

Appendix G Remedial Action Plan (GHD 2016)



NSW Health Infrastructure

New Maitland Hospital Stage 1 Development Area

Metford, NSW

Remedial Action Plan / Contamination Management Plan

July 2016

Executive summary

GHD was engaged by Health Infrastructure (HI) to prepare a Remedial Action Plan / Contamination Management Plan (referred to herein as the RAP) for Lot 7314 DP 1162607 (the site), being the proposed Stage 1 Development Area for a health services facility, including hospital (the New Maitland Hospital), at the former CSR/PGH clay mine and brickworks, Metford Road, Metford, NSW.

This RAP provides a summary of identified site contamination issues, and description of the proposed remediation and soil management programs, procedures and standards which are to be followed during the course of the redevelopment, to ensure the successful remediation of the site and consequently the protection of the environment and human health, so that the site can be made suitable for the nominated land uses by implementation of this RAP.

A conceptual development plan for the hospital has been developed by Woods Bagot, as illustrated by the drawings in Appendix B. It is evident that significant earthworks will be required to achieve the landform required for the proposed development. It is understood that bulk excavation is likely to be required to level the site to about RL 18 m AHD. Areas of the site, particularly within the north-western and southern strip, are at levels of up to RL 24 m AHD. Hence excavation of up to 6 m depth may be required. Depending on the final layout of the development, placement of up to 8 m of filling may be required within the former quarry floor.

On the basis of previous investigations carried out at the site, including detailed site investigations carried out by GHD in 2015, “contamination” (this term is used for convenience to indicate any materials presenting a health or environmental risk, including naturally occurring materials) at the site is considered to comprise the following:

- Fill or disturbed materials containing carbonaceous material, as well as in-situ carbonaceous material (associated with elevated concentrations of Total Recoverable Hydrocarbons (TRH) and one instance of benzene exceeding investigation levels)
- A small stockpile of polycyclic aromatic hydrocarbon (PAH) contaminated material at the north end of “Area 2”, which may correspond to stockpile SP4 (identified as contaminated with PAHs by previous investigations)
- Isolated occurrences of bonded asbestos containing materials (ACM) or potential asbestos containing materials (PACM)
- Aesthetic issues including bricks, and to a lesser extent building and domestic wastes
- Potentially combustible materials including coal and carbonaceous materials.

The findings of the investigations to date are based on lines of evidence including historical site use, site observations and sampling and analysis from discrete locations. While the site history indicates previous site use was predominantly quarrying activities, and investigations do not indicate any significant disposal of waste has occurred, smaller areas of incidental disposal are evident, and it is likely that other such areas will be encountered during redevelopment of the site. There is also a possibility that unexpected contamination could be encountered during earthworks for redevelopment of the site.

A review of remediation options has been carried out giving consideration to the nature of contamination identified at the site, and to relevant technical and policy considerations, resulting in the following preferred approach.

As a general principle in redevelopment of the site, HI has committed to using best endeavours to manage contamination on site, where appropriate. The types of contaminants identified at the

Site (primarily TRH, PAH, asbestos-containing materials and aesthetic impacts) cannot readily be destroyed, and soil treatment methods that reduce contaminant concentrations are not considered suitable for the contamination at the site. Therefore, the following remediation methods are considered appropriate for the Site:

- Physical removal and disposal of asbestos-containing materials that may be disturbed by the site works is the preferred initial remediation strategy and is consistent with regulatory requirements for PACM. Further, it is understood that CSR has committed to removal of any identified areas of ACM prior to bulk excavation works commencing. Any further remediation of ACM should be limited to “unexpected finds” as per Section 7 of the RAP.
- Visual screening and segregation of unacceptable materials (foreign inclusions, aesthetic impacts, PACM, hydrocarbon contaminated materials, potentially combustible materials) to address contamination impacts within stockpiles and across the general site area.
- Capping and containment as a conservative soil management option for segregated materials (as above) where contamination will not be subject to exposure under normal foreseeable use of the site (eg. burial at depths greater than 2 m below design structure levels or beneath permanent infrastructure as part of the redevelopment).
- Re-use of uncontaminated materials (VENM, screened overburden and fill) for bulk fill subject to geotechnical requirements or constraints.

The particular methods to be used for each material / source should be agreed with HI and their designers for the development in conjunction with finalisation of design, to account for any particular geotechnical requirements, optimise earthmoving and minimise the potential for future disturbance of contaminated or problematic materials. It is anticipated this will take the form of a material re-use schedule, to be prepared as part of final design and consistent with the principles described in this RAP. A Construction Quality Assurance (CQA) plan will be required as a basis for verifying and documenting the appropriate implementation of this RAP and final design documentation. These documents (including relevant aspects of the final design, specifications, material re-use schedule and CQA plan) shall be reviewed by the Environmental Consultant and Site Auditor prior to the commencement of remediation to confirm that they are consistent with the principles of this RAP.

It is understood that HI is developing a Contamination Finds Protocol as part of commercial negotiations with CSR. This protocol should also be taken into account in implementation of this RAP.

Interim management of the site is required between the date of this RAP and commencement of redevelopment activities, to minimise the potential for additional contamination to occur from activities such as illegal dumping, or for changes to site characteristics to occur from on-site remediation activities in other areas of the CSR property that may affect the site.

A Long Term Site Management Plan (LTSMP) will be required following completion of the development earthworks, to record the placement of any contaminated or combustible material on site, and provide procedures to be used in the event that it should be disturbed.

GHD considers that the site can be made suitable for the proposed use (Health Services Facility, including hospital) subject to implementation of this RAP during earthworks undertaken for development of the site.

Table of contents

1.	Introduction.....	1
1.1	Introduction	1
1.2	Proposed development	1
1.3	Purpose of this RAP / Contamination Management Plan	2
1.4	Objectives	2
1.5	Scope of work	2
1.6	Roles and responsibilities	3
2.	Summary of site conditions	4
2.1	Site location and description	4
2.2	Surrounding land use	5
2.3	Environmental setting	5
2.4	Previous investigations	6
2.5	GHD (2015).....	7
2.6	Site contamination status.....	9
2.7	Data gaps – level of confidence in findings	12
2.8	Refined site conceptual model.....	12
2.9	Site and material suitability	15
3.	Relevant guidelines and legislation.....	17
3.1	Guidelines for contamination assessment and management.....	17
3.2	State legislation and guidelines	18
3.3	Commonwealth Legislation.....	20
4.	Assessment criteria	21
4.1	Relevant guidelines.....	21
4.2	Soil assessment/validation criteria.....	21
4.3	Waste classification criteria	25
4.4	Surface water and groundwater.....	25
5.	Remediation options review	26
5.1	Overall objectives and remediation goals	26
5.2	Technical and policy considerations	26
5.3	Evaluation of remediation technologies	27
5.4	Recommended remediation/soil management options	30
5.5	Applicability to particular areas	31
6.	Remediation works plan.....	32
6.1	Preliminaries	32
6.2	Site mobilisation	33
6.3	Vegetation clearance	33
6.4	Asbestos management	33
6.5	Development earthworks	34

6.6	On site re-use of materials –burial at depth or capping.....	36
6.7	Transport of material.....	39
6.8	Site reinstatement.....	40
6.9	Imported fill materials.....	40
6.10	Interim site management.....	41
6.11	Long term site management.....	41
7.	Remediation contingency plan.....	42
7.1	Unexpected finds protocol.....	43
7.2	Emergency response plan - environmental protection and pollution control.....	43
8.	Protection of environment and community.....	44
8.1	Interim controls.....	44
8.2	Hours of operation.....	44
8.3	Contact details during remediation.....	44
8.4	Heritage and ecology issues.....	45
8.5	Containing contaminated material.....	45
8.6	Traffic movements and management.....	47
9.	Data quality objectives.....	48
9.1	Step 1: The “Problem”.....	48
9.2	Step 2: Identification of the decision(s).....	48
9.3	Step 3: Inputs to the decision.....	49
9.4	Step 4: Boundaries of the study.....	49
9.5	Step 5: Site decision rule.....	49
9.6	Step 6: Specify limits on decision errors.....	49
9.7	Step 7: Optimising the design for obtaining data.....	50
9.8	Data quality indicators.....	50
10.	Health and safety.....	52
10.1	Workplace health and safety.....	52
10.2	Community health and safety.....	53
11.	Community consultation.....	54
12.	Regulatory requirements.....	55
12.1	Preparation of the RAP.....	55
12.2	Remediation notification or consent.....	55
12.3	Maitland City Council requirements.....	56
12.4	Asbestos removal regulations and code of practice.....	56
12.5	Protection of the Environment Operations Act 1997.....	57
13.	Conclusion.....	58
14.	Limitations.....	60
15.	References.....	62
	Quality assurance/quality control plan.....	80

Table index

Table 2-1	Summary of site conditions.....	5
Table 2-2	Soil Contamination status summary by Area.....	9
Table 2-3	Potential SPR linkages for the site	13
Table 4-1	Soil assessment criteria – asbestos	24
Table 5-1	Overview of remediation technologies.....	28
Table 6-1	Bulk earthworks – tasks and responsibilities	34
Table 7-1	Contingency procedures.....	42
Table D-1	Soil assessment criteria – heavy metals.....	69
Table D-2	Soil assessment criteria – TRH and BTEX.....	70
Table D-3	Soil assessment criteria – PAHs.....	72
Table F-4	Guidelines for Assessment of Quality Control Results	83

Appendices

Appendix A – Figures
Appendix B – Woods Bagot Conceptual Drawings
Appendix C – Combined Analytical Results Tables
Appendix D – Validation criteria
Appendix E Unexpected Finds Protocol
Appendix F Validation methodology and QA/QC

List of abbreviations

ACM	Asbestos Containing Material
ANZECC	Australia and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BaP	Benzo(a)pyrene
bgl	Below ground level
BTEXN	Benzene, toluene, ethyl benzene and xylenes plus naphthalene
BTOC	Below top of casing (well casing)
CLM Act	Contaminated Land Management Act 1997(incorporating amendments made by the Contaminated Land Management Amendment Act 2003)
COC	Chain of Custody
CoPC	Contaminant of Potential Concern
CQA	Construction Quality Assurance
DP	Deposited Plan
DQO	Data quality objectives
EIL	Ecological Investigation Level
EPA	Environment Protection Authority
ESL	Ecological Screening Level
<	Less than (laboratory reporting limit or PQL)
GIL	Groundwater Investigation Level
Ha	Hectare
HIL	Health Investigation Level (relating to defined land use scenario)
HI	NSW Health Infrastructure
HSL	Health Screening Level
L	Litre
LOR	Limit of reporting (equivalent to PQL)
µg/L	Micrograms per litre
µS/cm	Micro-Siemens per centimetre
mbgl	Metres below ground level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per litre
NATA	National Association of Testing Authorities of Australia
ND	Not Detected (above laboratory PQL)
NEHF	National Environmental Health Forum
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council

NSW EPA	New South Wales Environmental Protection Authority
NSW DEC	Former New South Wales Department of Environment and Conservation
NSW DECC	Former New South Wales Department of Environment and Climate Change
NSW DECCW	Former New South Wales Department of Environment, Climate Change and Water
OCP	Organochlorine Pesticide
OEH	Office of Environment and Heritage
OPP	Organophosphate Pesticide
PACM	Potential asbestos containing material
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated Biphenyl
PFC	Perfluorinated Compounds
pH	$-\log[H]$
PID	Photo-ionisation detector
ppm	Parts per million
PQL	Practical quantitation limit (equivalent to LOR)
QA/QC	Quality assurance/quality control
PACM	Potential Asbestos Containing Material
RAP	Remedial Action Plan
Redox	Reduction-oxidation potential
RPD	Relative percentage difference
SAC	Site Assessment Criteria
SAQP	Sampling, Analytical and Quality Plan
SPT	Standard Penetrometer Test
SWL	Standing water level
TCLP	Toxicity Characteristics Leaching Procedure
TEQ	Toxicity equivalent quotient (in reference to BaP)
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
UCL	Upper Confidence Limit
UST	Underground storage tank
VENM	Virgin Excavated Natural Material
VOC	Volatile organic compounds

1. Introduction

1.1 Introduction

GHD Pty Ltd (GHD) was engaged by NSW Health Infrastructure (HI) to prepare a Remedial Action Plan (RAP) / Contamination Management Plan for Lot 7314 DP 1162607, Metford Road, Metford, NSW. Lot 7314 is referred to as the 'site' for convenience in this report, and is the proposed Stage 1 Development Area for a health services facility, including hospital (the New Maitland Hospital). The 'site', as defined for the purpose of this report, forms a portion of the overall development area for the health services facility. The overall area (formerly the CSR/PGH clay mine/brick works) is being investigated in stages that may not necessarily correspond to subsequent development activities. The property identifiers for the overall development area are provided in Section 2.1.

The location of the overall development area (red boundary) and the boundary of Lot 7314 (yellow northern and eastern boundaries) are shown in Figure 1 in Appendix A.

A Phase 2 Environmental Site Assessment (ESA) of the site was prepared by GHD in December 2015, in order to provide HI with confidence that the site contamination characteristics are sufficiently understood to determine the remediation required to make the site suitable for the final land use. No significant contamination was found at the site, however natural carbonaceous material was present, isolated instances of potential asbestos-containing material (PACM) were identified, with numerous areas of anthropogenic wastes and the potential for "unexpected finds" of contamination to occur during earth works. The ESA concluded that the investigation works undertaken have sufficiently characterised the site to enable an assessment of its suitability for the proposed purpose (hospital with open space grounds), subject to implementation of a soil management plan.

This RAP / Contamination Management Plan should be read in conjunction with previous investigations (as described in Section 2) and the limitations described in Section 14.

1.2 Proposed development

Redevelopment of the site is proposed to involve a change of land use to include a health care facility comprising long term care (hospitals, child care, aged facilities, hospices), commercial / industrial land use (training facilities, administration and ancillary buildings) and open spaces (gardens, play areas).

A conceptual development plan for the hospital has been developed by Woods Bagot, as illustrated by the drawings in Appendix B. It is evident that significant earthworks will be required to achieve the landform required for the proposed development.

The geotechnical investigation report for the Stage 1 development area (DP 2015b) states that the earthworks associated with development of the site are expected to include excavation and recompaction of existing fill materials and the placement and compaction of relocated or imported fill materials.

DP (2015b) states that it is understood that bulk excavation is likely to be required to level the site to about RL 18 m AHD. Areas of the site, particularly within the north-western and southern strip, are at levels of up to RL 24 m AHD. Hence excavation of up to 6 m depth may be required. Depending on the final layout of the development, placement of up to 8 m of filling may be required within the former quarry floor.

1.3 Purpose of this RAP / Contamination Management Plan

This document (referred to herein as a RAP for convenience) presents the management and remediation strategies required to ensure unacceptable contamination is not present or subject to exposure during the proposed future use of the site, and to manage any contamination that may be encountered during the redevelopment of the site.

The purpose of this RAP is to provide a description of the proposed contamination management and remediation programs, procedures and standards, which will be followed during the course of the project, to ensure the successful management or remediation of contamination at the site and consequently the protection of the environment and human health, so that the site can be made suitable for the nominated land uses by implementation of this RAP.

1.4 Objectives

The objectives of the RAP are to:

- Set soil management and remediation goals so that the site can be made suitable for the nominated land uses, and will pose no unacceptable risk to human health or the environment under those uses.
- Evaluate the range of management or remediation options available to address the existing site contamination issues, and thereby reduce risks to acceptable levels.
- Establish a framework for interim management of the site prior to the commencement of development.
- Document the preferred contamination management or remediation techniques and procedures.
- Establish the various safeguards required to complete the contamination management or remediation work in a safe and environmentally acceptable manner.
- Identify the necessary approvals and licences required by regulatory authorities in order to enable the remediation works to proceed.
- Enable an independent accredited site auditor to certify that the site can be made suitable for use as a health services facility, including hospital, if the site is remediated and managed in accordance with this RAP.

