation Report & RAP, and the radiological data and findings of the Radiation Assessment Report prepared by RsssA (Q2026.4049) and the associated QLD Health Certificate of Analysis. HMC has not independently verified the third-party radiological results and assumes no responsibility for errors in data obtained from others. The scoping investigation comprised three boreholes; the lateral and vertical extent of elevated material is not fully delineated, and additional material may be encountered during excavation.

HMC Environmental Consulting has performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental and radiation-protection profession, and in accordance with the NSW EPA (2020) Consultants reporting on contaminated land – Contaminated land guidelines. No warranties or guarantees, express or implied, are given. This report does not constitute legal

advice on regulatory matters, for which a separate opinion should be sought, and relates only to the objectives and scope of work stated.

7 SIGNATURE

This report has been prepared by Mark Tunks of HMC Environmental Consulting Pty Ltd, a suitably qualified environmental consultant, in accordance with the NSW EPA (2020) Consultants reporting on contaminated land – Contaminated land guidelines, drawing on the radiological assessment of Radiation Safety Support Services Aus. HMC Environmental Consulting holds current Professional Indemnity Insurance to 4 August 2

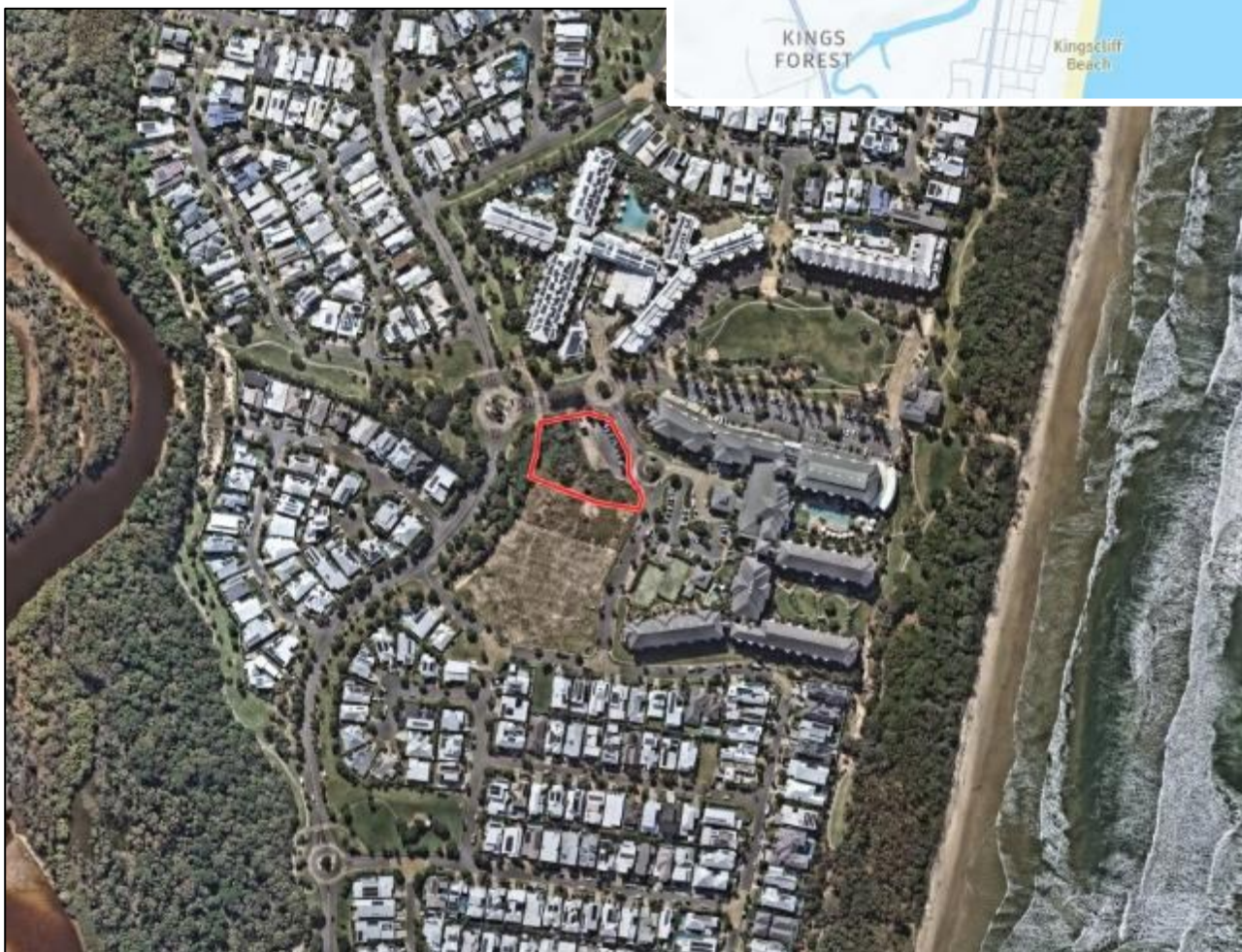
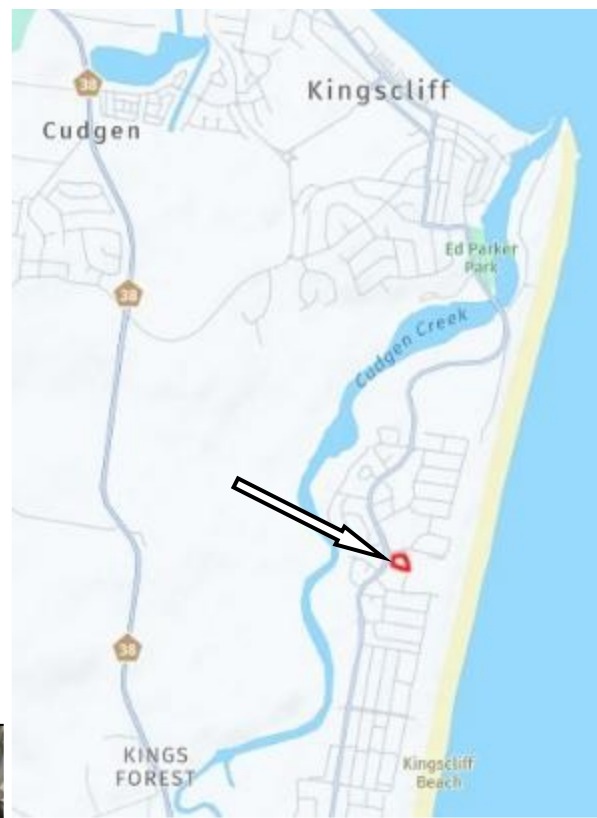


Mark Tunks
Principal
6 July 2026

8 APPENDICES

See following pages.

APPENDIX 1 - LOCATION MAPS



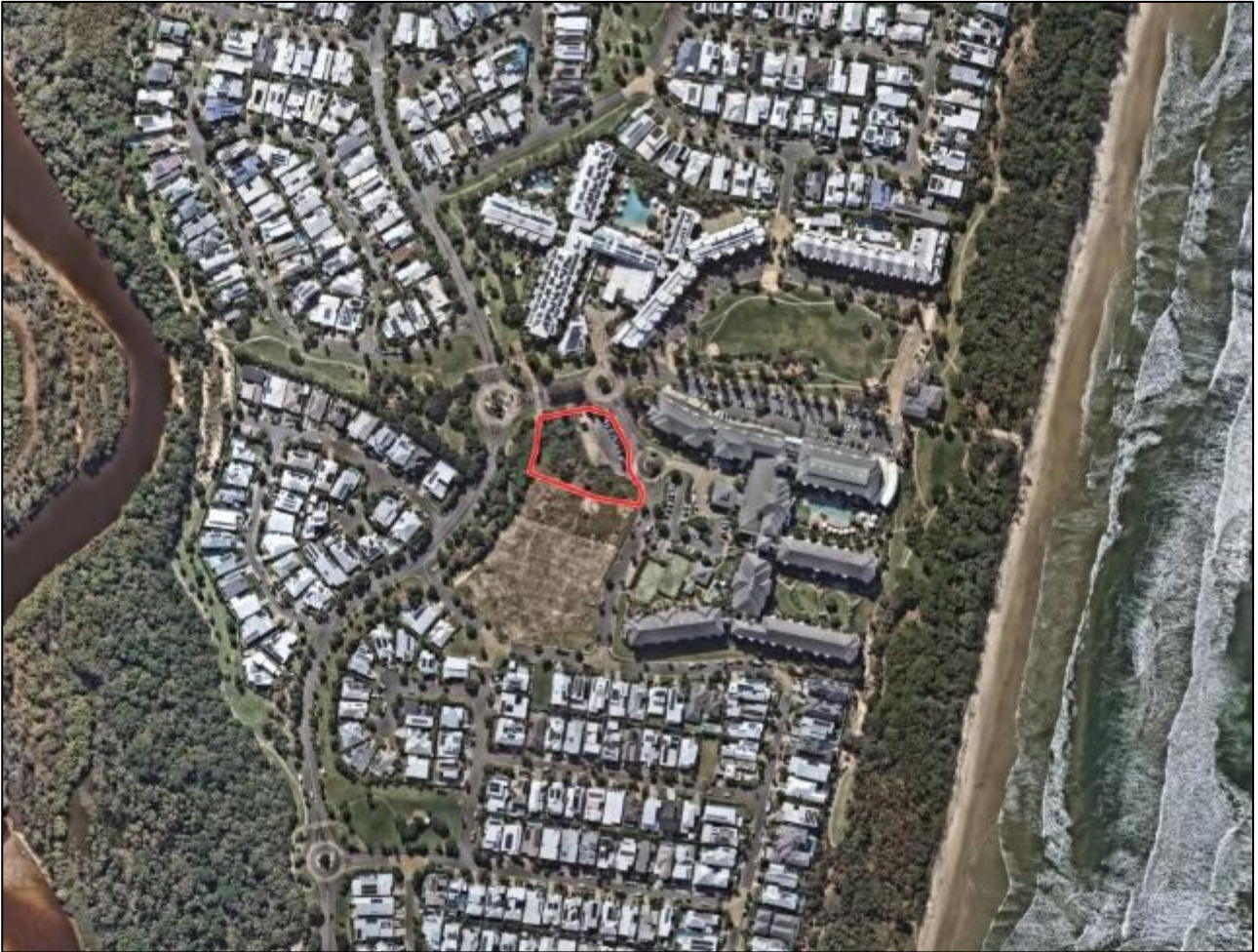
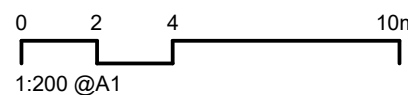
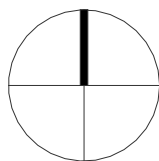


Figure 1 - Surrounding Area (Source: Nearmap 2025)

APPENDIX 2 - PROPOSED DEVELOPMENT

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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	29-05-2026	FOR INFORMATION	MQ	WG
2	05-06-2026	FOR INFORMATION	MQ	WG
3	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

**BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF**

Drawing Name

FLOOR PLAN - BASEMENT 01

Date

24-06-2026

Scale

1 : 200

Sheet Size

A1

Drawn

LR

Chk.

JV

Job No.

6906

Drawing No.