1.5 Scope of work

The scope of works to meet the stated objectives comprised the following:

- Collate and review existing data.
- Identify the areas of concern within the site requiring management or remediation.
- Document the relevant guidelines.
- Set remediation goals.
- Outline the management or remediation strategy.
- Develop management or remediation procedures to form a basis from which the earthworks / remediation Contractor(s) can develop their own detailed work methods.
- Document a validation process to be followed where required.
- Identify appropriate licence and approvals required to undertake the remediation works.
- Outline contingency and emergency response measures.

1.6 Roles and responsibilities

The roles and responsibilities of the various parties involved in the remediation and validation of the site are outlined below.

HI Project Manager

Responsible for overall direction of civil and environmental work (including any management or remediation) associated with the earthworks contract.

HI Design Team

Responsible for taking the requirements of this RAP into account in preparation of final earthworks design and configuration and relevant design documents and specifications, including consultation with the Environmental Consultant and Site Auditor.

Earthworks / Remediation Contractor (Contractor)

Responsible for:

- Required civil works (i.e. any physical management, remediation or associated works), including all measures required to protect worker and public health and the environment during the works.
- Preparing a detailed work plan for implementing the works.
- Undertaking material inspections and clearances in accordance with this RAP, the approved Construction Quality Assurance (CQA) program, final design and specifications.
- Preparing / obtaining and providing all relevant supporting documentation to the environmental consultant in relation to any remediation works carried out.

Environmental Consultant

Responsible for:

- Providing technical guidance to the earthworks / remediation contractor in appropriately implementing the requirements of the RAP.
- Verifying the Contractor's adherence to the RAP, relevant aspects of the CQA program, final design and specifications.
- Monitoring of work areas for environmental purposes, collection and analysis of validation and characterisation samples, and advising HI of appropriate actions on the basis of observations, sampling and analysis.
- Preparing a Remediation and Validation Report (RVR) at the completion of remediation.

NSW EPA Accredited Site Auditor

Responsible for:

- Reviewing the CQA plan and other relevant documentation to be developed as part of the final design and specifications, for consistency with this RAP.
- Reviewing the work of the Environmental Consultant.
- Providing a Site Audit Statement regarding the suitability of the site at the completion of remediation and validation.

2. Summary of site conditions

2.1 Site location and description

The site is located at the former CSR quarry on Metford Road, Metford, NSW as shown in Figure 1 in Appendix A. The overall development area (as discussed in Section 1.1) comprises Lot 7314 DP 1162607, Lot 266 DP 755237, Lot 3 DP 1091727, and Lot 401 DP 755237.

The site which is the focus of this report (Lot 7314) is about 17 ha in size, and is proposed to be redeveloped for the initial stages of the New Maitland Hospital. The remaining areas of the CSR site will eventually be taken up for future stages of the hospital campus.

The site was divided into 4 main areas (see Figures 1 and 2, Appendix A) as part of GHD 2015 to aid in description of the Site and interpretation of results:

- **Area 1** - Located in the southwest portion of the Site, comprises disturbed (previously cleared) and undisturbed bushland. Historical information indicated no significant use of this Area apart from tree clearing and access roads. Topography was variable with steep banks in the south and west/northwest. Stockpiles of fill and re-worked material were present across Area 1, along the eastern side of the area apparently pushed out from historical quarrying activities in Area 2, and also in the south western portion and central portion. Mixed building waste, including concrete, metal and potential asbestos containing materials (PACM) was observed at isolated locations on the surface in the northwest portion, presumed to be from illegal dumping. A number of small water bodies (ponds in a drainage line) are located towards the south western corner of this area.
- **Area 2** – Located to the north of Area 1, comprises the most disturbed area of the site with approximately 80% un-vegetated and comprising numerous stockpiles and undulations (noise berms and quarry voids) and rock outcrops (high wall) from historical quarrying activities. The northern boundary forms part of a levelled area adjoining the CSR site and high walls remain along the southern and south western perimeters with noise berms along the top. Several small stockpiles were present in the northern portion. A large water filled body (formed by the dip of the geology at the base of the quarry excavation) is located at the eastern side of the area and an outcropping of carbonaceous material (extending into Area 3) is located in the south-eastern corner of the area. A flat low lying area was present in the central western portion (most likely formed from quarrying activities), in between stockpiles and the western high wall. A single piece of PACM was identified on the surface near the top of the high wall along the southern boundary of the area.
- **Area 3** – Located east of Areas 1 and 2, has also been quarried (to a lower elevation than Area 2) and comprises a swampy / low lying area and shallow water bodies in the central and northern portion (base of former quarry). A large carbonaceous shale stockpile is located in the southern portion which extends across the majority of Area 3 from east to west. A high wall remains to the south of the large carbonaceous stockpile. A portion of relatively undisturbed land remains present along the southern boundary above the high wall.
- **Area 4** – Located at the eastern side of the Site, generally comprises natural or disturbed vegetated land. Historical information indicates that most of the area was cleared by 1954 with a large area of exposed soil evident by 1975 and stockpiled materials present in the early 1990's. The north western portion consists of relatively flat, low lying land with some hummocks of fill or excavated natural material (now vegetated with scrub). A small stockpile predominantly comprised excavated natural material, however also contained building waste, including bricks, mortar and PACM (observed on the surface). The central portion is elevated with steep banks on all sides, and densely vegetated. A large gully is located in the

southern portion adjoining the high wall. The southern boundary of the area was elevated and densely vegetated.

2.2 Surrounding land use

The surrounding land uses (and approximate distances) include:

- North – CSR site comprising former PGH Bricks & Pavers (sales and display and manufacturing areas, adjacent); Northern Railway (300 m); East Maitland Cemetery (400 m); Raymond Terrace Road (500 m); East's Leisure & Golf (golf course adjacent Raymond Terrace Road); and Two Mile Creek (700 m).
- South – Residential (adjacent, separated by power line easement).
- East – CSR site comprising former PGH Bricks & Pavers quarry site (predominantly unused and vegetated, adjacent); Northern Railway (400 m); East Maitland Cemetery (unused and vegetated), rural residential properties and Three Mile Creek (400 m); Raymond Terrace Road (600 m); scale model aircraft flying field and rural property (adjacent Raymond Terrace Road); and Four Mile Creek (1.2 km).
- West – Metford Road (adjacent); Fieldsend Oval (public sporting/football field), Council Depot and industrial properties (adjacent Metford Road); and Two Mile Creek (300 m).

2.3 Environmental setting

Table 2-1 summarises the environmental conditions of the site and surrounding area, including geology, soil, topography, hydrology and hydrogeology. The information is based on information from GHD 2015 and previous investigations (italicized), particularly as summarised in the Remediation Action Plan for the CSR / PGH brickworks (DLA, 2014b).

Table 2-1 Summary of site conditions

Aspect	Summary
Geology and Soils	<p>Based on information from previous investigations, <i>the regional geology comprises the Tomago Coal Measures consisting of shale, mudstone, sandstone, coal seams and clay layers. Carbonaceous layers have been excavated from the natural layers as part of the onsite works. These layers have been stockpiled on the site.</i></p> <p><i>Geology encountered during investigations generally comprised clay, brick and ash fills to a depth averaging approximately two metres deep. Beneath this were variable clays, silt stones, fine grained sandstones and shales. Most of these were exposed in the excavations associated with clay and shale extraction over the site.</i></p> <p>This is generally consistent with the findings of GHD 2015 except that large quantities of clay, brick and ash fills were not generally encountered, and are understood to predominantly be present on the former PGH land north of Area 2.</p>
Topography	<p>Based on the topographic map of NSW (reviewed as GHD 2015), the southern portion of the Site has an elevation of approximately 20 metres Australian Height Datum (mAHD), with variable falling landform to approximately 10 mAHD (excluding pits present in the central portion, predominantly Areas 2 and 3). A gully in the western portion (Area 1) falls towards Two Mile Creek to the northwest. The eastern portion (Area 4) falls to the east, towards Three Mile Creek. The central portion has been disturbed by mining operations, with highly variable landform including mounds, channels and pits.</p> <p>A steep high wall (up to 10 m high) extends along the southern portions of Areas 2, 3 and 4 with mounded fill (presumed to be a noise berm) located</p>

Aspect	Summary
	<p>at the top of the high wall adjoining natural ground levels to the south, and the areas to the north generally at the base of the quarry or with material stockpiled above the base (in Areas 2, 3 and 4).</p> <p>The site topography is shown on Figure 3 in Appendix A.</p>
Hydrology	<p>Area 1 appears to drain to the northwest, toward Two Mile Creek, located approximately 300 metres to the west and 700 metres to the north. Area 4 appears to drain to the east, toward Three Mile Creek, located approximately 400 metres to the east.</p> <p>As noted in Section 2.1 above, Areas 2 and 3 contain water bodies in low-lying areas of the base of the former quarry. The landform in these areas is highly variable and so too is surface water flow. However, it appears that there is low lying land (wetlands) present to the northeast of the site (north of Raymond Terrace Road). It was presumed that surface water from the site would generally flow towards this feature.</p> <p><i>Stormwater at the site appears to collect in the upper of five sedimentation ponds at the east site. Water flows progressively through these to discharge from the site at the north eastern boundary into what is known as Three Mile Creek which flows north. (LeVert, 2011). The above-mentioned sedimentation ponds are located north of Area 3.</i></p>
Hydrogeology	<p>Groundwater flow direction was generally assumed in GHD 2015 to be toward the northeast. As noted above wetlands are located approximately 500 metres to the northeast, and it is presumed that shallow unconfined groundwater flow would also be to the northeast.</p> <p><i>Perched groundwater was encountered in fill at depths of approximately two metres in some of the test pits, mainly along the north eastern part of the site. [To the north of Area 2]. Groundwater depths recorded in three groundwater monitoring bores were approximately 6.5 metres below ground level (mbgl). (LeVert, 2011).</i></p> <p>An online search of the Department of Primary Industries Office of Water database (GHD 2015) found nine licenced groundwater bores within a 500 metre radius of the site, three of which were within or adjacent to the Site. It is noted that there were no bores within 500 metres of the Site licenced for domestic, stock or irrigation use.</p>

2.4 Previous investigations

Numerous environmental investigations have been undertaken on the Site, with the most recent being a Phase 2 ESA prepared by GHD in December 2015. These studies, along with several other previous reports, were reviewed as part of preparation of the RAP and include the following:

- Closure Mine Operation Plan [Closure MOP] for: Metford Clay Mine ML 1523, 5848, 4865, and 5090. VGT, March 2015.
- Phase 2 Detailed Environmental Site Assessment, CSR/PGH Maitland, Metford Road, Metford NSW 2323. DLA Environmental, January 2014.
- Remediation Action Plan [RAP], CSR/PGH Metford. DLA Environmental, May 2014.
- Stage 2 Soil Investigation, CSR/PGH Maitland NSW. LeVert, September 2011.
- Preliminary Contamination Assessment, PGH Site, Metford NSW. Environmental Auditors (EA), February 2011.
- New Maitland Hospital Stage 1 Development Area. Phase 2 Environmental Site Assessment. Metford Road, Metford, NSW. GHD. December 2015.

It is noted that, with the exception of GHD 2015, these investigations were for the entire CSR operations. GHD 2015 provides a detailed review of relevant information for Stage 1 from the previous investigations. Previous results summary tables are presented in Appendix C and previous investigation locations are shown on Figure 2, Appendix A.

2.5 GHD (2015)

The primary objective of the Phase 2 ESA for Stage 1 was to provide HI with a high level of confidence that the site contamination characteristics were sufficiently understood to determine the remediation required to make the site suitable for the final land use; and with sufficient confidence and reliance that there will be no foreseeable contamination issues which may affect handing the site over to contractors to undertake redevelopment and construction works on the site.

The results of the investigations found that:

- The site has predominantly been used as a quarry and for stockpiling of material, with the exception of perimeter areas towards the west, south and east which appear to be largely undisturbed. The northern boundary lies adjacent to the former CSR / PGH brickworks site, which has been significantly disturbed by historical brickmaking and associated activities. Previous investigations across the Site had identified a number of exceedances of the current health-based assessment criteria for TRH in the fraction >C₁₀-C₁₆ (F2) and BaP, predominantly in the northern portion of Area 2 and within the large carbonaceous shale stockpile in the southern portion of Area 3.
- Investigations conducted indicated that the Site contained large areas of fill material to depths up to 3.0 metres below ground level (mbgl). Large stockpiles of quarried material were also present in Area 2 and Area 3. Fill materials generally contained silty sandy clay/clay materials (Area 2) or carbonaceous shale (Area 3) with some areas including anthropogenic materials including bricks and brick fragments, domestic waste, rubble, and coal chitter. Excluding bricks and brick fragments, other anthropogenic wastes were generally confined to fill material pushed up along the top of the high walls to the south or west of the quarry areas, or in smaller stockpiles at the north end of Area 2, the northern portion of Area 3 and western portion of Area 4.
- Contaminants of potential concern (CoPC) were below the adopted health-based assessment criteria for the soil and sediment samples analysed, with the exception of exceedances of the HSL A/B for TRH F2 (eight samples) and benzene (one sample), and the HILs A, B and C for BaP (TEQ) (one sample). Concentrations of CoPC above the ecological assessment criteria were more wide spread, with 19 samples (excluding Quality Control duplicates) exceeding the ecological screening level (ESL) urban residential for TRH F2 and/or F3 (fraction >C₁₆-C₃₄), four samples exceeding the ecological investigation level (EIL) for BaP and numerous samples exceeding the EILs for zinc and to a much lesser extent nickel and copper. Generally, elevated concentrations of TRH F2 and F3 and benzene were associated with soils containing carbonaceous material, predominantly in the southern portion of Area 3 and the south-eastern end of Area 2 comprising the carbonaceous shale stockpile and in-situ outcroppings of weathered shale.
- Statistical assessment of the data set for soils from the carbonaceous shale stockpile and adjacent outcropping shale indicates the 95% UCLav concentrations for TRH F2 and F3 exceed the HSL A/B (for soils at 0-1 mbgs) and the ESL for F2, and exceed the ESL for F3.
- Potential asbestos containing materials (PACM) were observed on the surface in three locations: Area 1- in the vicinity of HA402 and associated with dumped waste building

materials; Area 2 – an isolated fragment on the surface in the vicinity of TP414 on the top of the high wall; and Area 4 – in the vicinity of MW401 and associated with several small stockpiles containing waste building materials and excavated soil. All PACM fragments appeared to be in sound (bonded) condition. All soil samples submitted for asbestos analysis returned negative results for the presence of asbestos, including the two samples of soil collected beneath the identified PACM materials (A04 and A05) and samples from TP414.

- Both shallow and deep groundwater on the site naturally contains nickel and zinc above the freshwater GILs. It is considered that the concentrations are most likely associated with the naturally occurring geology and overall regional groundwater quality. TRH and PAH concentrations were only detected in groundwater sampled from one well (MW404S) and are likely to be associated with naturally occurring hydrocarbons present in coal/shale bands. The persistence and distribution of shallow groundwater contamination by hydrocarbons is unclear from the investigations undertaken. Additional shallow wells and repeat sampling of MW404S would be required to better assess the source of these organics in the groundwater. As Metford is supplied with potable water, it was considered unlikely that groundwater would be extracted for beneficial uses, particularly as the water is brackish. Therefore, any risk of exposure associated with groundwater use is considered to be low, except possibly in a construction / dewatering scenario if shallow groundwater with contaminants (as found at MW404S) is encountered.