DA-1002

Revision

/ B

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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

TYPE	COUNT
LEVEL 00	
RETAIL	12
BASEMENT 01	
RESIDENTIAL	25
VISITOR	10
BASEMENT 02	
RESIDENTIAL	44
TOTAL	91

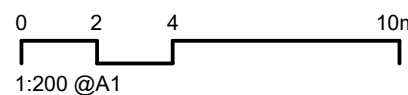
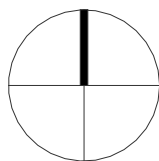
PARKING SCHEDULE

TYPE	COUNT
BASEMENT 01	
EASEMENT 2600x5400	25
EASEMENT ACCESSIBLE 2600x5400	2
SUBTOTAL	27
RESIDENTIAL 2600x5400	6
VISITOR 2600x5400	18
SUBTOTAL	24
RETAIL 2600x5400	24
RETAIL ACCESSIBLE 2600x5400	1
SUBTOTAL	25
RETAIL STAFF 2600x5400	6
RETAIL STAFF ACCESSIBLE 2600x5400	1
SUBTOTAL	7
BASEMENT 02	
RESIDENTIAL 2600x5400	110
SUBTOTAL	110
TOTAL	193

PARKING TOTALS

TYPE	COUNT
EASEMENT PARKING	25
EASEMENT ACCESSIBLE	2
RESIDENTIAL PARKING	116
RETAIL PARKING	24
RETAIL ACCESSIBLE	1
RETAIL STAFF PARKING	6
RETAIL STAFF ACCESSIBLE	1
VISITOR PARKING	18
TOTAL	193

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B	24-06-2026	FOR RFI	MQ	WG

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Client

**BELLS
BOULEVARD
PTY LTD**

Project

**BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF**

Drawing Name

FLOOR PLAN - BASEMENT 02

Date

24-06-2026

Scale

1 : 200

Sheet Size

A1

Drawn

LR

Chk.

JV

Job No.

6906

Drawing No.

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Revision

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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

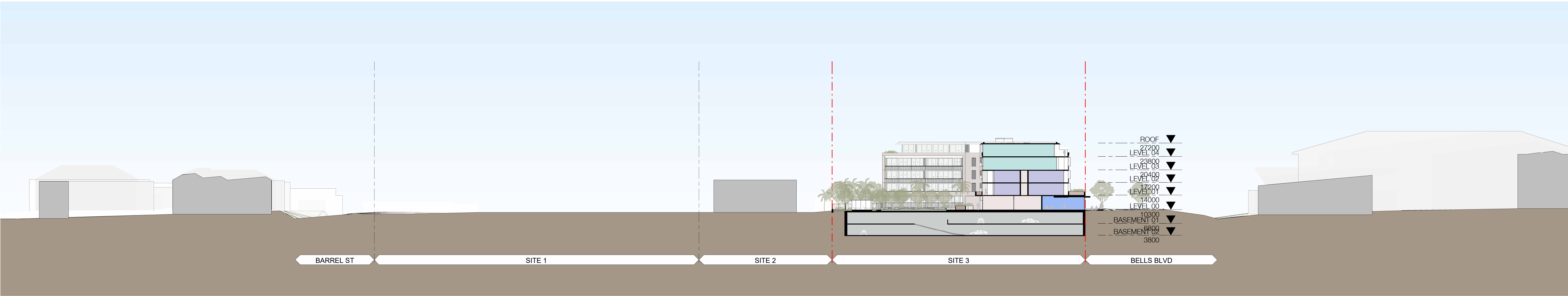
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BASEMENT 02	
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TOTAL	91

PARKING SCHEDULE

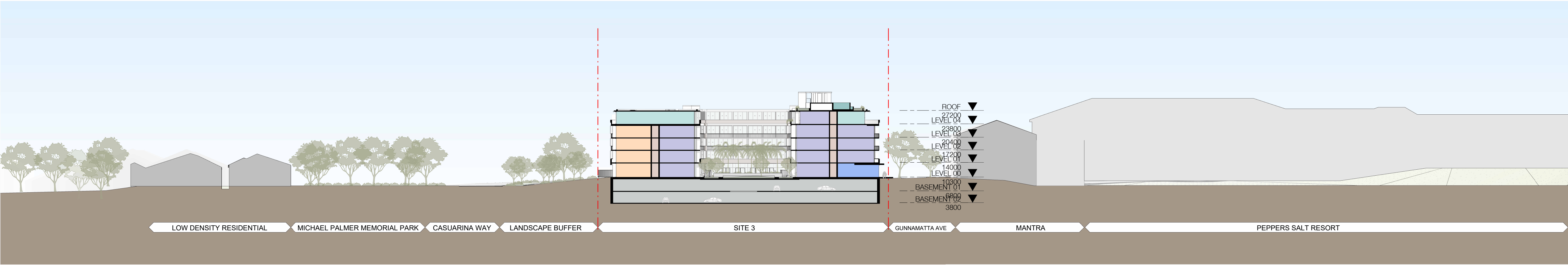
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RETAIL ACCESSIBLE 2600x5400	1
SUBTOTAL	25
RETAIL STAFF 2600x5400	6
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SUBTOTAL	7
BASEMENT 02	
RESIDENTIAL 2600x5400	110
SUBTOTAL	110
TOTAL	193

PARKING TOTALS

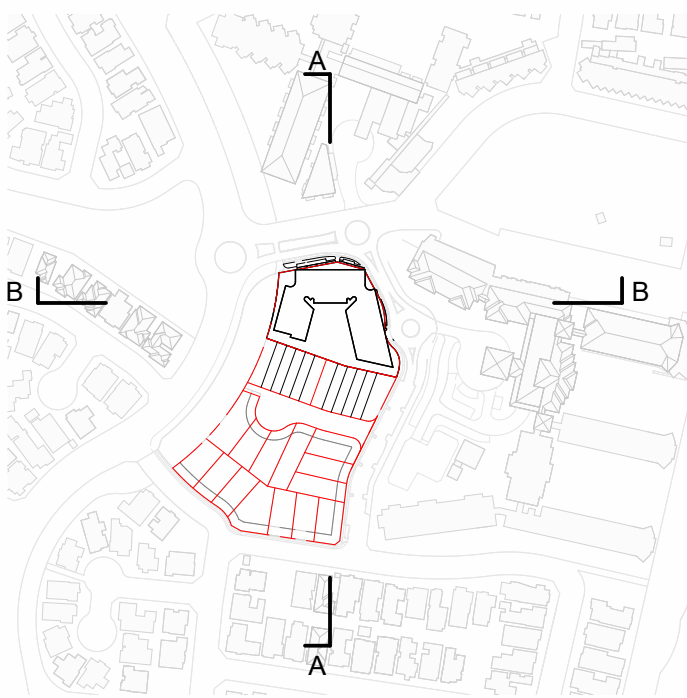
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RETAIL PARKING	24
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RETAIL STAFF PARKING	6
RETAIL STAFF ACCESSIBLE	1
VISITOR PARKING	18
TOTAL	193



OVERALL SECTION A
SCALE 1:500



OVERALL SECTION B
SCALE 1:500



KEYPLAN

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Rev	Date	Revision	By	Chk.
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Client

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Project

BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF

Drawing Name

OVERALL SECTIONS

Date

24-06-2026 1:500

Scale

Sheet Size

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Chk.

JV

Job No.

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Drawing No.

DA-1500

Revision

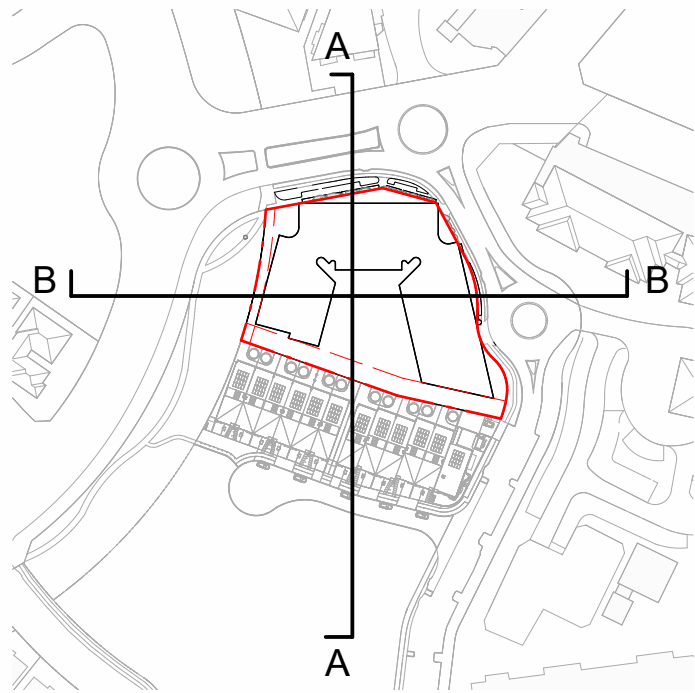
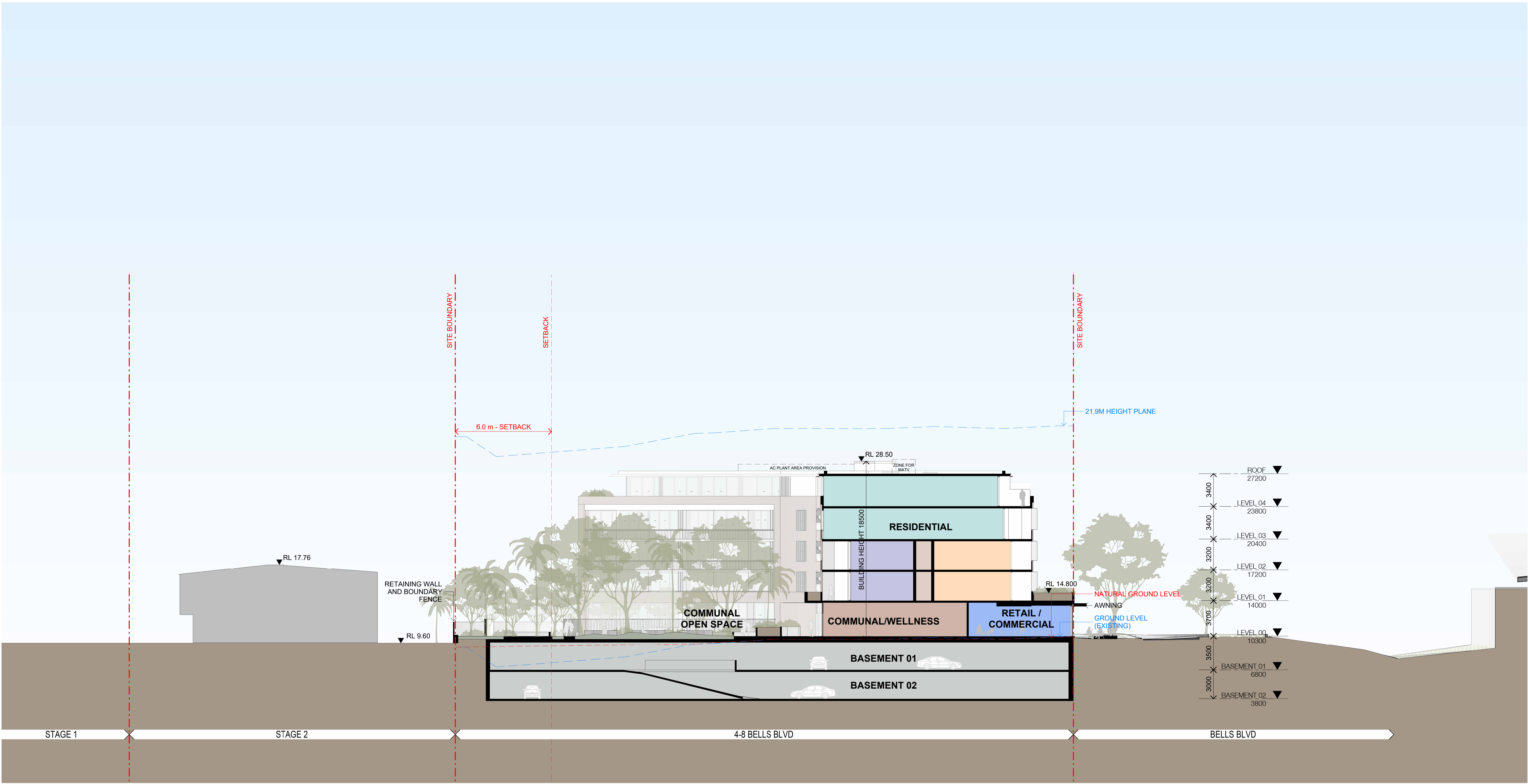
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SECTION A
SCALE 1:200

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Client

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PTY LTD**

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**BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF**

Drawing Name

BUILDING SECTION A

Date

24-06-2026

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LR

Chk.