Based on the scope of works completed, the objectives outlined above and subject to the limitations contained within GHD 2015, the following conclusions were made:

- Fill materials were generally above surrounding ground level and there was no evidence of any significant filled voids at the locations investigated.
- On the basis of the investigations undertaken, except for the large shale stockpile (Area 3), the adjacent weathered shale outcropping (Areas 3 extending to Area 2), and the small stockpile potentially identified as SP4 in DLA (Area 2), CoPC concentrations above assessment criteria are relatively minor and isolated, and from a contamination perspective, the fill materials are expected to be acceptable for use in the proposed development.
- PACM was only identified in a few isolated locations and was observed to be bonded, presenting a low risk to human health provided it is not disturbed. However, given the nature of vegetation coverage across the site, there may be other areas that contain PACM.
- Anthropogenic wastes (including PACM in isolated areas) were noted in many areas of fill on Site but were not generally found to be present in the larger stockpiles in Area 2 and Area 3, and are readily visually identifiable.
- Except for shallow groundwater from well MW404S, groundwater and surface water did not generally show evidence of impact from contamination at the Site or contaminant migration from adjoining areas that would affect the Site, and groundwater is unlikely to be beneficially used.
- GHD 2015 considered that the works sufficiently characterised the Site to enable an assessment of its suitability for the proposed purpose (hospital with open space grounds), subject to implementation of a soil management plan.

GHD 2015 recommended:

- Development works should include a soil management plan (SMP) containing an asbestos management plan (AMP) and an unexpected find protocol to identify

anthropogenic wastes, remove PACM prior to disturbance for appropriate disposal, and separate any wastes that are not acceptable for aesthetic or other reasons, for either management (eg. emplacement in deeper fill) or disposal off site. Should unexpected contaminated soils be identified during any future ground works, advice should be sought from a suitably qualified environmental consultant.

- Consideration should be given to a conservative management approach through the burial of the carbonaceous material exceeding the assessment criteria to a depth of at least 2 mbgl. This could be completed in conjunction with development earthworks using stockpiled material that does not have any unacceptable impacts, and material won from suitable areas designated for cut.
- Materials presenting ‘aesthetic issues’ (bricks, building and domestic waste) might not be acceptable for use at the surface, but could be buried at depth or disposed of off-site to a licenced landfill facility prior to development. Where these materials are to be buried, the location and depth should be documented.
- Further assessment of shallow groundwater should be considered if development (including construction) is likely to encounter or disturb hydrocarbon contaminants such as found in MW404S.

2.6 Site contamination status

The following review of the site contamination status is based on the combined results from previous investigations and GHD 2015. The combined data tables (soil, sediment, surface water and groundwater) are presented in Appendix C. Table 2-2 provides a summary of the contamination status of the Site.

Table 2-2 Soil Contamination status summary by Area

Area	Issue	Description
SOILS		
Area 1	Aesthetic Impacts	Fill materials were identified predominantly around the boundary with Area 2 (where materials have been pushed up from Area 2) and were up to 2.8 m deep with some areas containing foreign material such as domestic and construction waste, bricks, coal chitter and PACM. Shallower fill was also noted along the southern boundary and some smaller stockpiles in the southern portion which did not generally include any foreign material. Anthropogenic wastes (including PACM) were not found to be widespread in Area 1, and are readily visually identifiable. No odours or staining were observed.
	TRH F2 and F3, zinc, nickel impacts	TRH (F2) in soils at one location (TP417) above the HSL A/B associated with disturbed carbonaceous materials in the noise berm in south eastern end of Area 1. Hydrocarbon impacts were identified at depths 1.9-2.0 m and were not vertically delineated in this location. Zinc concentrations were above EILs at several locations TRH F2 and F3 at location TP417 and TRH F3 at HA407 and nickel at one location. Chemical exceedences were isolated and relatively minor. Apart from zinc (likely to be associated with the natural mineralogy of the soils), only one concentration exceeded 250% of the assessment criteria (TRH F3 in TQ069, the inter-laboratory duplicate of sample TP417_1.9-2.0). Further, the primary sample and the intra-laboratory duplicate were less than and slightly more than the ESL respectively. Therefore, from a contamination perspective, it's considered unlikely that a representative statistical assessment of the fill materials in Area

Area	Issue	Description
		1 would restrict their use for the proposed development.
	PACM impacts	PACM was observed in surface materials in the northern part of Area 1 associated with dumped waste building materials. The material was not significantly degraded and the soil sample collected beneath the PACM did not identify the presence of asbestos or asbestos fines. Although the PACM was not tested at the laboratory, from GHD's experience the material is likely to be asbestos and should be treated as such for remediation purposes. The PACM in its' current state presents a low risk to human health provided it is not disturbed.
Area 2	Aesthetic Impacts	Fill materials were present across much of Area 2 (large stockpiles, pushed up materials) and were recorded to a depth of up to 6.0 m. Fill in some areas contained foreign material such as coal chitter, bricks, rubble and domestic waste, predominantly in the vicinity of the boundary with Area 1 and the central north-western portion of the area towards the former CSR site (vicinity of TP404, TP403, TP401 and TP400). A slight sweet / organic odour was noted during excavation of TP306. No other odours or staining were observed in the fill material. There was no evidence of any significant filled voids at the locations investigated.
	TRH F2, F3, BaP (TEQ), BaP, Zinc, copper and nickel impacts	<p>TRH F2 above HSL A/B in a number of samples, predominantly in the north-western corner (TP306 and TP402) and associated with carbonaceous material (TP402, BH601 and TP478). One exceedance for BaP (TEQ) above the HIL A and HIL B was at TP401 on the northern boundary and may correspond with stockpile SP4 (DLA (2014a)).</p> <p>Results exceeding ESLs for TRH were also generally associated with carbonaceous materials, including the above samples over residential ESLs for TRH F2 and F3, and TRH F3 only at locations TP405 and TP407 (in the north western portion). BaP concentrations were above EILs at TP401 and also at locations TP303 and MW400 D (northern part of Area 2). Numerous samples were above the zinc EIL, two locations for nickel and one location for copper.</p> <p>As with Area 1, zinc concentrations are likely to be associated with the natural mineralogy. Apart from zinc, two concentrations exceeded 250% of the assessment criteria (TRH F3 in TP402_0.2-0.3 and BaP in TP401_0.5-0.7). On this basis, except for the stockpile of material at TP401, it is unlikely that a representative statistical assessment of any of the fill materials in Area 2 would restrict their use for the proposed development from a contamination perspective.</p>
	PACM impacts	One small fragment of PACM was observed on the surface at TP414. No dumped materials were observed in this vicinity and the fill in this location did not contain any building rubble or domestic waste. The fragment did not appear degraded. As for Area 1, the PACM was not tested at the laboratory, however, from GHD's experience the material is likely to be asbestos and should be treated as such for remediation purposes. The PACM in its' current state presents a low risk to human health provided it is not disturbed (prior to disposal).
Area 3	Aesthetic Impacts	Fill materials were present to varying depths with the exception of the south western corner and the low lying wetland area in the north. However, this wetland had some small stockpiles and an access road (assumed fill). Fill materials were recorded to a depth of 3.0 m deep and in some areas contained foreign material (coal chitter, brick fragments, ceramics and domestic

Area	Issue	Description
		<p>waste), predominantly south of the large shale stockpile and along the southern boundary (TP315, TP473 and TP474), north of the large shale stockpile (TP461, TP459, TP455) and around the north western corner adjacent the former CSR site (TP466, TP470). No odours or staining were observed in the fill material. There was no evidence of any significant filled voids at the locations investigated</p>
	<p>TRH F2 and F3, benzene, zinc, nickel and copper impacts</p>	<p>TRH (F2) above the HSL A/B at TP450 and TP452 and one detection of benzene above the HSL A/B at TP450 all within the large shale stockpile and associated with carbonaceous material underlying the stockpile.</p> <p>Results exceeding ESLs for TRH were also associated with carbonaceous materials, including above samples above ESLs for TRH F2 and F3, and TRH F3 only in six other samples associated with the large shale stockpile (TP445, TP446, TP447, TP448 and TP449) and weathered shale outcrop (TP477). Numerous samples exceeded the EIL for zinc, and one occurrence each of nickel and copper.</p> <p>As with Areas 1 and 2, zinc concentrations are likely to be associated with the natural mineralogy. Apart from zinc, one concentration exceeded 250% of the assessment criteria (benzene in sample TP450_2.3-2.5).</p> <p>As several samples from the shale stockpile and adjacent shale outcropping were above HSLs and ESLs for F2 and/or F3, the 95% UCLav concentrations were calculated (Appendix C) with results indicating the 95% UCLav concentrations for F2 and F3 were above HSL A/B 0-1 m and ESL for F2, and above the ESL for F3.</p> <p>While some samples above the F2 criteria were collected below 1 m, comparison was against the most conservative value as the material may be redistributed during development works, potentially resulting in some of the deeper material being present at the surface. The UCLav results indicate that the material within the large shale stockpile and adjacent outcropping would not be acceptable for the proposed development, and should be buried at depth to at least 2 mbgl.</p>
<p>Area 4</p>	<p>Aesthetic Impacts</p>	<p>Fill materials were present across Area 4, with the exception of the southern and eastern boundaries (HA409, HA410, HA411, HA412, HA414, TP438). Fill was recorded to a depth of 2.8 m deep and contained brick fragments in stockpiled material to the south (TP439 and TP441) and north (TP436). Remaining areas contained shallower fill with some coal chitter and no building rubble or domestic waste. No odours or staining were observed in the fill material. Fill materials were generally above surrounding ground level and there was no evidence of any significant filled voids at the locations investigated.</p>
	<p>Zinc, nickel and copper impacts.</p>	<p>Zinc concentrations in several samples were above EILs with one occurrence each of nickel and copper.</p> <p>As above, zinc concentrations are likely to be associated with the natural mineralogy.</p>

Area	Issue	Description
	PACM impacts	PACM was observed on the surface at a number of small stockpiles containing waste building materials (also with bricks and mortar) in the north western part of Area 4. The material was bonded and the soil sample collected beneath did not identify the presence of asbestos or asbestos fines. As for other areas, the PACM was not tested at the laboratory, however, from GHD's experience the material is likely to be asbestos and should be treated as such for remediation purposes. The PACM in its' current state presents a low risk to human health provided it is not disturbed (prior to disposal).
GROUNDWATER AND SURFACE WATER		
All areas	Heavy metals TRH PAH	The groundwater levels indicate that the inferred groundwater flow in the area is to the northeast which is generally consistent with local topography. Cadmium, copper, lead, nickel and zinc concentrations generally above the groundwater investigation levels (GIL) but is considered likely that concentrations are typical of natural groundwater conditions in the area. PAHs (BaP, fluorene and phenanthrene) above GILs in one location plus elevated TRH F2, F3 and F4. Given the observation of shale oil during drilling of most of the wells on site the detection of these analytes is likely to be associated with naturally occurring hydrocarbons. No further assessment of groundwater or surface water proposed.

2.7 Data gaps – level of confidence in findings

Based on the sampling density used in GHD 2015, there was a 95% level of confidence that a hot spot of diameter in the order of 50 m would have been detected. GHD also approached the investigation with a 'lines of evidence' approach, where both the historical site use, review of previous data and the site inspection were considered in conjunction with investigation results. As noted in the GHD 2015 sampling strategy, while the sampling densities investigated were lower than the minimum recommended in EPA (1995) Table A for detection of circular hot spots, the site characteristics were found to be consistent between previous investigations and that of GHD 2015 and no significant variability was encountered in the site materials. GHD considers that the works undertaken at the site to date have sufficiently characterised it for the proposed purpose (health facility with hospital), subject to implementation of a soil management plan.

2.8 Refined site conceptual model

A conceptual site model (CSM) has been refined for the site to identify the contamination sources at the site and provide an understanding of the pathways by which receptors at the site and surrounding areas may be exposed to contaminants.

The potential Source-Pathway-Receptor (SPR) linkages identified for the site, based on site information gathered during this investigation are presented in Table 2-3.

Table 2-3 Potential SPR linkages for the site

Potential Source	Pathway	Receptor	Pathway potentially complete?
Contaminated soils/fill on site	Volatilisation to indoor air and subsequent inhalation	Future residents or site users	Possible. Semi-volatile soil concentrations exceeding HSLs present in some areas. Areas to be developed for buildings not yet understood.
	Volatilisation to outdoor air and subsequent inhalation	Intrusive maintenance worker/ Industrial site workers	No. Volatile soil concentrations below relevant investigation levels.
		Future residents or site users	Unlikely. Semi-volatile soil concentrations present however would be dispersed in open air.
	Direct contact	Intrusive maintenance worker/ Industrial site workers	No. Soil concentrations below direct contact criteria.
		Future residents or site users	Unlikely. Soil concentrations below direct contact criteria except for one instance of BaP (TEQ) at TP401 (vicinity of previously identified SP4).
	Vertical migration of contaminants	Groundwater (and eventual discharge to Four Mile Creek)	Unlikely. Groundwater concentrations likely to be representative of regional water quality and are not expected to be an environmental risk, surface water samples do not indicate any significant impact.
Contaminated groundwater beneath the site	Volatilisation to indoor air and subsequent inhalation	Future residents or site users	No. Volatile groundwater concentrations below acceptable criteria.
	Volatilisation to outdoor air and subsequent inhalation	Intrusive maintenance workers	No. Volatile groundwater concentrations below acceptable criteria.
		Future residents or site users	No. Volatile groundwater concentrations below acceptable criteria.
	Direct Contact	Intrusive maintenance worker/	Possible. Groundwater concentrations from MW404S above

Potential Source	Pathway	Receptor	Pathway potentially complete?
	(including accidental ingestion)	Industrial site workers	acceptable criteria for incidental ingestion. Extent of groundwater impact unclear. Shallow groundwater present in low lying areas (to the north).
		Future residents or site users	Unlikely. Groundwater concentrations above acceptable criteria for beneficial use, however the area is supplied with potable water and groundwater is unlikely to be used for beneficial uses due to the brackish nature of the water.
	Lateral migration in groundwater	Ecological and recreational receptors of Four Mile Creek (approximately 400-500 m north-east)	Unlikely. Groundwater concentrations likely to be representative of regional water quality and are not expected to be an environmental risk. Surface water samples do not indicate any significant impact.
		Volatilisation risk to off-site residents	No. Volatile groundwater concentrations below investigation levels.
		Groundwater extraction for recreational, irrigation, stock watering or drinking water use	Possible (potentially through unregistered bores and groundwater discharge into low lying areas and waterways), although elevated concentrations of CoPC only encountered in MW404S and the brackish nature of water would preclude most beneficial uses.
PFC contaminated soils or water on site (impacted by historical use of fire fighting foams)	Direct Contact (non-volatile)	Intrusive maintenance worker/ Industrial site workers	No. Soil concentrations generally not detected, no concentrations above LOR in water.
Asbestos (bonded and friable)	Inhalation of fibres	Industrial workers on site, future residents or site users	Unlikely. Friable asbestos and/or asbestos fines not detected in soils on the site. Some bonded PACM observed which could release fibres if inappropriately managed.

2.9 Site and material suitability

General site and stockpiled materials

The site has been compared to “Tier 1” investigation or screening levels for land use settings equivalent to both residential development and open space, which is considered a conservative basis to assess the suitability of site materials for a hospital and associated grounds. It is noted that the HSLs and ESLs for hydrocarbons presented in the NEPM are based on petroleum hydrocarbons using a fuel composition typical of fresh petrol and diesel fuels, and may not be directly applicable to the type of hydrocarbons found at the site (considered to be associated with carbonaceous shales and shale oils). Site specific criteria would be complex to calculate and this is not considered warranted if a conservative approach is taken to assessment and management of the materials at the site.