JV

Job No.

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Drawing No.

DA-1503

Revision

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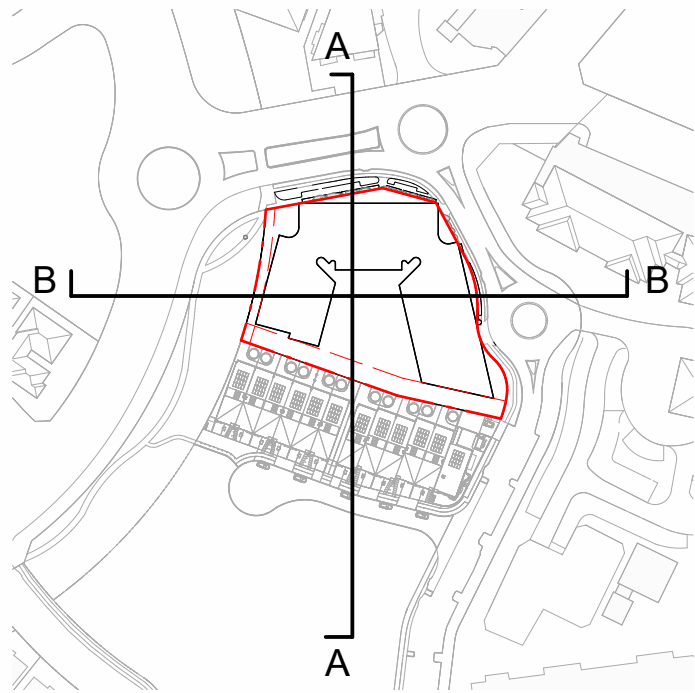
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Client

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Project

**BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF**

Drawing Name

BUILDING SECTION B

Date

24-06-2026

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Chk.

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Job No.

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Drawing No.

DA-1504

Revision

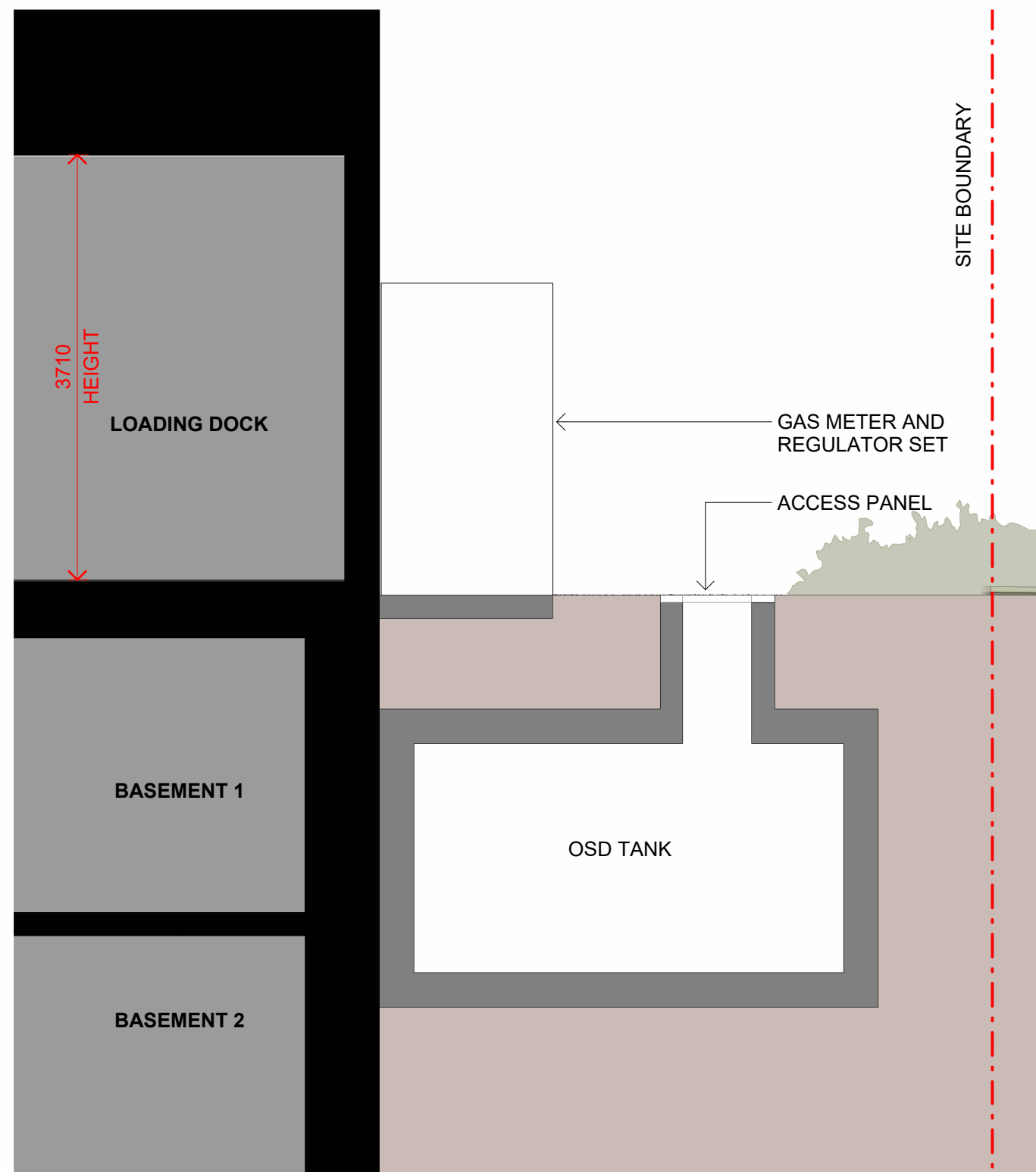
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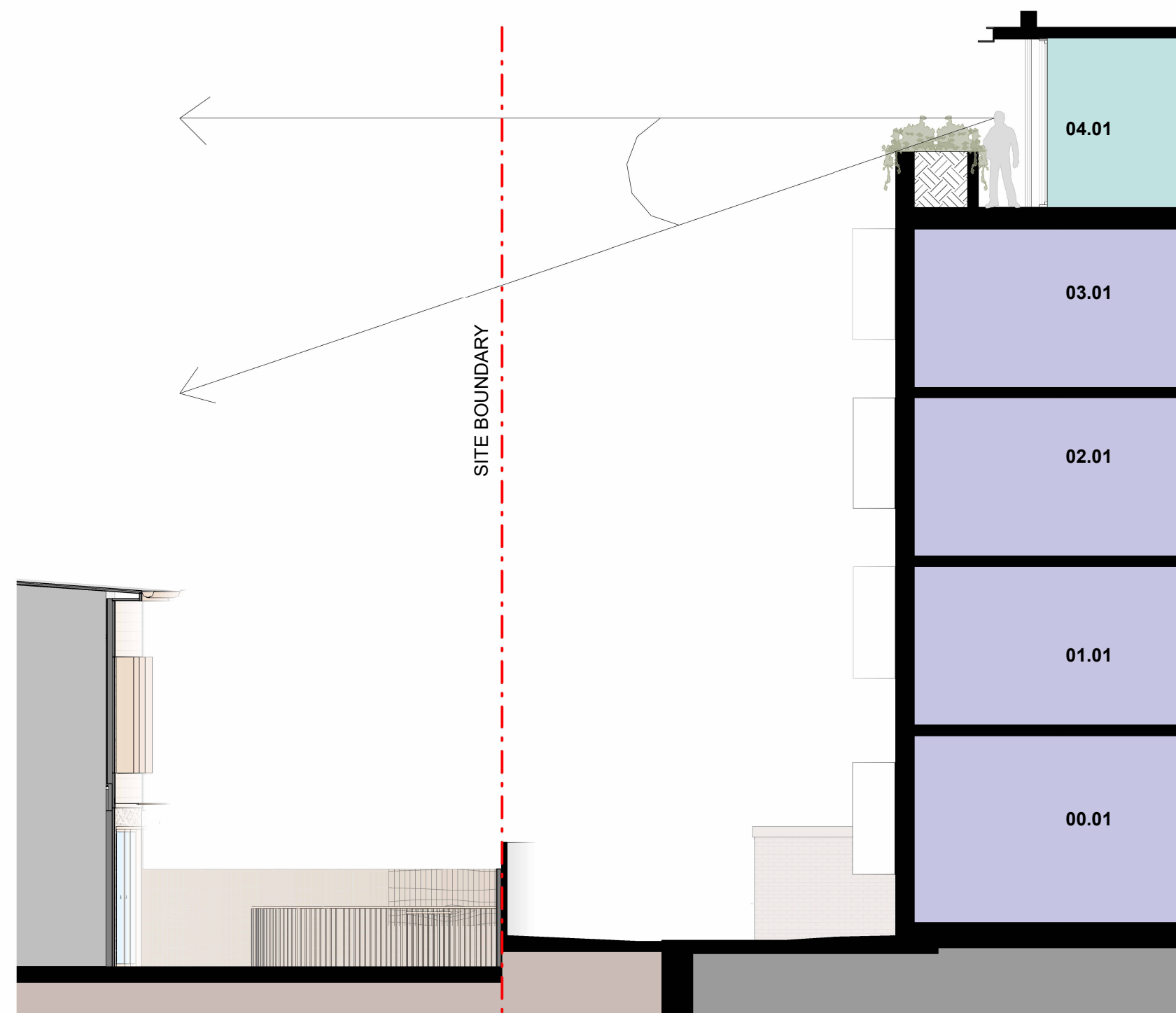
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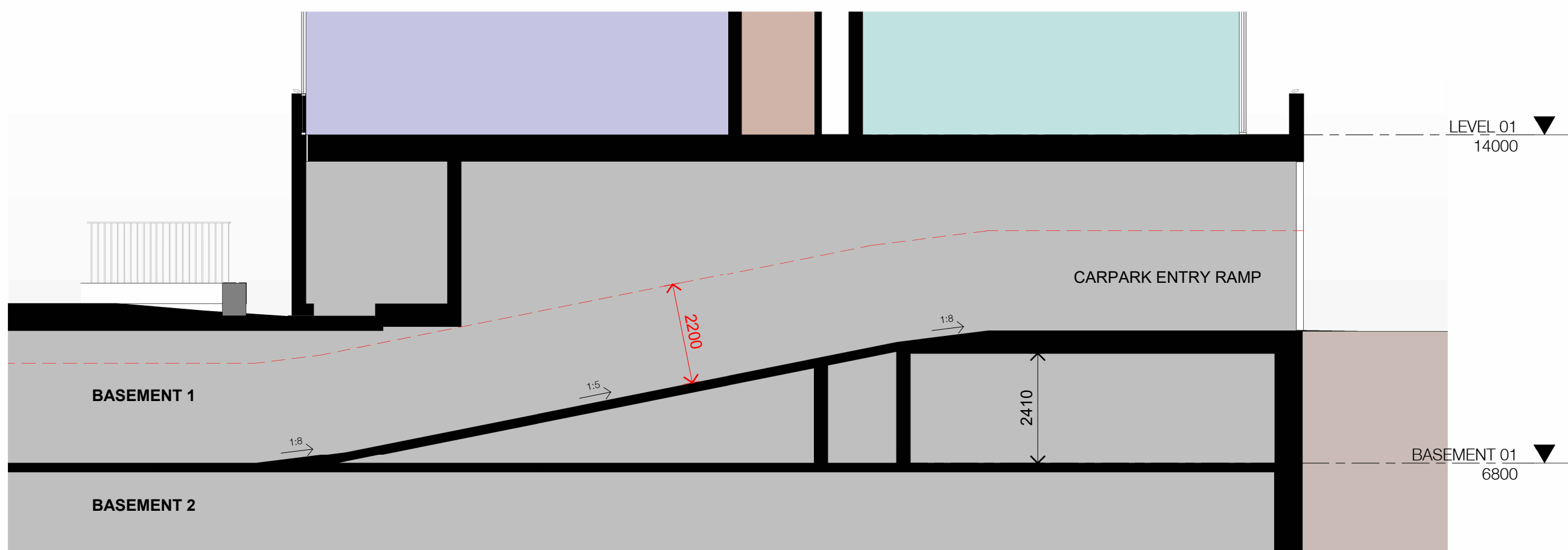




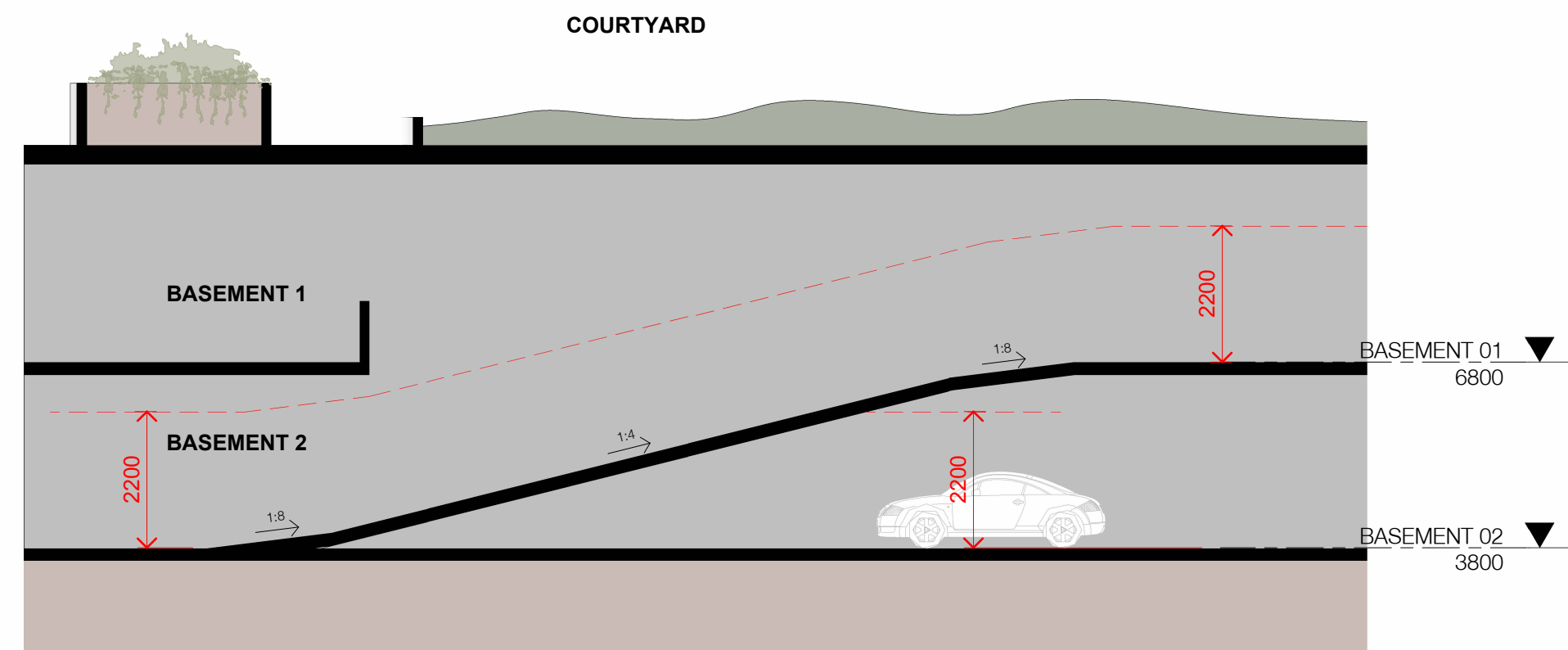
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2 SECTION_OVERLOOKING STUDY
DA-1002 SCALE 1:100



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

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Client

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PTY LTD

Project

BELLS BOULEVARD
4-8 BELLS BOULEVARD, KINGSCLIFF

Drawing Name

DETAIL SECTIONS

Date

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Scale

Sheet Size

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Drawn

MQ

Chk.

WG

Job No.

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Drawing No.

DA-1505

Revision

/ A

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NOT FOR CONSTRUCTION

APPENDIX 3 - SAMPLE LOCATIONS

**RADIATION ASSESSMENT
SAMPLING LOCATIONS**

 **Proposed Basement
Car Park**

 **RSSSA Sampling
Locations
(20/05/2026)**



**Lot 2 DP 1310938
4-8 Bells Boulevard
Kingscliff NSW**

Job: HMC2025.1646
Date: July 2026
Rev:
Drawn: JL
BASE: Nearmap 2025

HMC Environmental Consulting Pty Ltd
Tweed Heads NSW
0755368863
www.hmcenvironment.com.au
admin@hmcenvironment.com.au

Scale:

0 10 20m



APPENDIX 4 - PHOTOGRAPHIC LOG





Photo No. 3	Date 20/05/2026	
Description: BH1 (Radiation sampling location) showing brown sand soil profile		

Photo No. 4	Date 20/05/2026	
Description: BH1 (Radiation sampling location) showing dark grey sand lens in soil profile		

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		

APPENDIX 5 - BORELOGS

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

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

BH 3 Terminated at 3m

Page 1 of 1

UTM : 56S Easting (m) : 556449.00 Northing (m) : 6871863.00 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 :
--	--	---

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	St Stiff	PL plastic limit	DCP	DD dry density
RP ripper		VSt Very stiff	LL liquid limit		LL liquid limit
		H Hard			PL plastic limit
		Density	Soil Samples		LS linear shrinkage
		VL Very loose	B bulk		CC undrained console cohesion
		L Loose	D disturbed		CF undrained console friction angle
		MD Medium dense	U(63) U(63) push tube		FH falling head permeability
		D Dense	U(50) U(50) push tube		CH constan head permeability
		VD Very dense	WS water		CBR californian bearing ratio

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	Drill Rig :	Job Number : GI 3624-f
Easting (m) : 556469.25	Driller Supplier : GeoTech Investigations	Client : Podia
Northing (m) : 6871839.67	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
		1 <								

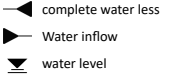
Job Number : GI 3624-f
Client : Podia
Project : Proposed 2 Lot Subdivision
Location : 4-8 Bells Blvd, Kingscliff NSW 2487, Australia
Loc Comment :

BH 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		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 DCP	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					
NE natural exposure					
EE existing xcavation					
RP ripper					
	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	Soil Samples B bulk D disturbed U(63) U(63) push tube U(50) U(50) push tube WS water		

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
		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  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		PL plastic limit	DCP	DD dry density
RP ripper	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	VSt Very stiff H Hard	LL liquid limit		LL liquid limit
		Density	Soil Samples		PL plastic limit
		VL Very loose L Loose MD Medium dense D Dense VD Very dense	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) : 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 :
--	--	---

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  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 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	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					

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				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				SPT 6,7,20 N = 27		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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Fax: 0755 233 981

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?	
		6.5			MD				
		7.0							
		7.5				SPT 7,8,10 N = 18			
		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							
		11.5							
				(SP) SAND: Fine to medium sand, Wet, Pale brown	VD	SPT 11,19,30 /130mm N > 50		ALLUVIUM?	

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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			

APPENDIX 6 - RSSA RADIATION ASSESSMENT REPORT



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

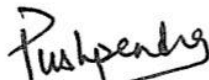
Traceability

- ☐ 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 γ -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).

Enquiries: Principal Health Physicist
Phone (+61) 7 3096 2901

39 Kessels Road
Coopers Plains QLD 4108
AUSTRALIA

PO Box 594
Archerfield QLD 4108
AUSTRALIA

Phone (+61 7) 3096 2900
Email RadiationSciences@health.qld.gov.au



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.

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Enquiries
Phone Principal Health Physicist
(+61) 7 3096 2901

39 Kessels Road
Coopers Plains QLD 4108
AUSTRALIA

PO Box 594
Archerfield QLD 4108
AUSTRALIA

Phone (+61 7) 3096 2900
Email RadiationSciences@health.qld.gov.au



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).

Enquiries
Phone

Principal Health Physicist
(+61) 7 3096 2901

39 Kessels Road
Coopers Plains QLD 4108
AUSTRALIA

PO Box 594
Archerfield QLD 4108
AUSTRALIA

Phone (+61 7) 3096 2900

Email RadiationSciences@health.qld.gov.au



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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Email: RadiationSciences@health.qld.gov.au

**APPENDIX 7 - 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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- 2 Contamination Isopach Plan
- 3 Past Aerial Photographs
- 4 Queensland Department of Health Radiation Investigation Reports
- 5 Remediation Excavation Plan
- 6 Occupational Health & Safety Guideline

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.

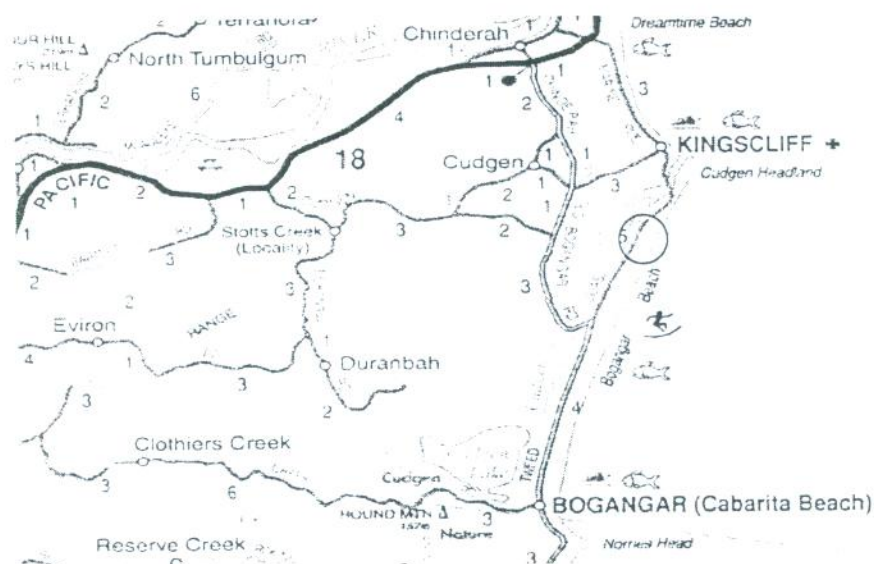


Figure 2.1 Locality map with site location circled

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.