Based on the distribution of soil concentrations of TRH exceeding the residential (HSL A/B for vapour intrusion and ESL) criteria, the “contamination” (this term is used for convenience to indicate any materials presenting a health or environmental risk, including naturally occurring materials at the site) is considered to predominantly result from the presence of fill or disturbed materials containing carbonaceous material, as well as in-situ carbonaceous material - as evidenced by samples from outcroppings of carbonaceous shale at the base of the quarry and beneath the stockpile in Area 3. Other health-based criteria exceedences were limited to one instance of benzene (associated with TRH F2 in the same material noted above) and one instance of BaP (TEQ) in a stockpile at the north end of Area 2, which may correspond to stockpile SP4 which was found to be contaminated in previous investigations.

While there were a greater number of EIL and ESL exceedences (TRH, BaP, metals), these are considered to be associated with the natural mineralogy and the occurrence of carbonaceous materials and shale oils within the strata. Exceedences were relatively minor and sufficiently isolated as to not present an unacceptable risk to human health or the environment.

On the basis of the investigations undertaken as discussed above, with the exception of fill containing the identified surface PACM, the large shale stockpile in Area 3 and the adjacent weathered shale outcropping extending into Area 2, and the small stockpile (potentially SP4) at the northern end of Area 2, other identified contaminant concentrations are considered relatively minor and isolated, and from a contamination perspective, the fill materials are expected to be acceptable for use in the proposed development.

Asbestos

As discussed above, no asbestos has been detected in soil samples from the site, and the PACM identified in its present state (bonded condition with no significant degradation or presence of fibres in soil) presents a low risk to human health provided it is not disturbed. However, no visible asbestos in surface soils should be present for residential and open space land use, and both the NEPM and WHS regulations require removal of visible asbestos prior to any work activities that may disturb it. Any PACM to be disposed off site would require appropriate classification in accordance with the *Waste Classification Guidelines: Part 1 – Classifying waste* (EPA, 2014) prior to disposal to an appropriately licenced facility. A final inspection of the areas by a suitably qualified consultant should be undertaken following removal of the PACM.

Given the nature of vegetation coverage and fill materials across the site, there may be other areas that contain PACM, particularly where stockpiles contain building rubble. Based on the future risk of disturbance to other areas of the site during redevelopment, any exposed PACM should be managed using an AMP containing an unexpected finds protocol.

Aesthetics

It is noted that many areas of fill on the site contain 'aesthetic issues' including bricks, and to a lesser extent building and domestic wastes. These materials may not be acceptable for use at the surface, but could be buried at depth or disposed of off-site to a licenced landfill facility prior to development. Where these materials are to be buried, the location and depth should be documented.

Potentially combustible materials

The geotechnical investigation report for the Stage 1 development area (DP 2015b) identified potentially combustible material at the following locations (see Figure 4 in Appendix A for locations):

- Test pits TP303 and TP305 - black coal filling to depths of up to 0.25 m in the north-western portion of Area 2
- Test pit TP310 - Clayey gravelly filling with some coal and carbonaceous siltstone to 1.2 m depth, within the "fingers" of filling reaching into the south-western area of the site [the sound berm pushed up along the eastern side of Area 1]
- Test pit 314 - Coal and carbonaceous gravel filling to 0.7 m depth over bedrock in the southern strip, adjacent to the former quarry face [Area 3]; and
- Test pit 316 - Exposed coal, as encountered in Pit 316 and also within the floor of the former quarry to the east of the pond, together with the lower sections of the former quarry face.
- Based on the assessment the stockpiled carbonaceous materials within the southern and central part of the site will also require some form of management and remediation to minimise and mitigate future combustibility risks.

Unexpected Finds and Soil Management

The findings of the investigations to date are based on lines of evidence including historical site use, site observations and sampling and analysis from discrete locations. While the site history indicates previous site use was predominantly quarrying activities, and investigations do not indicate any significant disposal of waste has occurred, smaller areas of incidental disposal are evident, and it is likely that other such areas will be encountered during redevelopment of the site. There is also a possibility that unexpected contamination could be encountered during earthworks for redevelopment of the site.

The management requirements for unexpected finds are discussed further in Section 7.

3. Relevant guidelines and legislation

3.1 Guidelines for contamination assessment and management

National Environmental Protection (Assessment of site Contamination) Amendment Measure 2013.

The National Environment Protection (Assessment of Site Contamination) Measure (referred to here as the NEPM) was produced by the federal National Environmental Protection Council (NEPC) in 1999 was revised and updated in 2013 by way of the National Environmental Protection (Assessment of site Contamination) Amendment Measure 2013. The amended NEPM is still referred to as the NEPM 1999. The NEPM provides a national framework for conducting assessments of contaminated sites in Australia.

The purpose of the NEPM is to “*establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, landowners, developers and industry.*”

The desired environmental outcome for the NEPM is to “*provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination*”.

The NEPM addresses assessment of contamination, and does not provide specific guidance for remediation or management of risk.

The NEPM includes two Schedules: Schedule A comprises a flowchart of the recommended general process for the assessment of site contamination and its relationship to the management of site contamination and Schedule B consists of technical guidelines about site assessment criteria, site investigation procedures, laboratory analyses, human health risk assessment, ecological risk assessment, derivation of investigation levels, groundwater risk assessment, community engagement and risk consultation and competencies and acceptance of environmental auditors and related professionals.

In broad terms, the assessment process can be described as:

- Tier 1 Preliminary investigation, laboratory analysis and interpretation, development of a conceptual site model (CSM) and assessment of results with reference to investigations or screening levels. The need for risk-based remediation assessment to derive response levels and/or the need for remediation is evaluated.
- Where required, Tier 1, Tier 2 or 3 Detailed investigation / Site specific risk assessment, laboratory analysis and interpretation is completed, and the requirement for remediation is evaluated.

Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites” (ANZECC/NHMRC, 1992)

The “Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites” (ANZECC/NHMRC, 1992), provide a risk management approach consistent with the attainment of Environmental Outcomes described in the NEPM.

A contaminated site, as defined by ANZECC/NHMRC (1992), is a site at which hazardous substances occur at concentrations above background levels, and where assessment (with reference to appropriate criteria) indicates it poses, or is likely to pose, an immediate or long term hazard to human health or the environment.

The objectives of contaminated site remediation (ANZECC/NHMRC, 1992) are:

- To render a site acceptable and safe for the long term continuation of its existing/proposed use.
- To minimise environmental and health risks both on and off-site to acceptable levels.
- To maximise to the extent practicable, the potential future uses of the site.

Wherever human health is a risk, either on or off-site, or the off-site environment is at risk, a contaminated site should be remediated to the extent necessary to minimise such risks in both the short and long terms. However, in cases where there is no threat to human health and the environment is not at risk, it may be appropriate to accept a strategy leaving contaminants on the site or using planning controls to manage and minimise risk.

Environmental and Human Health Risk is based on exposure to potential hazards and is defined as:

- Risk = Hazard x Exposure.

The elimination of risk can be achieved by the removal of the hazard and/or the exposure pathway. Remediation commonly involves removal of the hazard, while risk management involves removal of the exposure pathway but the hazard may remain. Exposure pathways to contaminated material can be managed by any physical action and/or management plan which prevents exposure to contaminants, such as planning controls, management controls, and/or site remediation.

A planning control is any means to control future change of end use and associated demolition/construction activities, and could take the form of leasing/selling arrangements to specific planning legislation controls. For example if contaminated soil is buried/capped in a particular zone, that zone may be designated to have a particular land use eg public open space or roadways. This enables the material to be placed in less sensitive land use areas (via under roadways) within land used for more sensitive purposes such as residential.

3.2 State legislation and guidelines

NSW has a comprehensive suite of guidelines relating to assessment and management of contamination, administered by the EPA¹ under the *Contaminated Land Management Act* (CLM Act) 1997 and the *Protection of the Environment Operations Act* (POEO Act) 1997. These include the following:

- NSW EPA (1995), *Contaminated Sites: Sampling Design Guidelines*.
- NSW OEH (2011), *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*.
- NSW DEC (2006), *Contaminated Sites: Guidelines for NSW Site Auditor Scheme*.
- NSW DEC (2007), *Guidelines for the Assessment and Management of Groundwater Contamination*.
- NSW EPA (2015). *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*. New South Wales Environment Protection Authority.
- NSW EPA (2014). *Technical Note: Investigation of Service Station Sites*
- NSW EPA (2014). *Waste Classification Guidelines Part 1: Classification of Waste*.

¹ The NSW Government re-established the EPA as an independent statutory authority in February 2012. Before this, the EPA was part of the Office of Environment and Heritage (OEH) within the Department of Premier and Cabinet.

Guidelines approved under the CLM Act also include:

- Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC/NHMRC, 1992).
- National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 (NEPC 2013).
- Australian Drinking Water Guidelines (NHMRC/ NRMCC, 2011).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ ARMCANZ, 2000).

Other guidelines used in the framework for assessment of asbestos contamination include:

- Western Australian Department of Health (WA DoH) Guidelines for Remediation and Management of Asbestos Contaminated Sites in Western Australia (WA DoH 2009).

State Environmental Planning Policy 55

SEPP55 introduces state wide planning controls for the remediation of contaminated land. Under the provisions of SEPP55, *“land must not be developed if it is unsuitable for a proposed use owing to contamination and must be remediated prior to development”*.

Under the requirements of the SEPP55, remediation is to be classified as either:

- Category 1– remediation work for which development consent is required; or
- Category 2 – remediation work not requiring development consent.

Protection of the Environment Operations Act

Activities requiring an EPA license under Schedule 1 of the POEO Act include contaminated soil treatment works for on-site or off-site treatment (including in either case incineration or storage of contaminated soil but excluding excavation for treatment at another site) that:

1. Handle more than 1,000 m³ per year of contaminated soil not originating from the site on which the works are located; or
2. Handle contaminated soil originating exclusively from the site on which the works are located and:
 - Incinerate more than 1,000 m³ per year of contaminated soil.
 - Treat otherwise than by incineration and store more than 30,000 m³ of contaminated soil.
 - Disturb more than an aggregate area of 3 hectares (30,000 m²) of contaminated soil.

It is not anticipated that any of these thresholds will be exceeded by the proposed remediation works, and hence licensing would not be required under the POEO Act.

Work Health and Safety Act

All proposed remediation works for the Site (including asbestos work) should be completed in accordance with the *Work Health and Safety Act and Regulation 2011*. Asbestos works must also follow the guidelines of the *Safe Work Australia Code of Practice - How to Manage and Control Asbestos in the Workplace* (December 2011), and the *Code of Practice – How to Safely Remove Asbestos* (December 2011).

3.3 Commonwealth Legislation

The principal Commonwealth environmental legislation potentially relevant to the site is the Environment Protection and Biodiversity Act 1999 (EPBC Act). The EPBC Act provides that the Commonwealth is to be involved in matters of “National Environmental Significance” (NES). The EPBC Act vests the Commonwealth Environment Minister, in the absence of a referral, with the power to request referral of a proposal.

Under the environmental assessment provisions of the EPBC Act, actions that are likely to have a significant impact on a matter of NES are subject to an assessment and approval process. The EPBC Act identifies seven matters of NES:

- World Heritage properties
- National Heritage places
- Ramsar Wetlands of international significance
- Nationally listed threatened species and ecological communities
- Listed migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining)

When there are habitats or species of national significance (as listed under the schedules of the Environment Protection and Biodiversity Conservation Regulation 2000) within the project remediation area likely to be impacted negatively upon by the proposed remediation works, then preparation and lodgement of an EPBC Act referral to the Commonwealth for the assessment would need to be considered and addressed accordingly.

Such requirements will presumably be addressed in planning and approval documentation for redevelopment of the site, and have not been further considered in this RAP.

4. Assessment criteria

4.1 Relevant guidelines

The framework for the contamination assessment was developed with reference to relevant guidelines relating to assessment and management of contamination as detailed in Section 5.

In the first instance, the most sensitive assessment criteria will be compared with the concentrations of any contamination identified at the site. If these are exceeded, the specific land use and exposure scenarios relevant to the area and depth at which the subject material is located will be examined, and the concentrations compared with the appropriate criteria for those circumstances. If the relevant criteria are exceeded, the material will be managed or remediated in accordance with this RAP. This process of assessment will take place during final design, as discussed in Section 5.4.

4.2 Soil assessment/validation criteria

The NEPM includes a range of ecological investigation and screening levels, health investigation levels and health screening levels for a range of contaminants and for a range of land use and exposure scenarios. The selection of the assessment criteria has been based on the following considerations, some of which are peculiar to the proposed development of the site as a health services facility, including a hospital:

- The site development footprint is currently undetermined; therefore, it is uncertain which soils may or may not be subject to exposure.
- There is a potential for direct contact with contaminated soils.
- There is a potential for vapour intrusion from hydrocarbon contamination for future buildings (this is considered a low potential given the nature of the historical site use, with contaminants of concern unlikely to include volatile hydrocarbons; however carbonaceous materials at the site may be a source of semi-volatile hydrocarbons).
- The HILs developed for the commercial/industrial land use scenario are not applicable to a site used frequently by more sensitive groups such as children (within childcare centres, hospitals and hotels) and the elderly (within hospitals, aged care facilities and hospices), given the following:
 - Potential 'child care' exposure is 10-12 hours per day (compared to the workplace 8 hours).
 - The most sensitive receptors are people with generally poor health, in particular those who get sick first i.e. very young, very old and people who have a lowered immune system.
 - The impact to these receptors is chemical specific e.g. BaP is a cancer-causing agent with a mutagenic mode of action, therefore new-borns are the highest risk category (not necessary the elderly).
 - Sections of the hospital may be dedicated to long-term care, providing accessible gardens and open space (potentially used by children as 'play areas').

Where investigation levels are not presented in the NEPM, other reference sources (such as the USEPA regional screening levels) will be used, eg. for CoPC associated with brick manufacturing – barium and fluoride, and firefighting perfluorinated compounds (PFCs).

4.2.1 Health investigation and screening criteria

Health investigation levels have been developed for a broad range of metals and organic substances and are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of 3 m below the surface for residential use. Site specific conditions determine the depth to which HILs apply for land uses other than residential.

Given the considerations outlined above, the following assessment criteria, which are sourced from Schedule B1 of the NEPM, will be adopted:

- HIL A – residential with garden/accessible soils
- HIL B – residential with minimal opportunities for soil access
- HIL C – open space purposes (public open space such as parks, playgrounds, playing fields e.g. ovals, secondary schools and footpaths)
- Health Screening Levels (HSLs) for Vapour Intrusion – HSL A/B and C
- HSLs for Intrusive Maintenance Workers
- Direct Contact for TRH Fractions in Soil – HSL A, B and C

4.2.2 US EPA Regional Screening Levels (RSLs)

The US EPA residential soil guidelines are risk-based screening levels (RSLs) that have been derived from equations combining exposure assumptions with chemical-specific toxicity values.

The RSLs have been used to assess the soil exposure pathway for contaminants in the absence of a HSL or HIL guideline value.

4.2.3 Ecological investigation levels and ecological screening levels

Ecological investigation levels (EILs) have been developed for selected metals and organic substances and are applicable for assessing risk to terrestrial ecosystems. EILs depend on land use scenarios and generally apply to the top 2 m of soil. EILs have been developed for three generic land use settings including areas of ecological significance, urban residential areas and public open space and commercial and industrial land uses.

Added contaminant limit (ACL) based EILs have been derived for As, Cu, Cr III, DDT, naphthalene, Ni, Pb and Zn. Application of ACL based EILs is also dependent on site specific soil characteristics including pH and cation exchange capacity (CEC) and clay content. GHD 2015 analysed a selection of samples for pH and CEC and the following assumptions have been made based on the results:

- pH ranged between 4.7 and 7.4. EILs were adopted covering pH 4.5 to 5.5 for the selection of copper and zinc criteria.
- CEC ranged between 0.8 meq/100g and 17.2 meq/100g. A range for the ACL EILs was adopted that covered CEC 5 to 10 for the selection of copper, nickel and zinc criteria.
- For selection of the Cr III criterion, clay content of between 1% and 2.5% was assumed. The selection of Cr III criterion is not CEC or pH dependent.