South Kingscliff Developments Pty Ltd
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

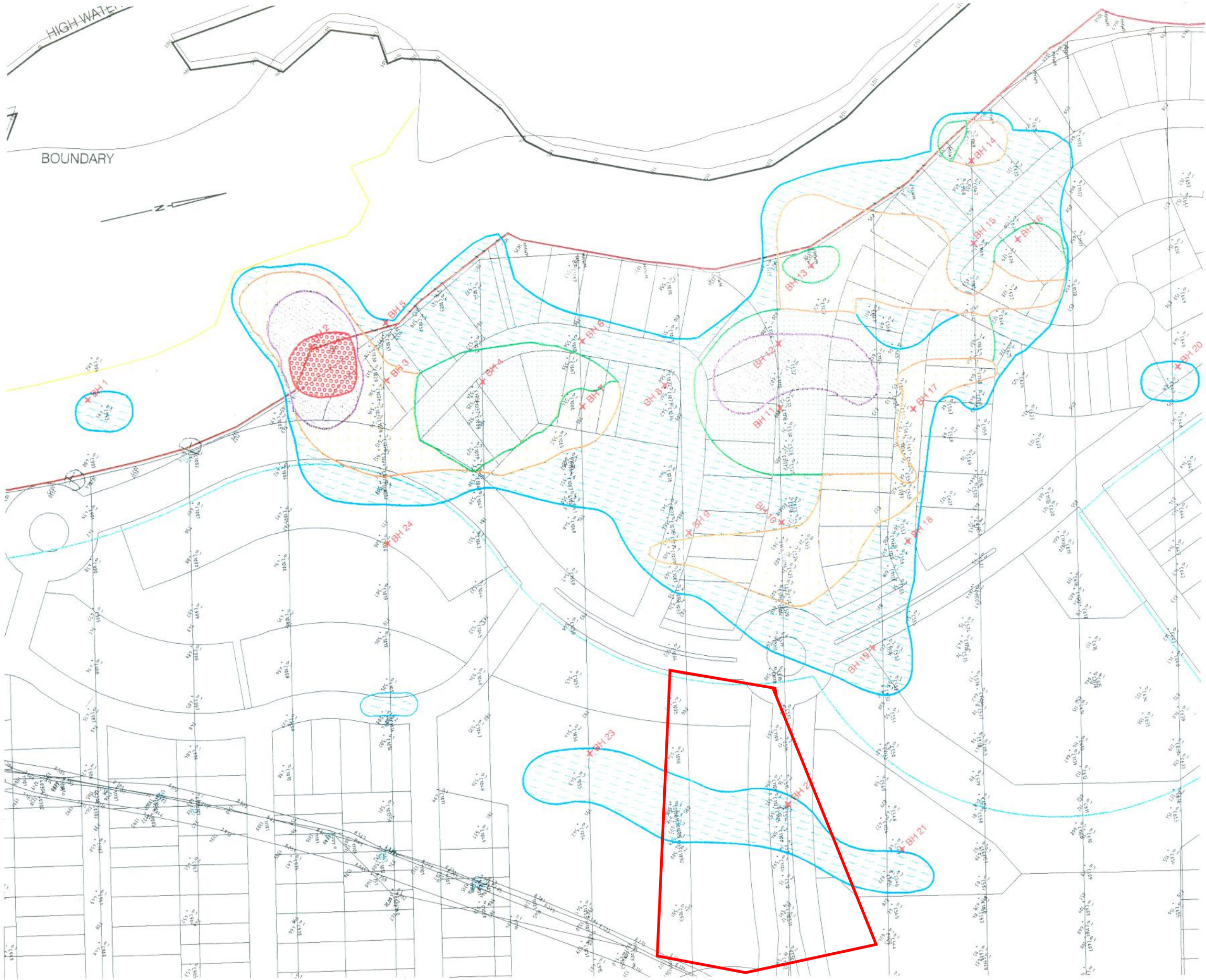
SITE LAYOUT/SITE INVESTGATION PLAN



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
- BH 23 BORE HOLE

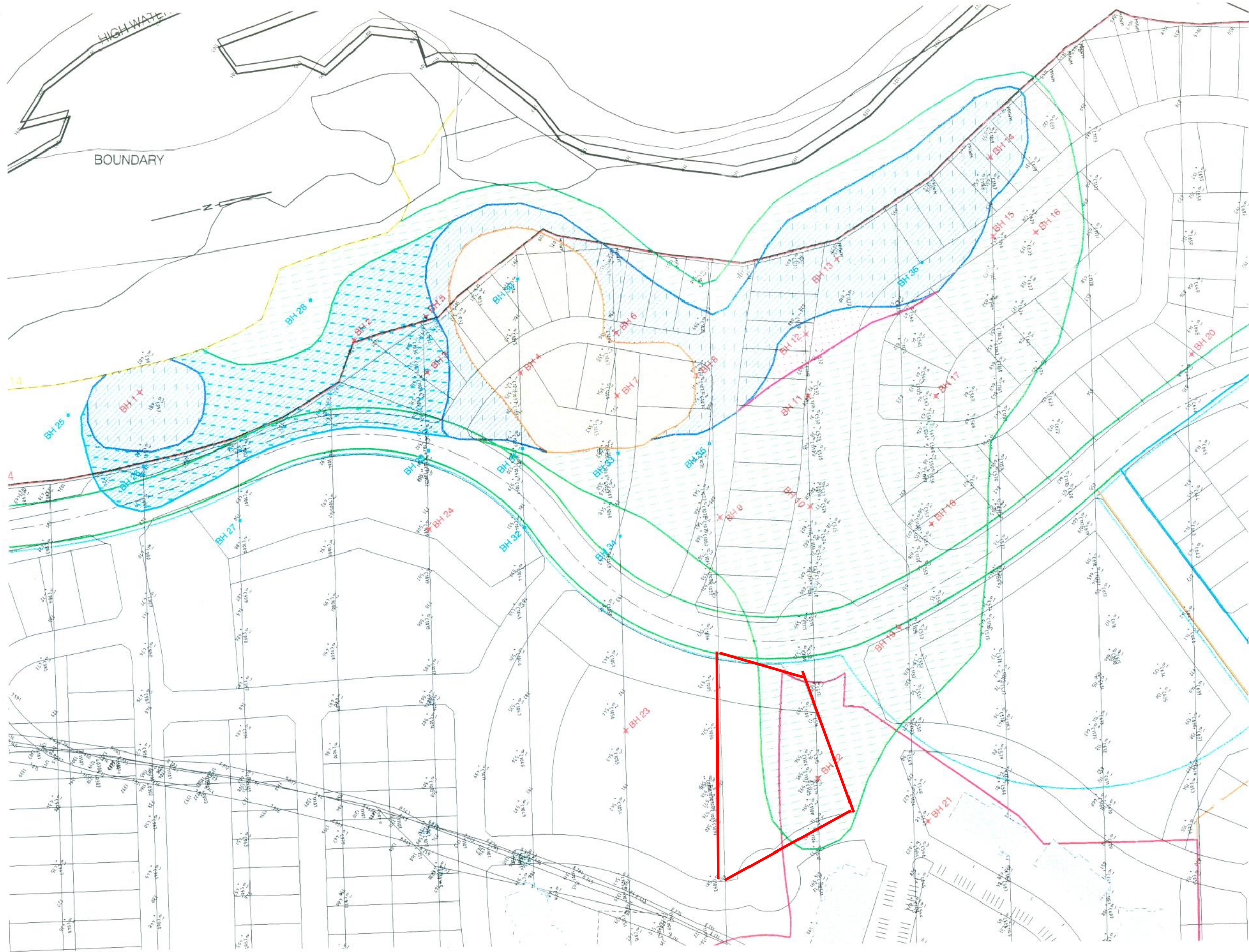


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 AutoCAD Filename: G:\708301\85\Sketch\70830185-sk04.dwg

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

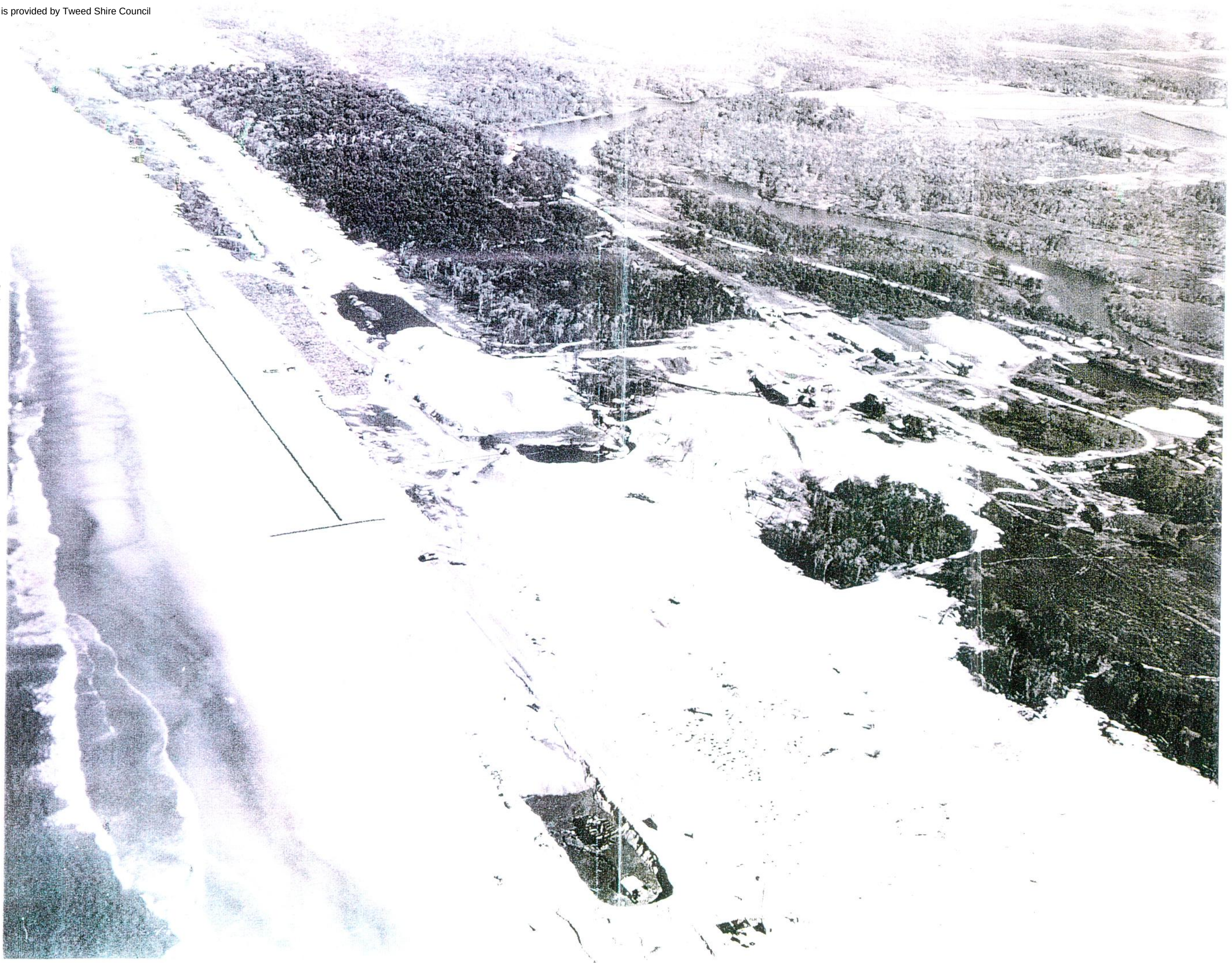
SK No. 9 (22/07/02)
DETAILED DEPTH ASSESMENT

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

Queensland Health

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 $0.2\mu\text{Gy.h}^{-1}$ to $2.4\mu\text{Gy.h}^{-1}$. 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.