The NEPM has established generic EILs for aged As, fresh DDT and fresh naphthalene and further, GHD have used EILs derived from the NEPM 1999 for heavy metal criteria not addressed in the NEPM 1999 (Amendment 2013). These include cadmium, chromium (VI) and mercury.

Ecological Screening Levels (ESLs) have been developed for selected petroleum hydrocarbon compounds and TRH fractions and are applicable for assessing risk to terrestrial ecosystems.

ESLs also depend on land use scenarios (identical to EILs) and broadly apply to coarse- and fine-grained soils and various land uses. They are generally applicable to the top 2 m of soil.

Given the proposed development of the Site, the following assessment criteria will be adopted:

- Soil Specific ACL-based EILs for urban residential and public open space.
- Generic EILs (for arsenic and fresh DDT) for urban residential and public open space.
- ESLs (for TRH and BaP) for urban residential areas and public open space.

4.2.4 Management limits

The NEPM includes “Management Limits” which are considered after application of the HSLs and ESLs, to address a number of policy considerations which reflect the nature and properties of petroleum hydrocarbons:

- Formation of observable light non-aqueous phase liquids (LNAPL)
- Fire and explosive hazards
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services by hydrocarbons

The management limits have been adopted in the NEPM as interim Tier 1 guidance to avoid or minimise these potential effects. The NEPM states that application of the management limits will require consideration of site-specific factors such as the depth of building basements and services and depth to groundwater, to determine the maximum depth to which the limits should apply, and that the management limits may have less relevance at operating industrial sites (including mine sites) which have no or limited sensitive receptors in the area of potential impact.

As part of GHD 2015, management limits for TPH fractions F1-F4 in soil were considered for residential, parkland and public open space, however none of these criteria were exceeded.

4.2.5 Health screening levels for asbestos contamination in soil

The NEPM provides guidance relating to the assessment of known and suspected asbestos contamination in soil and addresses both friable and non-friable forms of asbestos. The health screening levels for asbestos in soil have been adopted from the Western Australian Department of Health (WA DoH) *Guidelines for Remediation and Management of Asbestos Contaminated Sites in Western Australia* (WA DoH 2009).

The NEPM guidance emphasises that the assessment and management of asbestos contamination should take into account the condition of the asbestos materials and the potential for damage and resulting release of asbestos fibres. Therefore, for the purposes of assessing the significance of asbestos in soil contamination, three terms are used as summarised below:

- Bonded asbestos containing material” (Bonded ACM) – sound condition although possibly broken or fragments and the asbestos is bound in a matrix.
- Fibrous asbestos (FA) – friable asbestos materials such as severely weathered ACM and asbestos in the form of loose fibrous materials such as insulation.
- Asbestos fines (AF) – including free fibres of asbestos, small fibre bundles and also fragmented ACM that passes through a 7 mm x 7 mm sieve.

From a risk to human health perspective, FA and AF are considered to be equivalent to “friable” asbestos in Safe Work Australia (2011), which is defined therein as ‘material that is in a powder form or that can be crumbled, pulverised or reduced to a powder by hand pressure when dry, and contains asbestos’.

Bonded ACM in sound condition represents a low human health risk. However, both FA and AF materials have the potential to generate, or be associated with, free asbestos fibres and may represent a significant human health risk if disturbed and fibres are made airborne.

The following health screening levels have been adopted as the most appropriate to the Site:

- Residential A – includes residential with gardens/accessible soils.
- Recreational C – includes public open space such as parks, playgrounds, playing fields (eg. ovals), secondary schools and unpaved footpaths, herein referred to as HSL C.

Table 4-1 Soil assessment criteria – asbestos

Form of Asbestos	Health Screening Level (w/w)	
	Residential A	Recreational C
Bonded ACM	0.01%	0.02%
FA and AF ^a (friable asbestos)	0.001%	
All forms of asbestos	No visible asbestos for surface soil	

a. The screening level of 0.001% w/w asbestos in soil for FA and AF only applies where the FA and AF are able to be quantified by gravimetric procedures. This screening level is not applicable to free fibres.

A tiered approach to risk assessment of asbestos contamination is recommended, including the development of an appropriate Conceptual Site Model (CSM) as presented in **Section 7.5**. A weight of evidence approach is recommended with consideration given to factors such as the distribution of different fill types, the heterogeneity of the contamination and the uncertainty associated with the sampling methodology.

The NEPM states that if the Tier 1 screening levels are not exceeded, and an appropriate level of investigation has been carried out, then no contamination management actions are required except for ensuring the surface soil is free of visible asbestos. Final visual inspection of the assessment and remediated areas should not detect any visible asbestos. Further discussion of validation criteria is presented in Appendix F.

4.2.6 Aesthetics

Assessment of aesthetic issues will be undertaken as outlined in Schedule B(1) of the NEPM (1999) which states that ‘there are no specific numeric aesthetic guidelines, however site assessment requires balanced consideration of the quantity, type and distribution of foreign material or odours in relation to the specific land use and its sensitivity’.

General assessment considerations include:

- That chemically discoloured soils or large quantities of various types of inert refuse, particularly if unsightly, may cause ongoing concern to site users.
- The depth of the materials, including chemical residues, in relation to the final surface of the site.
- The need for, and practicality of, any long-term management of foreign material.

The NEPM notes that in some cases, documentation of the nature and distribution of the foreign material may be sufficient to address concerns relating to potential land use restrictions.

4.3 Waste classification criteria

Materials that may require offsite disposal as part of site remediation will be classified using the six-step process and criteria detailed in *Waste Classification Guidelines – Part 1: Classification of Waste* (NSW EPA 2014).

In accordance with the Waste Classification Guidelines, the applicable classification principles include (but are not limited to) the following:

- “If asbestos waste is mixed with any other class of waste, all the waste must be classified as asbestos waste. For example, asbestos waste mixed with building and demolition waste, must be managed as asbestos waste.”
- ‘Special waste’ is a class of waste that has unique regulatory requirements. The potential environmental impacts of special waste need to be managed to minimise the risk of harm to the environment and human health.
- Special wastes are:
 - Clinical and related waste
 - Asbestos waste
 - Waste tyres

Producers of special waste do not need to make any further assessment of their waste if it falls within the definitions of special wastes except as follows:

- Asbestos waste means any waste that contains asbestos. Chemical classification of soil contaminated with asbestos is still required.

4.4 Surface water and groundwater

Further assessment (investigation or remediation) of surface water and groundwater is not proposed at this stage. However, groundwater investigation levels (GILs) from the NEPM (which are based on the *Australian Water Quality Guidelines* (ANZECC 2000), the *Australian Drinking Water Guidelines* (NHMRC 2011) and the *Guidelines for Managing Risk in Recreational Waters* 2008 (GMRRW)) have been adopted as investigation levels in the context of the framework for risk-based assessment of groundwater contamination i.e. levels above which further assessment is required.

The GILs define acceptable water quality for various contaminants at the point of use and provide frequently used values for drinking water and protection of fresh water ecosystems. Further assessment of groundwater or surface water at the site would only be proposed should unexpected contamination be identified during the redevelopment works.

5. Remediation options review

5.1 Overall objectives and remediation goals

The overall goal of the contamination management or remediation is to cost effectively manage or remediate contamination at the site to manage potential impacts during redevelopment of the site and to prevent exposure during the proposed future use as a health services facility including a hospital.

In order to achieve this overall objective, management or remediation works will be required at the site to address contamination issues identified in Section 2, including unexpected contamination that may be encountered during the site redevelopment. The specific remediation goals are as follows:

- Remediate and validate known areas of contamination (currently limited to PACM and the small stockpile (potentially SP4) at the northern end of Area 2)
- Manage the naturally occurring carbonaceous materials so they do not present a risk to the proposed development
- Manage aesthetic impacts so they do not detract from the proposed development
- Appropriately manage or remediate as required any unexpected finds that may be encountered during the site redevelopment.

5.2 Technical and policy considerations

The key principles for remediation and management of contaminated sites presented in the NEPM (NEPC 2013) indicate that the preferred hierarchy of options for site clean-up and management should include (in descending order):

- On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level.
- Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site.

If the above are not practicable,

- Consolidation and isolation of the soil on site by containment with a properly designed barrier.
- Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material.

or

- Where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.

Other options, which are consistent with the philosophy of contamination management described in the NEPM, could include the following:

- Adopting a less sensitive land use to minimise the need for remedial works, which may include partial remediation.
- Leaving contaminated material in-situ providing there is no immediate danger to the environment or community and the site has appropriate management controls in place.

The NEPM also states the following:

When deciding which option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option.

In cases where no readily available or economically feasible method is available for remediation, it may be possible to adopt appropriate regulatory controls or develop other forms of remediation.

It should be emphasised that the appropriateness of any particular option will vary depending on a range of local factors. Acceptance of any specific option or mix of options in any particular set of circumstances is therefore a matter for the responsible participating jurisdiction.

In relation to asbestos, the NEPM (Schedule B1 section 4.11) notes that remediation options which minimise soil disturbance and therefore public risk are preferred; and management of asbestos in situ is encouraged, which may include covering the contamination with uncontaminated fill or other protective or warning layers. However, Section 4.1 of Schedule B1 notes that this guidance is not applicable to asbestos materials which are wastes such as demolition materials present on the surface of the land. Section 4.3 also notes that if visible asbestos is present and it may be disturbed during work activities, it must be removed.

DEC (2006) states that if remediation is likely to cause a greater adverse effect than leaving the site undisturbed, remediation should not proceed; and in cases where it is not viable to remediate large quantities of soil with low levels of contamination, alternative strategies should be considered or developed.

The Waste Avoidance and Resource Recovery Act 2001 establishes the following hierarchy for the management of resources:

- Avoid unnecessary resource consumption
- Recover resources (including reusing, reprocessing, recycling and recovering energy)
- Disposal

5.3 Evaluation of remediation technologies

Presented below is a brief overview of commonly used remediation technologies, and whether they are applicable to the contaminants identified at the site. This is a “screening level” evaluation, from which relevant technologies have been further examined in Sections 5.4 and 5.5.

Table 5-1 Overview of remediation technologies

Remediation Method	Description	Applicability
Health Risk Assessment (HRA)	A site-specific consideration of the toxicology and exposure to contaminants present and may demonstrate that higher concentrations of contaminants (greater than “investigation levels”) can justifiably remain on the site without presenting an unacceptable health risk.	A site specific HRA is not practical at this time given the future use of specific areas of the site have not been confirmed. Further, the extensive earthworks required at the site provide ample opportunity to remove exposure pathways to identified contamination, without HRA being required.
Management of Exposure	<p>Management of exposure risks can involve:</p> <ul style="list-style-type: none"> - Precluding access to the Site (secure fencing and signage) to prevent or minimise access to affected areas and reduce the potential for exposure. This method requires a Site Management Plan to ensure the site remains secure and no migration of contamination has occurred. - Preventing exposure to contaminants by placing them in an area where they would not be expected to be subject to disturbance under reasonably foreseeable future land use. 	<p>Given the objectives of the remediation work is to allow the Site to be redeveloped, the option of precluding access to the site is not considered to be applicable, although it may be appropriate as an interim management measure.</p> <p>The option of selective placement of contaminated materials may be applicable to areas of the site where future disturbance would not be expected to occur. This management option is discussed further under onsite capping and containment, below.</p>
Vertical Mixing	The technique of mixing contaminated surface soil with cleaner soil found at depth (generally developed for use on broad-acre agricultural land).	Vertical mixing (involving agitation of the soils) is not considered appropriate for asbestos or aesthetic contamination, or for the nature of this site.
Bioremediation	Use of microbial organisms to convert contaminants into harmless products often with the use of artificial stimulation. Often referred to as land farming, bioremediation technology is mainly used to destroy organic contaminants.	This is unlikely to be suitable for this site as TRH contamination is associated with natural carbonaceous materials which are unlikely to degrade in a reasonable time frame.
Chemical Remediation Methods	Vitrification/ Acid Leaching/Thermal Oxidation and Catalytic Chemical Oxidation/ Immobilisation	Not applicable due to the nature of the contaminants, generally low concentrations involved and high costs of establishment.

Remediation Method	Description	Applicability
Soil Washing	A physical process that separates the contaminants and then concentrates them into fractions which have much lesser volumes and can be treated	Not applicable due to the nature of contamination involved and high costs and complexity of soil washing systems.
Physical Separation	Physical separation (such as mechanical screening) to separate types or sizes of material enabling removal or concentration of contaminants.	<p>May be applicable to ACM contamination on site. Not applicable to hydrocarbon contaminated soils. Would not remediate all contamination at the site and would have to be used in conjunction with other methods.</p> <p>May be applicable to anthropogenic wastes (eg. bricks) presenting aesthetic impacts.</p>
Excavation and Disposal	<p>Excavation and offsite disposal to a NSW EPA approved landfill disposal site with appropriate environmental safeguards. The resulting excavation is generally backfilled (if required) using clean, validated fill materials.</p> <p>Disposal of contaminated material is permitted by the NSW EPA subject to the provisions of the POEO Act 1997. NSW EPA 2014 sets out the methodology for assessing and classifying solid wastes to be disposed to landfill.</p>	<p>This method is suitable for some contamination at the site where low volumes are expected or where policy prefers off-site disposal (such as ACM contamination).</p> <p>Principles including sustainability and waste minimisation may prefer other methods particularly where large volumes are involved.</p>
On-site capping and containment	<p>Capping involves the installation of a physical barrier to separate contaminated soil from infiltration and to provide a barrier to minimise human exposure. Containment involves the installation of a physical barrier around the contaminated area to prevent contaminants migrating away for the area. Thus, when used in combination, capping and containment essentially isolates the contaminated soil from the surrounding area. The inclusion of an effective low permeability capping system and appropriate surface water controls/management can be used to result in minimisation of groundwater generated within the cell.</p> <p>Capping and containment generally require long term management to prevent future exposure, in the form of a Site Management Plan.</p>	<p>Capping is a commonly used remedial strategy due to its effectiveness, simplicity and low overall cost. Further, significant excavation will be required for the proposed redevelopment which may be used for conservative management of the TRH and PAH affected soils.</p> <p>As noted in Section 5.2, the NEPM advocates in-situ management of asbestos contaminated soils (with some exceptions), and this may be applicable for large volumes of soil with low levels of occurrence (or potential occurrence) of ACM.</p>

5.4 Recommended remediation/soil management options

As a general principle in redevelopment of the site, HI has committed to using best endeavours to manage contamination on site, where appropriate.

The types of contaminants identified at the Site (primarily TRH, PAH, asbestos-containing materials and aesthetic impacts) cannot readily be destroyed, and treatment methods that reduce contaminant concentrations so that soils can be re-used on site are not considered suitable for the contamination at the site.

Physical removal and disposal of asbestos-containing materials that may be disturbed by the site works is the preferred strategy and consistent with regulatory requirements for PACM. It is understood that CSR has committed to removal of any identified areas of ACM, which will then be cleared by a licenced contractor and validated by an environmental consultant. Hence further remediation of ACM should be limited to “unexpected finds”, if present.

Where small quantities of asbestos are present (or potentially present) in large volumes of soil, considerations of sustainability and waste minimisation may result in on-site containment of such material.

Physical separation and removal of unacceptable material may be appropriate to address aesthetic impacts across the general site area, however it may be more effective to simply use such material for bulk fill (subject to geotechnical requirements or constraints) in areas where it is unlikely to be disturbed.

Capping and containment is considered appropriate as a conservative management option for TRH and PAH impacted soils where contamination will not be subject to exposure under normal foreseeable use of the site (eg. burial at depths greater than 2 m below design structure levels or beneath permanent infrastructure as part of the redevelopment). This would also address the issues of combustibility identified by DP (2015b), as discussed in Section 2.9.

Subject to further assessment of leachability where required (see Section 6.6.5), impermeable capping of material is not considered necessary.