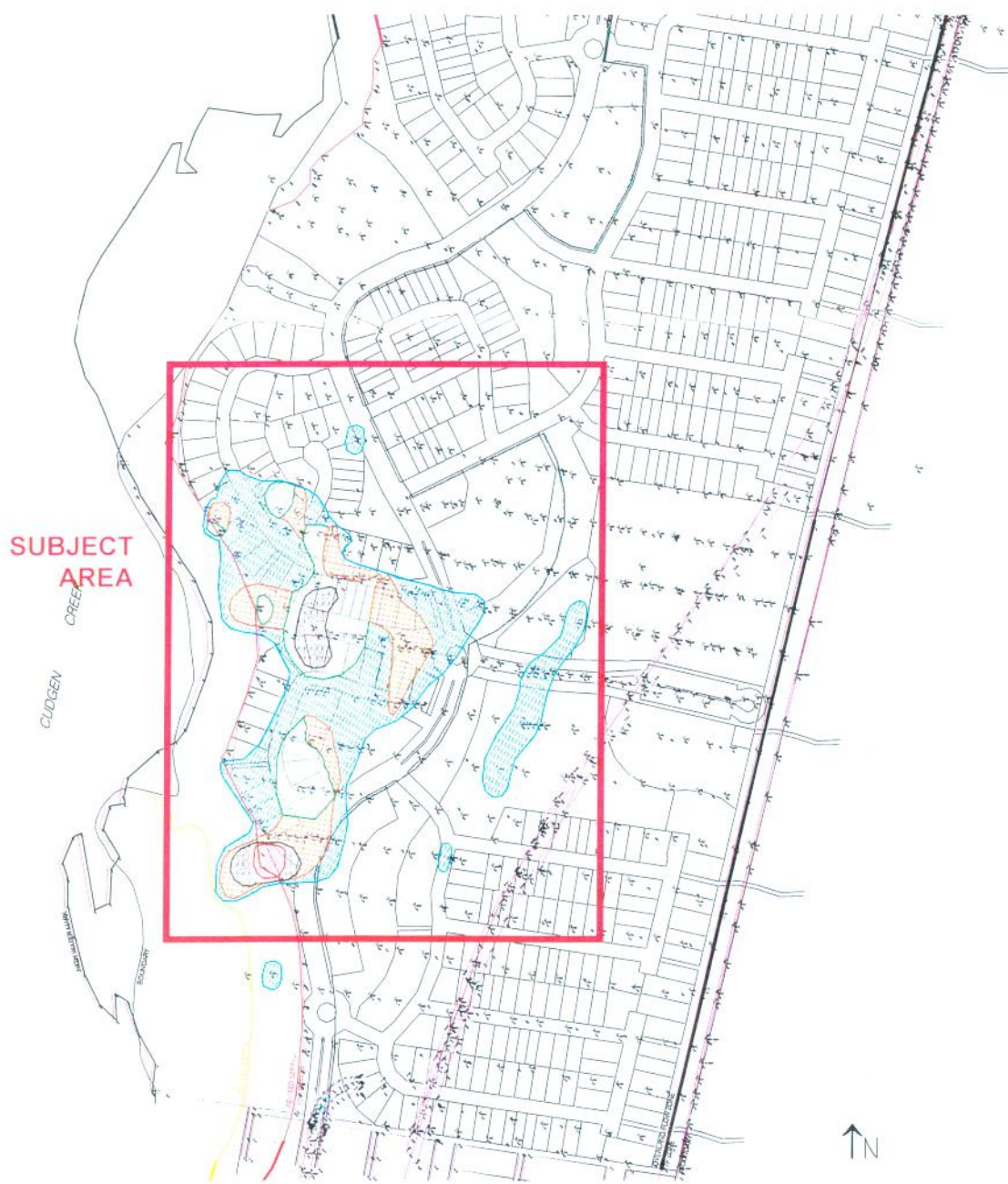
6.0 REFERENCES

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

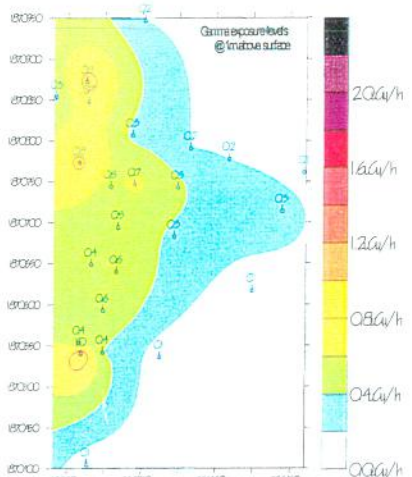


R Kleinschmidt
Senior Health Physicist
MARPS, SPERA

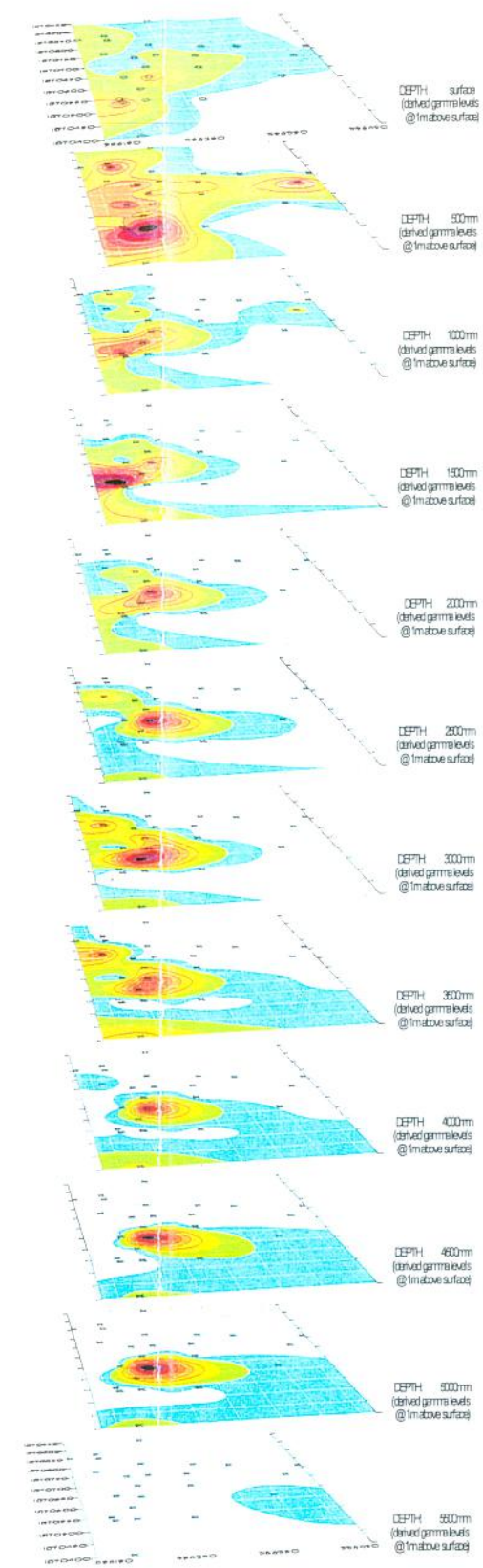
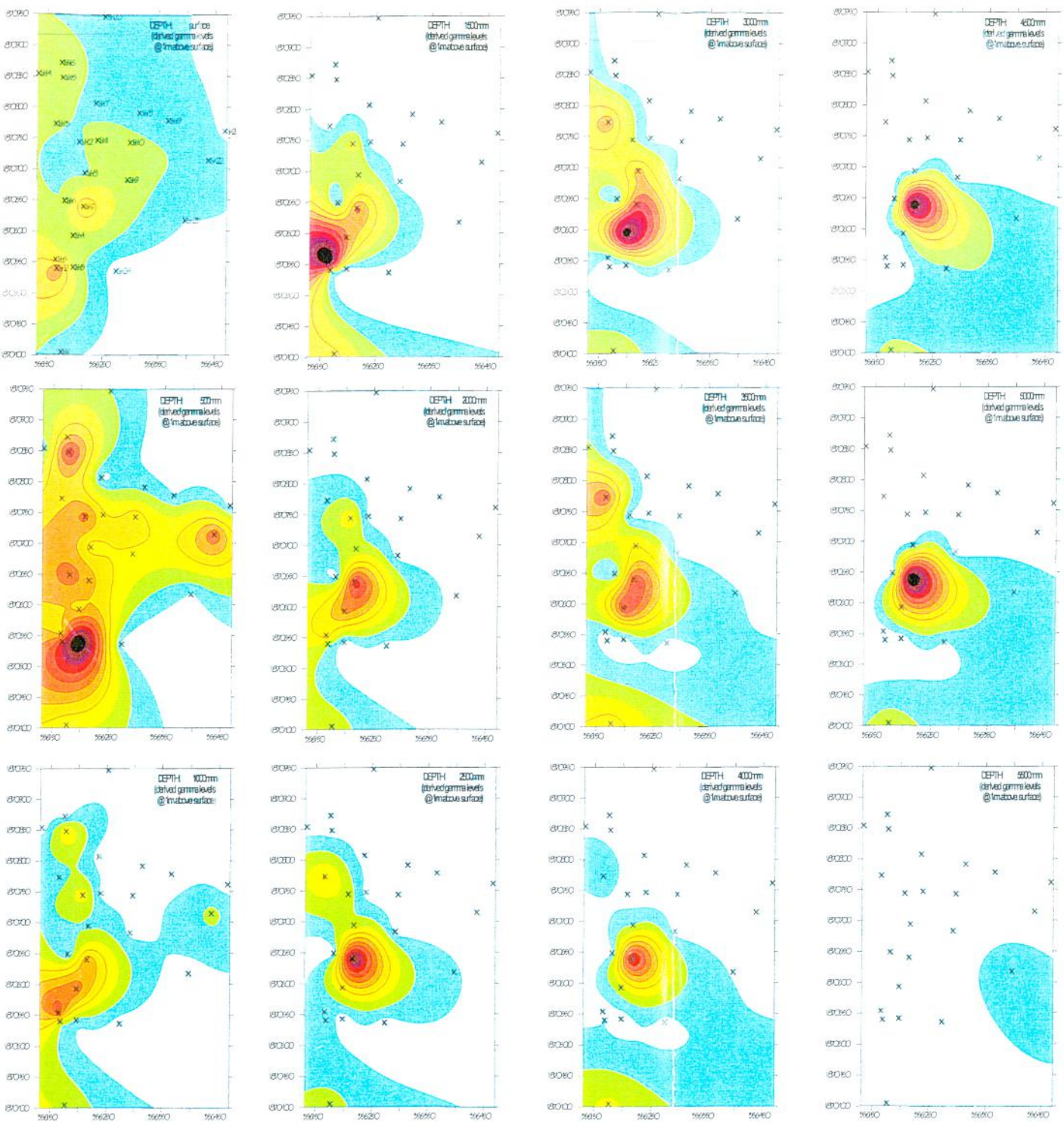
21 June 2002



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	Job/Lab No. 01PQ385	Date 19/06/02		Client CARDNO MBK (GOLD COAST)	Drawing No. FIGURE 1	Rev 1.0
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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: 6 th , 7 th & 13 th June 2002 Survey instrument: Downhole log system, Bicon Analyst + 1" dia. NaI detector		COPYRIGHT This drawing shall not be copied or reproduced by any means without the written consent of Queensland Health.	Drawn RK 	Scale 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	ABN: 66 329 169 412		Project KINGSCLIFF SOUTH PROJECT	Title DERIVED GAMMA EXPOSURE CONTOURS FOR EXCAVATED MATERIAL	
			Job/Lab No. 01PQ385	Date 19 June 2002				Client CARDNO MBK (GOLD COAST)	Drawing No. FIGURE 3	Rev 1.1
			File C:\01pq385_figure3.doc							