A Long Term Site Management Plan (LTSMP) will be required to record the placement of any contaminated material on site, and provide procedures to be used in the event that it should be disturbed.

The particular methods to be used for each material / source should be agreed with HI and their designers for the development in conjunction with finalisation of design, to account for any particular geotechnical requirements, optimise earthmoving and minimise the potential for future disturbance of contaminated or problematic materials. It is anticipated this will take the form of a “material re-use schedule”, to be prepared as part of final design and consistent with the principles described in this RAP. A CQA plan (as discussed in Sections 6.6 and 9.7) will be required as a basis for verifying and documenting the appropriate implementation of this RAP and final design documentation. These documents (including relevant aspects of the final design, specifications, material re-use schedule and CQA plan) shall be reviewed by the Environmental Consultant and Site Auditor prior to the commencement of remediation to confirm that they are consistent with the principles of this RAP.

The principles below should be followed in the finalisation of the earthworks design and specifications.

5.5 Applicability to particular areas

Remediation / contamination management for most areas of the site is relatively straightforward, and based on the review above, the following methodologies are considered applicable to the identified areas of contamination. Management of “unexpected finds” will apply to all areas of the site.

- **Area 1** – Removal of ACM impacts associated with illegally dumped materials (if not already undertaken by CSR). Segregation and disposal or management of waste materials presenting aesthetic impacts. Management of TRH impacts (including potential combustibility) associated with carbonaceous materials identified in the noise berm through burial or capping under hardstand.
- **Area 2** – Segregation and disposal or management of waste materials presenting aesthetic impacts and selective hot spot removal of ACM identified at one location (if not already undertaken by CSR). Remediation of TRH and BaP impacts in the north west corner and associated with carbonaceous materials (stockpiles and outcrops) and impacts within SP4 through burial or capping under hardstand.
- **Area 3** – Segregation and disposal or management of waste materials presenting aesthetic impacts. Remediation of TRH and benzene impacts in the large shale stockpile, adjoining fill areas and outcrops through burial at depth or capping under hardstand.
- **Area 4** - Removal of ACM impacts associated with several stockpiles (if not already undertaken by CSR) and segregation and disposal or management of waste materials presenting aesthetic impacts.

Although offsite disposal is low on the remediation hierarchy, this option (where required) is considered to be the most appropriate and practical to be used for ACM and other unacceptable materials (aesthetic impacts) where these cannot be incorporated in fill material and managed on site.

6. Remediation works plan

This section provides a description of the steps and procedures required during redevelopment to protect health, safety and the environment. It is expected that these will be supplemented by technical specifications for the earthworks, and that the Contractor will prepare an appropriate detailed work plan based on the requirements of this RAP and the technical specifications.

The “material re-use schedule” and CQA plan mentioned in Section 5.4 may be prepared as part of final design prior to engaging a Contractor, or may be prepared after contract award, in consultation between the Contractor and design team. It is recommended that the Environmental Consultant and Site Auditor be consulted during the preparation of these documents (i.e. prior to final review), to facilitate appropriate interpretation of the contamination remediation or management requirements.

The roles and responsibilities of the HI Project Manager, Site Auditor, Environmental Consultant and Contractor are outlined in Section 1.6.

6.1 Preliminaries

Prior to commencing remedial works, all relevant licences and approvals must be obtained by the Site owner and/or Contractor from the relevant authorities including the Client (refer to Section 12).

Prior to the establishment at the site, the Contractor is required to prepare a Detailed Work Plan incorporating the following documentation:

- Work Health and Safety Plan (WHSP)
- Environmental Management Plan (EMP)
- Asbestos Management Plan (AMP)
- Emergency Response Procedures

It is a requirement for the various plans to be reviewed and accepted by the nominated responsible parties (HI project manager with input from the Environmental Consultant and the Site Auditor) prior to any remediation works commencing. A separate WHSP will be prepared for environmental consulting works.

It is the responsibility of the Contractor to prepare and/or obtain all appropriate documentation prior to the commencement of the works including plans, programmes, licences and certificates and have undertaken any notifications necessary for the commencement of the work. All such documents must be completed and approved by the relevant consent authority (where required). These documents are anticipated to include, but are not limited to, the following:

- Consent from the relevant approving authority to undertake the remediation works (if not already covered by the project approvals).
- Insurance Certificates.
- WorkCover Authority notifications.

Following provision and approval of these documents, the Contractor will mobilise all necessary plant, equipment and amenities as required to complete the project in accordance with these requirements.

6.2 Site mobilisation

Management of the site mobilisation process is to be included in the Detailed Work Plan including the following:

- Site access and security - The Contractor will be responsible for ensuring the security of all work areas and all plant and equipment maintained on-site during remediation works. This includes signage, control of site access (authorised personnel and vehicles only) and safety inductions and documentation.
- Plant re-fuelling/maintenance/cleaning - The Contractor will be responsible for designating locations/areas for equipment refuelling, maintenance, and cleaning activities undertaken during the site works and to ensure all vehicles leaving the site are free of any contaminated material. No refuelling or maintenance activities shall be undertaken without specific approval from the HI Project Manager.
- Traffic control - The Contractor will be responsible for ensuring adequate traffic control measures are in place to ensure site safety and take into consideration the entry and egress of vehicles from the main site entrance off Metford Road or other approved access points.
- Environmental controls - The Contractor will be responsible for installing and maintaining environmental controls consistent with their EMP.

6.3 Vegetation clearance

Vegetation clearance will be subject to any requirements of the project approvals and design. In relation to site contamination, particular care shall be taken when clearing any thickly vegetated areas to avoid disturbance and spreading of contaminated materials, particularly PACM. An appropriately trained “spotter” shall supervise all vegetation clearance to ensure these requirements are met. The unexpected finds protocol shall be implemented if any contamination is observed during vegetation clearance.

6.4 Asbestos management

As noted in Section 6.1, the Contractor is required to prepare an AMP as part of their site management documentation. The Contractor's AMP shall be consistent with the following requirements for remediation or management of asbestos encountered at the site, and meet the requirements of the WHS Regulation (2011) and relevant Codes of Practice.

6.4.1 Initial remediation works – Surface ACM removal

In relation to asbestos, the NEPM (Schedule B1 section 4.11) notes that asbestos materials which are present on the land surface and are included in wastes such as demolition materials, must be removed prior to disturbance during proposed site work activities.

As noted in Section 5.4, it is understood that CSR has committed to removal of any identified areas of ACM, which will then be cleared by a licenced contractor and validated by an environmental consultant.

To confirm whether this has taken place, clearance / validation documentation should be reviewed, and inspection for ACM of the surface materials where ACM was previously identified (GHD 2015) should be completed with hand picking of any observed fragments (as required) by a licenced asbestos removal contractor (if it is more than 10m²) or competent person in consultation with the Environmental Consultant.

Hand picking procedure

- If ACM is identified/collected during hand picking, the location and weights of asbestos should be recorded.
- Hand picking should consist of at least two passes of the picking area made with 90° direction change between each and using a grid pattern. If fragments are partially buried, surface raking of the top 100 mm of soil should be undertaken to disturb the subsurface soils and remove any partially buried fragments.
- ACM should not be further damaged or distributed by the process.
- Percent ACM contamination may be calculated using 1 cm as soil depth for hand picking.
- A final visual inspection should not detect surface ACM.
- The affected areas should be validated to confirm the removal of the ACM by visual and mechanical screening.
- Any asbestos materials found and recovered will be handled in accordance with *How to Safely Remove Asbestos – Code of Practice*, Safe Work Australia 2011 (approved under Section 274 of the Work Health and Safety Act 2011), classified in accordance with the NSW EPA Waste Classification Guidelines, Part 1: Classifying Waste (NSW EPA 2014), and disposed of offsite to a facility licenced to receive asbestos waste.

Excavation procedure

Should extensive surface or buried ACM be identified during excavation of stockpiles or surface materials, that cannot be feasibly removed by handpicking, these materials may be addressed by management of the ACM impacts through excavation and burial or capping under hardstand as per the procedure detailed in Section 6.5 below.

6.5 Development earthworks

One of the major components of the proposed redevelopment of the site is the bulk excavation and re-use of stockpiled overburden materials and sub surface materials that may contain low impact contamination (aesthetic impacts, ACM and carbonaceous materials). Bulk earthworks will generally include the following steps as outlined in Table 6-1. Error! Reference source not found.

Table 6-1 Bulk earthworks – tasks and responsibilities

Activity	Responsibility
Locate the areas designated for bulk earthworks and assess the area as to the risk of disturbance of identified contamination, in accordance with a “material re-use schedule” (based on GHD 2015).	Contractor and Environmental Consultant
Removal of vegetation as appropriate (eg shrubs) for mulching or as otherwise required by specifications. See Section 6.3.	Contractor
Visual assessment of exposed surface for potential PACM and foreign materials.	Contractor and Environmental consultant
Excavation/movement of site soils (stockpiles, surface and subsurface materials) with visual screening for potentially contaminated material (ACM, aesthetic impacts).	Contractor and environmental consultant
Segregation and stockpiling or direct re-use of different waste streams (as required) based on visual assessment (see Section 6.6 for further details).	Contractor
Characterisation of stockpiled material for management on site (burial or	Contractor /

Activity	Responsibility
capping), or for waste classification/disposal off site in accordance with NSW EPA 2014.	Environmental Consultant
Use of suitable material in designated areas as appropriate for the development ensuring burial at depths greater than 2 m below design structure levels, or capping under proposed hard stand (as per Section 6.6).	Contractor
Transport contaminated material by licensed waste transporter, to an appropriately licensed site for disposal or to an approved recycling facility where appropriate. (Section 6.7)	Contractor
Final design surfaces including topsoiling and revegetation as required.	Contractor

All excavation and materials movement shall be conducted in accordance with the Contractor's Detailed Work Plan and EMP. All excavations undertaken within suspected contaminated stockpiles or areas shall be conducted under supervision of the Environmental Consultant to ensure all contamination is addressed and the objectives of this RAP are fulfilled, while minimising the amount of uncontaminated soil that is disturbed.

The Environmental Consultant shall undertake visual inspection and sampling on completion of the excavations to validate the remediation as required. As a general principle, if materials encountered during the site development are consistent with those characterised by the DSA (GHD 2015), validation sampling is not considered necessary (as conservative management measures will be applied). Validation sampling may be required in the event of unexpected finds or for potentially contaminated materials remaining at the site surface, or if materials are imported to the site. Validation procedures are described in Appendix F, and would be used where necessary to determine the extent of follow-up remediation required.

Excavation procedures shall be documented in the Detailed Work Plan as prepared by the Contractor and should include (but not be limited to):

- Definition of the boundaries of the areas to be disturbed (excavated) and expected depths (including liaison with the environmental consultant where required).
- Methods for excavation and stockpiling including selective excavations should different materials be encountered.
- Designated areas and depths for placing (i.e. for immediate re-use) or stockpiling excavated materials
- Plans for surface run-off protection measures around the immediate area in order to prevent surface waters running into or out of the disturbed areas (also to be included in EMP).
- Backfill and compaction requirements
- Material tracking control covering all stages of the works including excavation, stockpiling and backfilling to include:
 - Minimisation of mixing unless specifically required or approved
 - A register of material movements (source area, material characteristics / description, stockpile identification, the volume of material, the destination (including on-site locations for intermediate movement), the date of any movements, authorisation details)
- Material transport control.

Upon completion of the excavation works the Contractor shall ensure that plant and equipment is cleaned and decontaminated as per Section 8.6. Waste generated during the decontamination works is to be disposed of in accordance with NSW EPA 2014.

6.6 On site re-use of materials –burial at depth or capping

6.6.1 Principles of re-use

The discussion presented below is based on the assumption that HI will opt to re-use the majority of the materials from the contaminated stockpiles, noise berms and shale outcrops preferentially at depth in existing voids, or under permanent structures (roads, car parks) following development of the site. Such containment may also apply to fill materials with aesthetic impacts (bricks, coal chitter) or potentially combustible materials from other areas of the site that are not suitable to remain at the surface or in areas of future sensitive land use.

Based on the Conceptual Development Plan a substantial area of the Site may be used for car parks or roadways. Where necessary to accommodate final design levels, excavation of uncontaminated material from under road or parking areas may be undertaken to allow containment of contaminated materials requiring management. As a detailed design has not been completed to date, final surface areas and depths of potential locations for containment are not confirmed. These shall be established by the design team as part of final design.

As noted in Section 6.1, it is anticipated material excavation and re-use would be detailed in a “material re-use schedule” to be developed by the design team and/or Contractor for approval by the HI project manager with input from the Environmental Consultant and Site Auditor. Key principles for re-use include the following:

- Preference should be given to burial of problematic materials (eg. contamination, potentially combustible or aesthetic impacts) at depths greater than 2 m below design structure levels (including basement footings or subsurface infrastructure invert levels) to minimise the disturbance of such materials during redevelopment of the site. Consideration should also be given to avoiding areas that will require deep piles or other excavation extending more than 2 m below the design levels.
- Problematic materials encountered during later stages of the development could be contained in shallower fill beneath areas of pavement provided these areas are unlikely to be disturbed.
- In-situ native soils (to be excavated for design levels) and stockpiles of ripped sandstone material should be reserved for the upper layers of the development.

6.6.2 Visual screening / segregation

Appropriate identification and segregation of the different material types on site will lower the costs associated with on-site management, and potential off-site disposal during the redevelopment works.

Visual screening can be applied to the large scale treatment (segregation) of a stockpile to detect ACM, foreign inclusions (aesthetic impacts) and potentially combustible materials. With regard to ACM, it is most suitable for minor bonded ACM impact, not for fibre generating materials. The general methodology is described below:

- May be preceded by hand picking of visual ACM impacts if appropriate.
- Excavation works should be supervised by a competent person and any indication of building or demolition wastes, aesthetic impacts (coal chitter, rubbish) or combustible materials noted and selected materials segregated as required.

- Visual inspection and validation sampling (if required) will determine the suitability of the materials for re-use, placement under the required capping area or the requirement for disposal off Site.
- Materials should be segregated into specific stockpiles (or directed to agreed fill areas) according to the material re-use schedule and decision process for re-use or disposal.
- Impacted soils should not be mixed with other soils and impacted materials shall not be used for final surface levels in sensitive areas of the development.
- Final visual inspection of the screened materials should not detect ACM or aesthetic impacts.

Should ACM impacts be identified during the screening steps the following procedure should be followed:

- Soils should be pre-wet and the ongoing screening procedure subject to dust/fibre control and monitoring measures as outlined in the AMP.
- If suspect materials are identified, a detailed inspection should be undertaken with a subsample of the materials spread out over a contrasting surface (black plastic) for inspection for ACM.
- The materials should be segregated into stockpiles for burial at depth, capping on site under hardstand or disposal off site.

The selected methodology shall be described in detail by the Contractor in their Work Plan, and will depend on the frequency of occurrence and the nature of potential ACM finds and other foreign materials in the soil, as well as the physical characteristics of the soil itself. The methodology may need to be varied depending on the effectiveness.

6.6.3 Capping/Containment

Materials that are proposed to be contained on site are not considered to be sufficiently contaminated to warrant a containment wall around the emplacement areas. Also, subject to assessment of leachability (as discussed in Section 6.6.5 below), no impermeable capping is considered necessary. Appropriate capping (as described below) is considered sufficient to minimise potential exposure and (where relevant) the potential for leachate formation and impact to the site environment. "Containment" as used herein therefore refers to placing contaminated materials in a particular area of the site either at depth or capped by hard stand or similar surfacing. Capping and containment will only be used in appropriate areas and with methods complying with DEC 2006 and ANZECC 1999 *Guidelines for the Assessment of On-site Containment of Contaminated Soil*. This includes the following considerations:

- Geotechnical requirements appropriate for the future land use of the areas used for containment shall be met so as to maximise the long-term stability of the capping system and any proposed structures above it (from an engineering perspective) and, where applicable, minimises the potential for leachate formation.
- Containment will not be undertaken in any areas where structures would subsequently be built on the containment area that may result in a risk of harm to public health or the environment.
- Notification and enforcement mechanisms will be used to ensure that the containment areas are protected from any unintentional or uncontrolled disturbance that could breach the integrity of the physical barrier, such as placing a covenant on the property title and a notation on the s.149 certificate. The containment areas will be subject to a long-term site management plan as discussed in Section 6.11.

The method of capping and containment works will be undertaken as follows:

- Designated containment or capping areas/voids are to be excavated to the required depth (as per detailed design plans and material re-use schedule to be developed as part of final design).
- Placement of segregated materials to be contained/capped within the designated areas, minimising disturbance to surrounding areas as far as reasonably practicable, in accordance with geotechnical requirements and the principles outlined in Section 6.6.1.
- Placement of uncontaminated capping material (minimum 0.5 m thick, or greater in areas where deep-rooted landscaping or underground services are proposed) to physically separate sensitive receptors from the contained materials. Where capping thickness is less than 2 m (based on final design surface levels), a high visibility marker layer shall be placed over the contaminated material. Concrete slabs or surface paving (asphalt or concrete) over a gravel base may provide an equivalent barrier .
- To minimise the potential for surface water infiltration, the final design and location of the containment areas will need to be either located away from surface water sources or, the redevelopment should be engineered to divert any up gradient surface water sources away from the containment area. Further, the finished levels of the capping layer are to be designed to encourage drainage of surface water away from the containment area. Erosion of the cap surface layer will also require control (potentially through revegetation or sealing of the finished surface).

Final design and specification of the containment and/or capping will be provided to the site auditor for review once the requirement for containment is confirmed and the volumes of materials and nominated areas for containment are known. The design and specification shall comply with the minimum requirements of this RAP.

Both placement of the fill materials within the containment area and the construction of the final capping layer must be supervised by a competent person to ensure construction in accordance with any design specifications and geotechnical suitability for the final design.

In areas subject to management of contamination, any future services shall be installed above the contained materials designated by the marker layer or if installation is required at greater depth, services shall be installed in trenches lined with marker layer and in clean backfill material to facilitate any future repairs and maintenance. Excavation and preparation of trenches shall be subject to material handling requirements for contaminated soil.

Verification of capping construction (where utilised) will include inspection and testing of material characteristics and placement as required by the design and specifications, and validation of the final cap thickness in accordance with specifications by way of a survey prior to cap installation and following completion. Following placement of the cap, a detailed inspection of the cap profile, drainage systems and overall site will be undertaken.

A CQA plan should be prepared as part of final design and specifications, to detail the requirements for verification of capping construction and to provide a basis for verifying and documenting the appropriate implementation of this RAP and final design documentation.

6.6.4 Potentially combustible materials

As noted in Section 2.9, potentially combustible materials (generally carbonaceous fill, stockpiles or outcroppings) have been identified in areas of the site.

DP (2015b) stated that provided that the material is deemed suitable for re-use from a contamination viewpoint, it may be suitable as bulk filling provided the recommendations outlined below are followed.

- Capping – placement and compaction of a non-combustible layer of at least 0.5 m thickness over the identified potentially combustible materials;
- Removal of coal materials – excavation of accessible areas of concentrated combustible materials for disposal and/or reuse as part of blending operations;
- Reshaping works – earthworks in areas of potential combustible materials to reduce slope angles and compact loose materials to minimise the potential for oxygen ingress and subsequent combustion;
- Blending – mixing of highly combustible material with non-combustible material to reduce the overall combustible percentage of the material and minimise the risk of combustion. Blending may be with underlying soil/rock (e.g. ripping of near-surface coal with underlying soil/rock) or mixing with imported materials.
- DP also recommended that a management plan is prepared for future management of combustion risk at the sites.

DP 2015b states that where carbonaceous materials are to be used as controlled fill, the filling should be blended with non-carbonaceous materials and placed in horizontal layers not exceeding 300 mm loose thickness and compacted to a dry density ratio of at least 100% Standard.

6.6.5 Potential leachability

Where contaminated material or fill material not originating from the site (i.e. with potential for naturally occurring compounds not characteristic of the site materials) is proposed to be retained on site, the potential leachability should be assessed by means of Australian Standard Leaching Procedure (ASLP) or equivalent testing, particularly if the material is to be placed below existing or future groundwater levels (i.e. groundwater levels may rise in areas where the site is filled), or in areas where infiltration of surface water or precipitation is likely to occur.

A program for assessment of leachability shall be developed as part of final design and shall be incorporated in the material re-use schedule.

6.7 Transport of material

Transportation of material shall be undertaken in accordance with the Detailed Work Plan and EMP.

- All material movements, including on-site movements, shall be recorded on a material tracking plan documenting material source, type, description, volume, destination, reference to testing results, approval for movement and date(s) of movement. A register setting out this information shall be established as part of the CQA plan.
- Wastes shall only be removed off-site after the material has been classified and written approval has been received for the disposal of the contaminated soil at the nominated treatment or disposal site, or evidence of appropriate recycling (in accordance with regulatory requirements and relevant codes of practice) has been provided.
- All asbestos debris and contaminated PPE should be doubled bagged prior to transportation to an appropriately licensed landfill that can accept asbestos waste. Management of asbestos waste is to be undertaken in accordance with CI 42 of the POEO (Waste) Regulation 2005.
- Waste tracking shall be undertaken in accordance with EPA requirements (specifically CI 49 of the POEO (Waste) Regulation 2005) and include evidence of instructions, load registers/records (source, classification, volume, date and time, vehicle details etc), weigh bridge docketts.

- Any vehicles used to transport contaminated materials from the site shall meet NSW OEH licensing requirements for the waste transported.
- All trucks carrying contaminated materials off-site shall have the load covered, the exterior of the vehicle, including wheels, thoroughly cleaned down by the Contractor after it has received its load and prior to the vehicle leaving the site. Only vehicles which have clean exterior bodywork and which will not pollute the off-site transportation corridors shall be permitted to leave the site.

6.8 Site reinstatement

Following the completion of any excavation works, the Contractor shall reinstate the site. Reinstatement should be undertaken by re-contouring the surface to remove any trip hazards, and/or backfilling with suitable site materials and/or imported fill of suitable composition to address the final redevelopment design specifications. Fill of suitable composition shall meet geotechnical and other material property requirements for the area of use, not present hazards to future development from pH, electrical conductivity (EC) or contamination, and should also be compatible with the existing soil characteristics for site drainage purposes.

Compaction requirements will be dependent on final redevelopment design, dimensions of excavations, and the type of soil used in each location. The compaction method proposed for the area must be approved by the HI Project Manager prior to commencing works. *Australian Standard AS 3798-2007 Guidelines on earthworks for commercial and residential developments* should be used as a guideline document for compaction.

The area shall be revegetated or otherwise reinstated to a stable condition as directed by the HI Project Manager.

6.9 Imported fill materials

It is expected that final design will aim to balance cut and fill volumes on the site, and that importation of significant volumes of fill material will not be required, except for construction materials for which specific characteristics are required (eg. road base, structural fill, drainage gravels, landscaping materials etc).

Any imported fill must be Virgin Excavated Natural Material (VENM) or material subject to a Resource Recovery Order that is permitted to be used as a fill material under the conditions of the associated Resource Recovery Exemption, in accordance with the provisions of the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment (Waste) Regulation 2014*.

Any imported construction or landscaping materials must comply with the relevant Australian Standards for that material.

Where there is any question of the suitability of the material from an environmental or health-risk perspective, the Contractor shall advise HI of the material characteristics prior to importation to the site, for assessment by the Environmental Consultant.

All material imported to the site shall be appropriately validated in accordance with the procedures described in Appendix F.

6.10 Interim site management

Management of the site is required between the date of this RAP and commencement of redevelopment activities, to minimise the potential for additional contamination to occur from activities such as illegal dumping, or for changes to site characteristics to occur from on-site remediation activities in other areas of the CSR property that may affect the site.

It is recommended that HI implement a site security program to ensure a secure fence is maintained around the site, that access to the site from within the CSR property is limited to activities approved by HI and that all activities undertaken on the site are documented.

Should illegal dumping or other incidents occur, an assessment should be made as to whether contamination can be adequately managed on site until the commencement of redevelopment, or whether immediate remediation is required to prevent the spread of contamination. The relevant procedures outlined in this RAP should be followed if any remediation is required.

6.11 Long term site management

A Long Term Site Management Plan (LTSMP) will be required to record the placement of any contaminated material on site, and provide procedures to be used in the event that it should be disturbed. The LTSMP will also address any combustion risk management requirements remaining at the site.

The LTSMP would include measures to prevent exposure under normal site use, and specific procedures would need to be developed for any works which would result in potential exposure.

The LTSMP is not likely to require any “active” management measures because contamination will only be left in locations that are not subject to exposure (eg. at depths greater than 2 m below design structure levels or under roads/car parks), but is likely to be a simple “awareness” plan to document the locations, depths and types of contaminated material in case structures that prevent exposure to the contamination are removed in the future, or future development or maintenance works disturb the material.

As per DEC 2006 the LTSMP will succinctly describe the nature and location of contamination remaining on-site and state what the objectives of the plan are, how contaminants will be managed, who will be responsible for the plan’s implementation and over what time frame actions specified in the plan will take place.

As implementation of the LTSMP would involve no “active” requirements until such time as site surfaces are disturbed or site structures are removed, enforcement could be linked to the planning process, and the LTSMP would be registered as a covenant on the title and/or a notation on the planning certificate, subject to discussions with HI and the Auditor.

7. Remediation contingency plan

The site has been investigated for contamination as detailed in previous investigations. However, a degree of uncertainty is inherent in any site contamination investigation and there is a potential for undetected contaminated soils or wastes to be identified in other areas of the Site. In particular, there is a potential for previously unidentified contamination (ACM) to be present at depth in stockpiles, other areas of illegal dumping not yet identified, or concealed beneath site vegetation.

Table 7-1 outlines some of the unexpected situations that may arise during the site works. The unexpected finds protocol and emergency response plans described in Sections 7.1 and 7.2 would apply in the event of any such issues arising.

Table 7-1 Contingency procedures

Issue	Response
A greater volume of soil contamination may be encountered than is presently estimated, or other types of contamination may be encountered.	<p>The presence of previously unidentified types of contaminants may be identified during remedial works by observation of any unusual physical/sensory characteristics of the impacted soil. Indications of potential contamination may include:</p> <ul style="list-style-type: none"> —Stained or discoloured fill, soils or seepage water. —Odorous fill, soils or seepage waters. —Construction/demolition wastes such as concrete, bricks, timber, tiles, asbestos sheeting, fragments and pipes. —General rubbish such as plastic, glass, packaging. —Imported materials such as ash or slag or coal chitter. <p>If previously unidentified types of contaminants are detected, then validation may be required and validation criteria may have to be revised to incorporate those contaminants.</p> <p>In the event that significant additional contaminants or volumes of contamination are identified work would cease in the area of concern. An assessment of the impact of the additional contaminants would be undertaken by the Environmental Consultant.</p> <p>Any potential contaminated material in addition to the type already identified will be treated in a method considered suitable for the type of contaminant. Additional testing would be undertaken to determine requirements in this respect. EPA requirements for treatment and disposal would be met in accordance with NSW EPA 2014.</p>
Identification of Asbestos Containing Materials (ACM)	<p>In the event that further ACM is identified during remediation works, and the nominated means of removing ACM from soil are not considered to be sufficient to remove the ACM then a surface scrape or excavation of the impacted area may be required, and the material would be disposed offsite in accordance with NSW 2014. This shall only be carried out at the direction of the HI Project Manager and Environmental Consultant, and in accordance with the AMP and unexpected finds protocol.</p> <p>Buried ACM shall be managed in accordance with relevant codes of practice and regulatory requirements.</p>
Unacceptable Environmental Impacts as a result of remediation activities	<p>The RAP has considered the potential environmental impact of side effects of the works such as noise, odour, dust and surface runoff. However, in the event that unacceptable levels of such side effects are detected at the site boundaries during remedial works, the Contractor shall cease work and the Environmental Consultant will</p>

Issue	Response
	assess the situation and direct corrective action, in accordance with the EMP prepared for the remediation works and current EPA regulations and requirements, and in consultation with the HI Project Manager.

7.1 Unexpected finds protocol

A contingency plan incorporating an “Unexpected Finds Protocol” (UFP) to be followed in the event of unexpected situations shall be prepared by the Contractor and form part of the Detailed Work Plan. The Contractor will be required to follow the contingency plan if unexpected situations are encountered.

A preliminary unexpected finds protocol (UFP) has been developed for the Site and is included in Appendix E. The UFP will be integrated with the site specific emergency response plan (ERP) as detailed in Section 7.1 below, however, the ERP would take precedence over the UFP should any unexpected contamination or materials be identified that present an immediate hazard.

It is understood that HI is developing a Contamination Finds Protocol as part of commercial negotiations with CSR. This protocol should be also taken into account in implementation of this RAP.

7.2 Emergency response plan - environmental protection and pollution control

The Contractor shall prepare a Site Specific Emergency Response Plan if unexpected situations are encountered. The following outlines some of the unexpected situations that may arise:

- Spills or leaks.
- Adverse weather conditions.
- Dust, noise, odour levels measured at site boundary may exceed acceptable levels.
- Surface runoff may leave the site.

The Contractor will have available measures, equipment and materials to counter these contingencies, and should ensure all staff are aware of and have had training in appropriate measures.

8. Protection of environment and community

Significant site levelling and earth movement at the site is required to enable development. A major part of the site management will involve the installation and maintenance of environmental protection and pollution control measures. The measures to be implemented are outlined within this section of the RAP. For the purposes of this RAP, these measures are specific to “remediation works”, including movement of potentially contaminated materials, but should also be applied to all development works undertaken at the site, and the Contractors’ safety and environmental management documentation should be developed on that basis.

These measures are designed to achieve the following objectives:

- Protection of the surrounding environment during all phases of remediation works.
- Protection of the local community during all phases of the remediation works.
- The containment of all contaminated and potentially contaminated materials (soils, run-off etc) to the site.

As per Section 6.1, prior to commencing works, the Contractor must possess plans, programmes, licences, certificates and other documents necessary for the commencement of the work, addressing as a minimum the requirements of this RAP. These documents shall be subject to review by the HI Project Manager and the Environmental Consultant.

The remedial program should be undertaken with due regard to legislative requirements and any relevant environment planning instruments that apply to the site.

8.1 Interim controls

Prior to the commencement of site remediation works, the following interim controls should be put in place:

- The Contractor is responsible for the construction of permanent fences around the subject area meeting appropriate specifications to prevent unauthorised entry.
- The Contractor is responsible for the construction of silt and sediment controls around the remediation site, meeting appropriate specifications to prevent erosion and runoff.

8.2 Hours of operation

Unless otherwise permitted by the project approvals, all remediation work, including transport, shall be conducted within the following hours:

- Monday to Friday: 7 am – 6 pm
- Saturday: 8 am – 1 pm

The above meets the requirements of Maitland City Council. No work will be undertaken on Sundays or Public Holidays.

8.3 Contact details during remediation

During remediation works, representatives and on-site supervisors from the Contractor will be available to be contacted at all times. The Contractor’s EMP should detail the incident reporting procedure for reporting environmental incidents during the project.

Additionally, the Site Health & Safety and Environmental Management plans as prepared by the Contractor will detail contact numbers for key project contacts once confirmed, emergency services and utility authorities.

8.4 Heritage and ecology issues

The subject site is highly disturbed. GHD understand that there are no known heritage or ecological constraints to the redevelopment of the site.