Enquiries: Ross Kleinschmidt

Telephone: 07 3274 9124

Facsimile: 07 3274 9123

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

Reference: 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

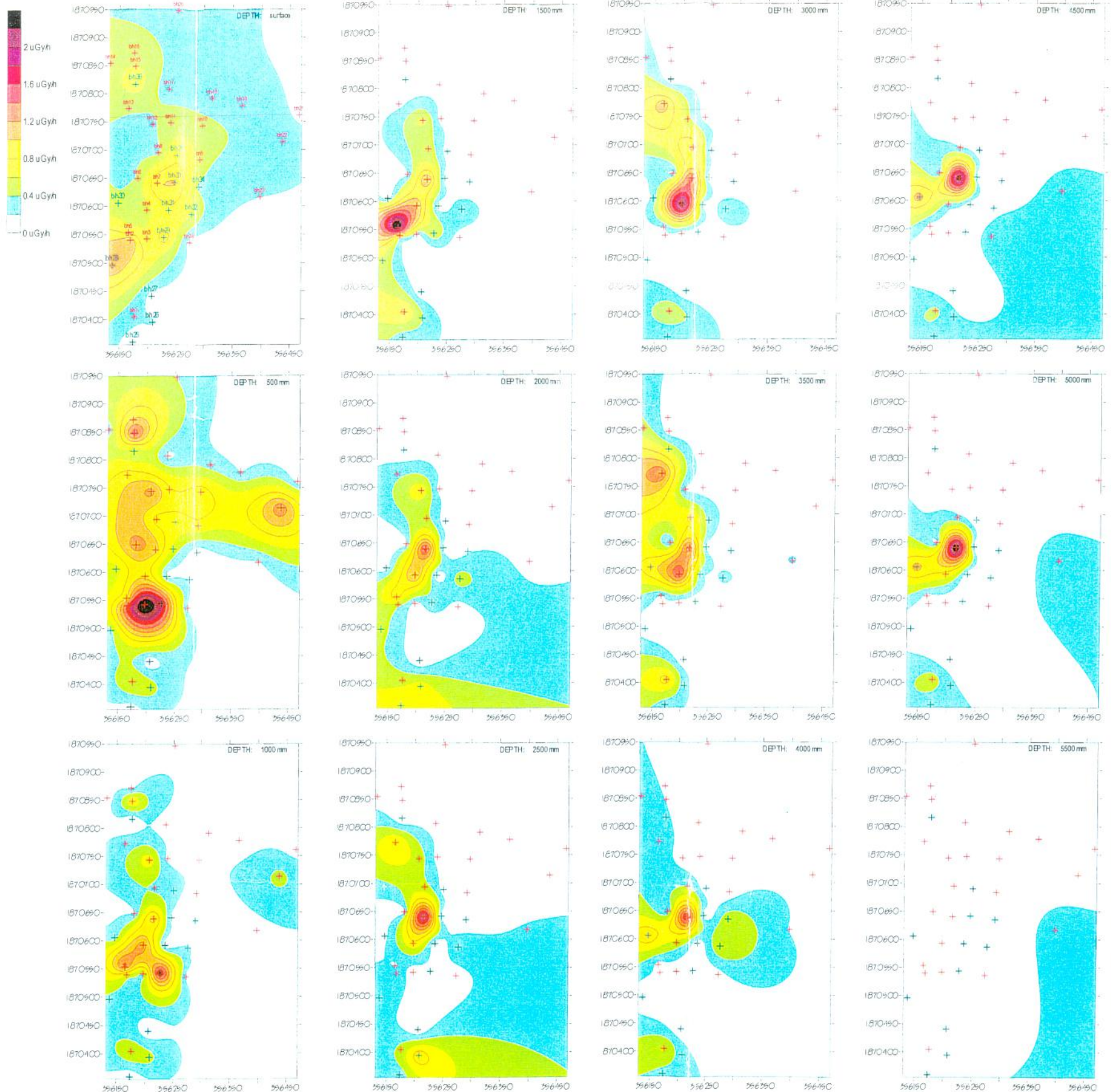
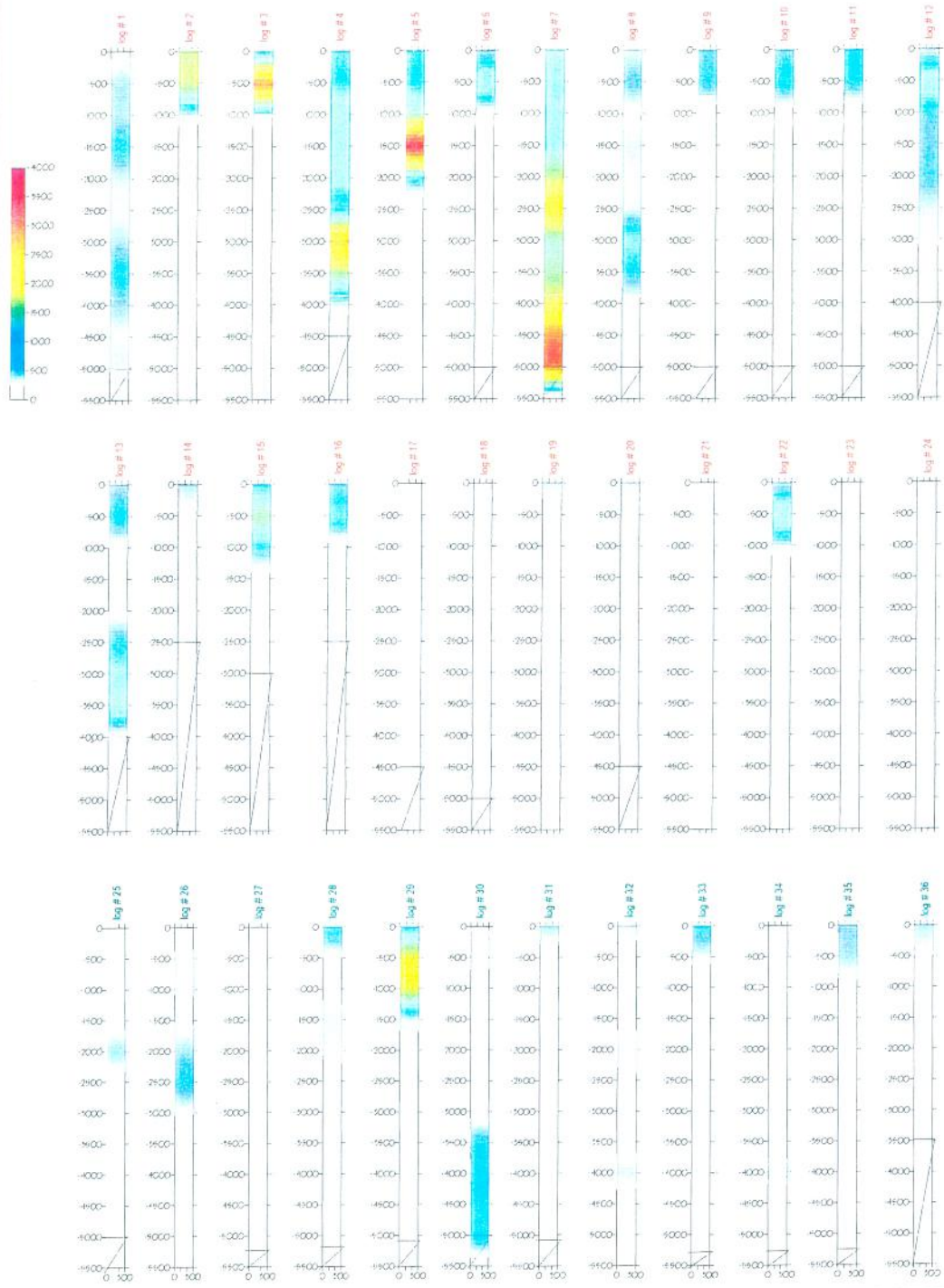
17 July 2002

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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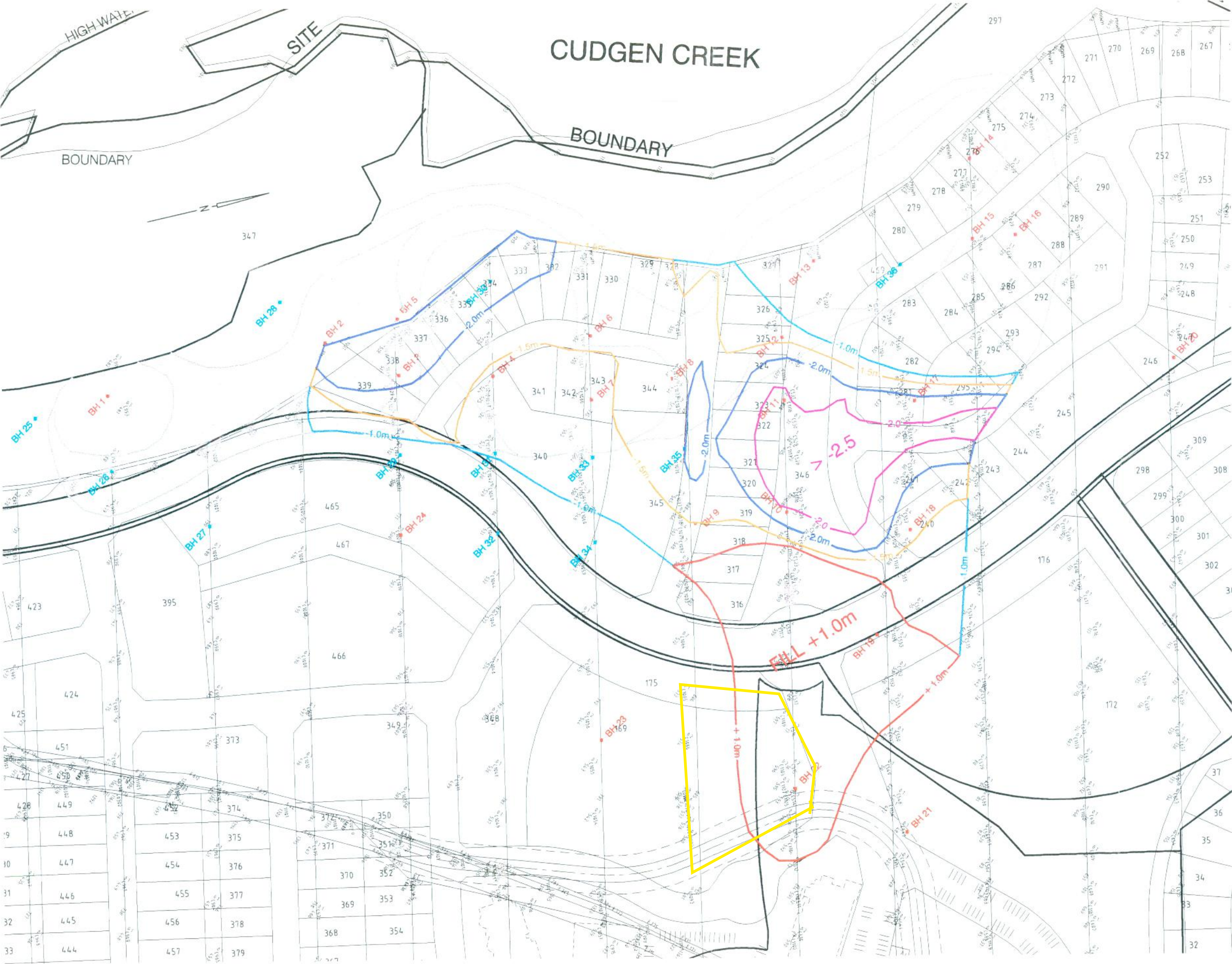


Queensland Government
Queensland Health
Scientific Services
PO Box 594 ARCHERFIELD Q 4108
Phone: 07 3274 9124 Fax: 07 3274 9123
e-mail: Ross_Kleinschmidt@health.qld.gov.au

ABN: 66 329 169 412

Project: KINGSCLIFF SOUTH PROJECT
Client: CARDNO MBK (GOLD COAST)

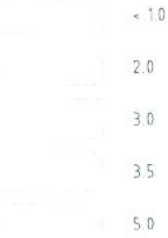
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Rev: 1.0



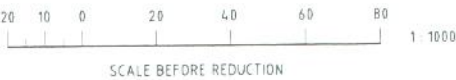
LEGEND

- 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

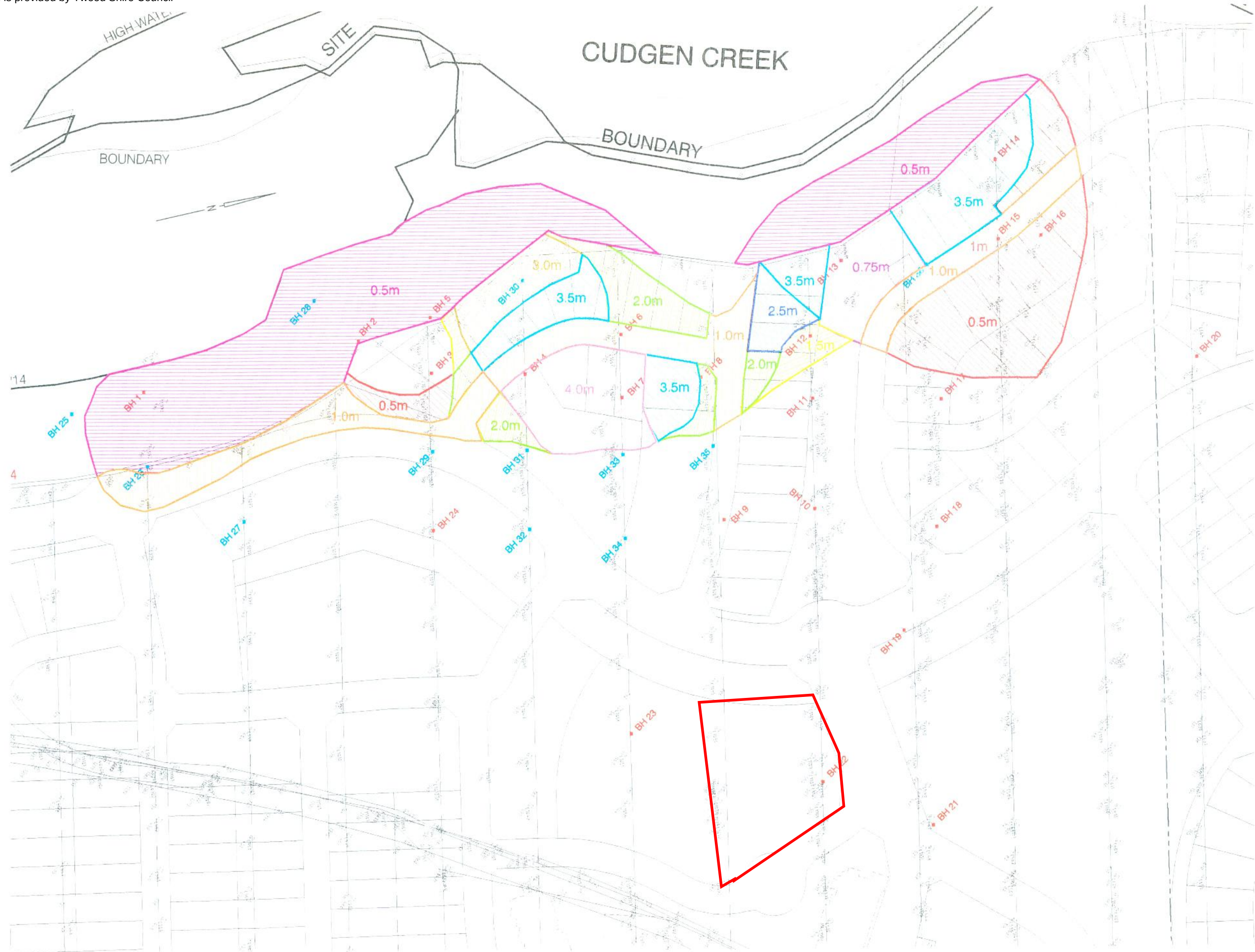
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DATE - August 2002 Rev A
JOB No 7083/1-5

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



LEGEND		
	SURFACE AREA	VOLUME
REMOVE 0.5 m	7,562m ²	3,781m ³
REMOVE 1.5m	906m ²	1,359m ³
REMOVE 2.0m	3,169m ²	6,338m ³
REMOVE 2.5m	901m ²	2,253m ³
REMOVE 3.0m	1,628m ²	4,884m ³
REMOVE 3.5m	6,100m ²	21,350m ³
REMOVE 4.0m	3,433m ²	13,732m ³
TOTAL	23,699m ²	53,697m ³

0.5m SEPP 14	18,900m ²	9,450m ³
1.0m ROAD	8,051m ²	8,051m ³
0.75m PARK	2,108m ²	1,581m ³
TOTAL	29,059m ²	19,082m ³

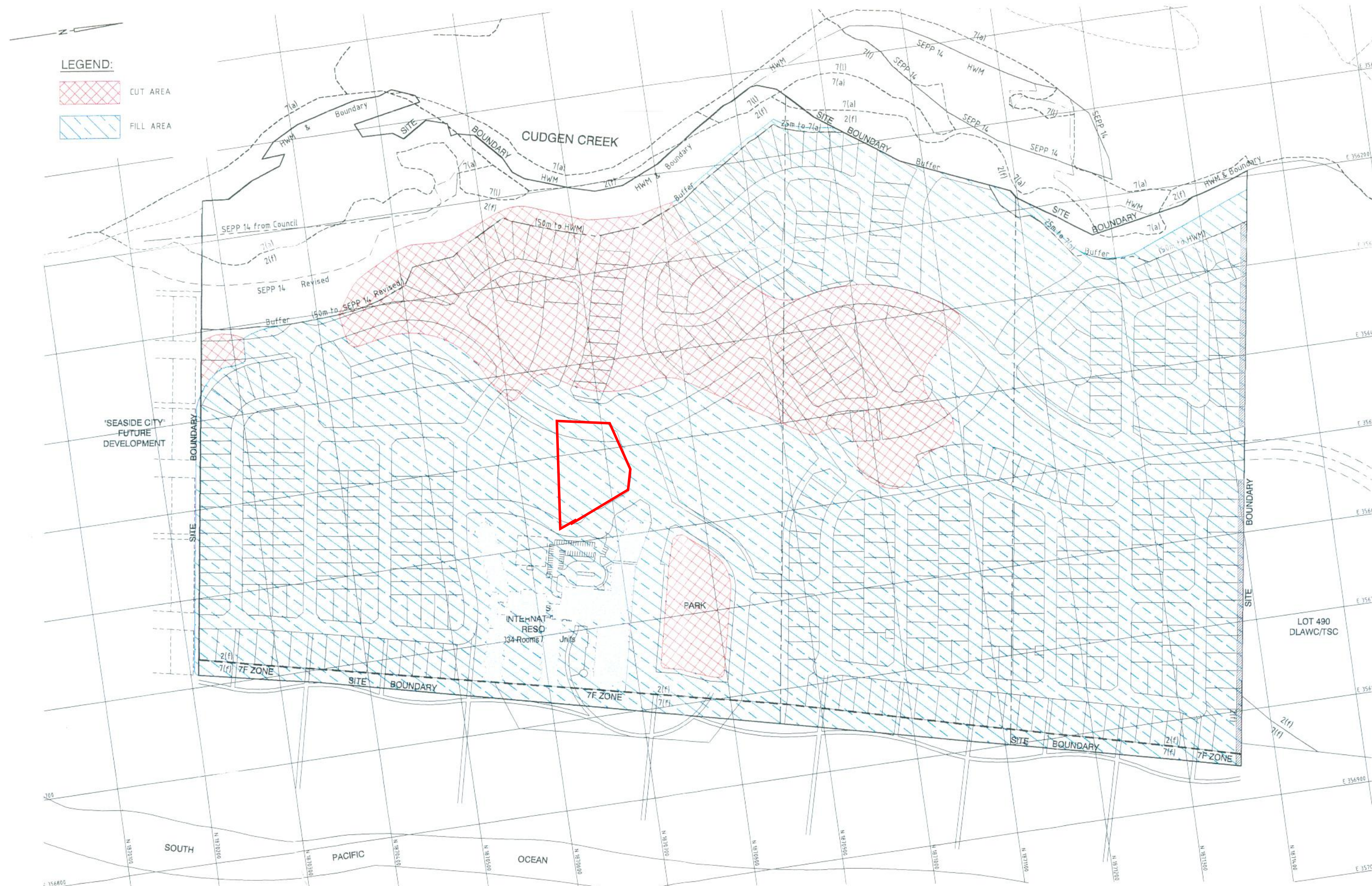
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Cardno MBK
Cardno MBK (Qld) Pty Ltd ABN 57 061 074 992
44/442 Franklin Hwy, QLD 4870 (07) 4700 0000

SOUTH KINGSCLIFF DEVELOPMENTS PTY. LTD.
C/O RAY GROUP PTY. LTD.
KINGSCLIFF SOUTH PROJECT
CONTAMINATION INVESTIGATION
7083/1-5

SK No. 13 (23/08/02)
RADIOACTIVE MATERIALS
REMAINING IN-SITU
AFTER FINAL DESIGN CUT/FILL



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SOUTH KINGSCLIFF DEVELOPMENTS PTY. LTD.					
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
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DATE - AUGUST 2002	Rev. 02				
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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).

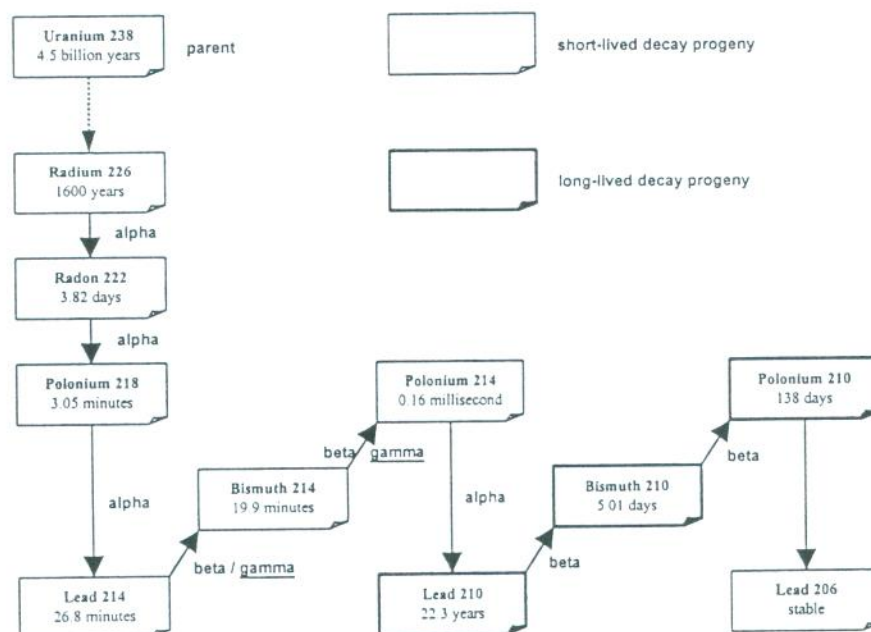


Figure A1: Uranium 238 decay series showing radionuclide half-lives and decay radiation emissions.

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.