8.5 Containing contaminated material

It shall be the responsibility of the Contractor to ensure all potentially contaminated materials are contained on-site, within the confines of the designated work areas. This will be achieved by the control of potential pathways capable of moving contaminated material off-site including surface water runoff, erosion/sediment transport, vehicle/plant movements and dust generation. Specific controls for the site works shall be provided in the Detailed Work Plan and the EMP prepared by the Contractor, as summarised in the following sections.

8.5.1 Soil and water management

All remediation works will be undertaken in accordance with an EMP that will provide the specific details of the soil and water management measures. It is expected that a detailed soil and water management plan will be required by consent conditions for the proposed development. The Contractor shall be responsible for implementation and maintenance of soil and water management measures throughout the remediation works. A summary of relevant measures is presented below:

- Surface runoff control – may include diversion drains, silt fences, sumps and pumping systems to prevent runoff entering or leaving excavation areas and to prevent runoff/suspended solids entering or leaving stockpile areas.
- Stockpiles – are not to be placed on footpaths or roads and shall be placed away from drainage lines, gutters or stormwater pits or inlets. Stockpiles likely to generate dust or odours shall be covered and stockpiles of contaminated soil shall be stored in a secure area. Preference will be given to storing segregated contaminated material in skip bins prior to disposal, where volumes are small enough for this to be feasible. This particularly applies to segregated foreign materials or ACM.
- Vehicle access - Movement of excavation equipment and trucks to and from the site will be strictly controlled, restricted to a minimum and will only take place during the designated working hours. Controls must be in place to prevent any material being tracked onto offsite roads including wheel washing and sediment barriers. Soil, earth, mud and other similar materials must be removed from the roadway preferably by dry methods (sweeping, shovelling)
- Excavation pump-out - If ponding occurs and it is not feasible for it to be re-used onsite (dust suppression, irrigated), or if time constraints restrict leaving water to evaporate or infiltrate, then offsite disposal will be required. Pump-out and transportation of ponded water within excavations for appropriate treatment/disposal may be required. Disposal (if required) should be undertaken by a liquid waste transporter. It is noted that discharge to stormwater would require consultation with HI, NSW EPA and local Council, if considered. No surface runoff and/or water from excavations/pits/trenches from the working area of the site is permitted to be discharged to the surrounding environment, except as may be required for dust suppression with the express approval of the Project Manager and Environmental Consultant.

- Subject to approval from HI and compliance with relevant consent conditions and regulatory requirements, sediment dams may be constructed and/or existing voids and ponds on the site or adjoining areas of the overall development area may be utilised for detention of stormwater runoff. Details shall be prepared and approved as part of the detailed soil and water management plan, including design flows, sampling and discharge requirements.
- Landscaping - Due care shall be taken to protect any existing vegetation unless removal is required to undertake the remedial works. Any vegetation designated for protection shall be fenced to prevent disturbance during the works.

8.5.2 Noise

It shall be the responsibility of the Contractor to minimise noise generated from the remediation operations in accordance with NSW EPA and local council standards. Noise controls will be specified in the Detailed Work Plan and EMP.

The remediation works shall comply with the NSW Department of Environment and Climate Change (DECC) *Interim Construction Noise Guideline*, July 2009 (ICNG).

8.5.3 Vibration

The use of any plant and/or machinery shall not cause vibrations that can be felt or are capable of being measured at any off-site premises.

8.5.4 Air quality

Dust and particulate control

Dust emissions shall be confined within the site boundary. Dust control procedures may be employed to comply with this requirement including erection of perimeter dust screens, covering of stockpiles, dust suppression (water) and covering of truck loads. Dust control measures shall be specified in the Contractors' Detailed Work Plan and EMP.

Odour control

It is noted that based on the nature of the contamination identified on the site odours are unlikely, however no odours should be detectable at any boundary of the property relying purely on a sense of smell. Dust control measures shall be specified in the Detailed Work Plan and EMP. Controls may include covering stockpiles, use of fine mist sprays, odour mitigating agents and minimising exhaust emissions.

Air quality monitoring

Consideration should be given to air quality monitoring during bulk earth works in accordance with the NSW Department of Environment and Conservation (DEC) *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (2005).

Airborne fibre monitoring for asbestos should be conducted in accordance with the site AMP and NSW Work Safe Code of Practice How to Safely Remove Asbestos and the WHS legislation (NSW) during disturbance of materials potentially contaminated with asbestos, where emission of fibres is likely to occur or as otherwise required by the WHS Regulation (2011) or relevant Codes of Practice. The monitoring should be conducted in accordance with NOHSC Guidance Note on the Membrane Filter Method for Estimating Method Airborne Asbestos Fibres 2nd Edition [NOHSC:3003 (2005)]. Asbestos air monitoring requirements and action levels will be specified in the AMP and HESP.

8.6 Traffic movements and management

Management of traffic movements will form part of the Detailed Work Plan as provided by the Contractor.

9. Data quality objectives

The Data Quality Objective (DQO) process will be applied to the bulk earth works and validation sampling (as and if required) as described below, to ensure that data collection activities are appropriate and achieve the stated objectives.

A process for establishing data quality objectives for an investigation site has been defined by Australian Standard AS4482.1 (1997) Guide to the Sampling and Investigation of Potentially Contaminated Soil - Parts 1 and 2 and DEC 2006. The DQO process involves seven steps as follows:

- Step 1: State the problem.
- Step 2: Identify the decision.
- Step 3: Identify inputs to the decision.
- Step 4: Define the study boundaries.
- Step 5: Develop a decision rule.
- Step 6: Specify limits on decision errors.
- Step 7: Optimise the design for obtaining data.

The DQO steps defined above have been addressed as follows.

9.1 Step 1: The “Problem”

Historically the Site has been used for quarrying, storage of stockpiles and illegal dumping. The Site is no longer operational and is being considered for redevelopment as a health facility (including a hospital).

Contamination has been identified at the site that may adversely impact the site’s suitability for various uses and/or may have adverse impacts upon environmental receptors (eg. soil and groundwater). Sources of contamination at the Site have been identified to include:

- Filling at various locations across the Site containing demolition wastes and ACM.
- Naturally occurring carbonaceous soils and shale oils (source of TRH and PAH contamination).
- Illegal dumping on site (general rubbish and PACM).

In its current state the Site is not suitable for the proposed development without management of ACM and contaminated soils.

9.2 Step 2: Identification of the decision(s)

The decisions are those required to document the contamination management and remediation programs, procedures and standards, which will be followed during the course of the project, to ensure the successful management or remediation of contamination at the site and consequently the protection of the environment and human health.

9.3 Step 3: Inputs to the decision

Data input to the decision making process includes:

- Information gained via the review of previous investigations (desk based studies).
- Quantitative data gained via intrusive soil, surface water and groundwater sampling and analytical works (GHD 2015 DSI).
- Current assessment criteria as discussed in Section 4 and presented in Appendix D.
- Consideration of future land use option as discussed in Section 1.
- Monitoring the Contractor's work and the Contractor's implementation of the CQA plan.
- Review of relevant documentation to be provided by the Contractor.
- Observations and analyses to be undertaken during the site development earthworks.

9.4 Step 4: Boundaries of the study

The lateral boundaries of the study area are the boundaries of the Stage 1 area, as illustrated in Figure 1 in Appendix A.

The vertical boundaries of the study area are the vertical extent of proposed earthworks (to be developed as part of final design), and contamination identified in site materials including:

- Area 1 – Fill materials impacts up to 2.8 m deep. TRH impacts in stockpiles up to 2.0 m deep.
- Area 2 – Fill materials in large stockpiles and pushed up materials were recorded to a depth of up to 6.0 m. TRH and BaP impacts in disturbed carbonaceous materials to 0.7 m deep.
- Area 3 - Fill materials were recorded to a depth of 3.0 m deep. TRH and benzene impacts at the base of a carbonaceous materials stockpile at 2.5 m deep.
- Area 4 - Fill was recorded to a depth of 2.8 m.

9.5 Step 5: Site decision rule

Review of previous site investigations has been used to identify the main contaminants of concern and areas requiring remediation or management prior to site redevelopment.

Although specific validation sampling and analysis is not proposed (except for imported fill), it may be required should unexpected contamination be identified during site works.

Concentrations of contaminants for validation (where required) will be compared with the criteria discussed in Section 4 and presented in Appendix D, giving consideration to the redevelopment land uses relevant to the particular areas of the site, to assess the success of the remediation and/or screening processes and/or to assess waste disposal requirements.

9.6 Step 6: Specify limits on decision errors

The guidelines as listed in Section 3 will be used to assess the contamination status of the soils within the subject areas selected for this assessment. DQIs as described in Section 9.8 will be used to evaluate the acceptability of the data.

Where quantitative data is used as a basis for decisions, data will be evaluated on a statistical basis as described in the NEPM (NEPC 2013), to a 95% confidence level.

9.7 Step 7: Optimising the design for obtaining data

As detailed above, no specific validation sampling and analysis has been proposed for the bulk earthworks, except for imported fill (if required). If required, validation sampling will be undertaken as per the Validation Methodology and Quality Assurance (QA) procedures presented in Appendix F.

A CQA program will be developed as part of final design and specifications, which will include appropriate inspection and test plans and documentation requirements including material tracking to verify that site works are undertaken in accordance with this RAP. The Contractor will be responsible for implementing the CQA plan, which will be monitored and reviewed by the Environmental Consultant. Where necessary to verify appropriate implementation of the CQA plan, the Environmental Consultant will undertake independent inspections and/or testing as required.

9.8 Data quality indicators

The following Data Quality Indicators (DQIs) have been selected to ensure that the data is of a quality from which to draw conclusions:

- **Data representativeness** - expresses the degree which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples in an appropriate pattern across the Site, and by using an adequate number of sample locations to characterise the Site. Consistent and repeatable sampling techniques and methods are utilised throughout the sampling. These principles will also be applied to visual observations during the site works.
- **Completeness** - defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study. If there is insufficient valid data, then additional data are required to be collected. Completeness will also be applied to visual observations and inspection records undertaken during implementation and review of the CQA plan.
- **Comparability** - is a qualitative parameter expressing the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analysing laboratories use consistent analysis techniques and reporting methods. In relation to qualitative observations, comparability will be maintained by using appropriately experienced and qualified environmental staff to undertake inspections, and comparison of observations with conditions documented in the DSI report (GHD 2015).
- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the data is assessed by calculating the Relative Percent Difference (RPD) between duplicate sample pairs.

$$RPD(\%) = \frac{|C_o - C_d|}{C_o + C_d} \times 200$$

Where C_o = Analyte concentration of the original sample

C_d = Analyte concentration of the duplicate sample

The adopted the nominal acceptance criteria of 30% RPD for inorganics and 50% RPD for organics; however it is noted that this will not always be achieved, particularly in heterogeneous soil or fill materials, or at low analyte concentrations (concentrations less

than 10 times the laboratory PQL will not be assessed against the acceptance criteria). Precision criteria will only apply to analytical data.

- **Accuracy** - measures the bias in a measurement system. Accuracy can be undermined by such factors as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analysing laboratory. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes, laboratory blanks and analyses against reference standards. The nominal “acceptance limits” on laboratory control samples are defined as follows:

1. * Laboratory spikes – 70-130 % for metals/inorganics, 60-140 % for organics.
2. * Laboratory duplicates - <30 % for metals/inorganics, <50 % for organics.
3. * Laboratory blanks - <practical quantitation limit.

Accuracy of field works is assessed by examining the level of contamination detected in field and equipment blanks. Blanks should return concentrations of all organic analytes as being less than the practical quantitation limit of the testing laboratory.

The individual testing laboratories will conduct an assessment of the laboratory QC program, internally; however the results will also be independently reviewed and assessed by the Environmental Consultant.

Accuracy criteria will only apply to analytical data.

10. Health and safety

10.1 Workplace health and safety

Workplace Health and Safety (WH&S) is a necessity on all remediation projects to ensure the health and safety of all personnel working/visiting the site. Therefore work shall be carried out in accordance with a site-specific Work Health and Safety Plan (WH&S Plan). The Contractor shall prepare a site specific WH&S Plan for the remediation works, addressing as a minimum the requirements of this RAP, and shall appoint a Site Safety Officer for the duration of the works. .

It is the responsibility of the Contractor to take all necessary practicable actions to safeguard the safety and health of all employees and subcontractors while they are on the site. The aim of the WH&S Plan shall be to provide and maintain safety standards and practices, which offer the highest practical degree of personal protection, based on current knowledge.

All work undertaken shall be performed in accordance with the provisions of the NSW Occupational Health and Safety Act (2000), OH&S Regulation (2001), Occupational Health and Safety (Safety Standards) Regulation 1994, Occupational Health and Safety (Commonwealth Employment) Act 1991, Occupational Health and Safety Code of Practice 2008, NOHSC 1016 (2005) National Standard for Construction Work, and any other relevant regulations or directions issued by regulatory authorities.

The site-specific WH&S Plan shall cover, but not be limited to the following aspects:

- Induction of personnel
- Amenities
- Hazard locations and identification, including:
 - Asbestos
 - Biological
 - Construction contractors and workplace visitors
 - Confined spaces (if required)
 - Dangerous goods
 - Dust
 - Driving and Travel
 - Excavations
 - First aid
 - Hazardous substances
 - Lead
 - Fitness for work
 - Manual handling
 - Noise
 - Occupational hygiene, health surveillance and housekeeping
 - Personal protective equipment (PPE)
 - Slips, trips and falling objects
 - Traffic management (vehicular or pedestrian)
 - Vehicles and mobile plant
 - Working at heights (if required)
- Description of exposure pathways and personnel protection requirements

- Location of all underground/aboveground services
- Work practice procedures, within the designated contaminated zones
- Monitoring protocols to identify a potentially hazardous practice
- Training and licensing
- Emergency response information and procedures
- Incident reporting

A number of exposure pathways exist, which could potentially result in on-site workers/visitors to the site or surrounding residences being exposed to the contamination. These potential exposure pathways include:

- Inhalation of contaminants (including asbestos fibres) in the form of dust or vapours
- Ingestion of contaminated soil
- Dermal absorption of contaminants through skin contact

The Site Safety Officer shall ensure that these and any other potential exposure pathways are controlled.

10.2 Community health and safety

To ensure the protection of the local community, the Contractor shall control the exposure pathways identified in this section.

Control mechanisms will include the following:

- Site security measures to control direct contact with the contamination
- Dust suppression measures to control inhalation exposure
- Cleaning and tarping trucks to control direct contact from migration of contaminated soils

These measures are described in Section 8 - Protection of the Environment and Community, and shall be documented in detail in the Contractor's EMP.

11. Community consultation

Any Community Consultation or consultation with other stakeholders will be conducted by the HI Project Manager or nominated representative.

Any enquires made by members of the public to worker on site during remediation should be directed to a HI representative.

12. Regulatory requirements

12.1 Preparation of the RAP

This RAP has been prepared with consideration of relevant guidelines and policy, as listed in Section 3. Brief discussions of particularly relevant aspects of these guidelines, Acts and regulations are provided in the following sections.

The Contractor shall be responsible for ensuring the remediation works are carried out in accordance with regulatory requirements such as those arising under the EPBC Act 1999 and the POEO Act 1997 as detailed in Section 5.3.

12.2 Remediation notification or consent

SEPP55 introduces state wide planning controls for the remediation of contaminated land. Under the provisions of SEPP55, *“land must not be developed if it is unsuitable for a proposed use owing to contamination and must be remediated prior to development”*.

Under the requirements of the SEPP55, remediation is to be classified as either:

- Category 1– remediation work for which development consent is required; or
- Category 2 – remediation work not requiring development consent.

Clause 9 of SEPP 55 defines a category 1 remediation work as a remediation work to which clause 14 (b) does not apply, and that is:

- (a) *designated development, or*
- (b) *carried out or to be carried out on land declared to be a critical habitat, or*
- (c) *likely to have a significant effect on a critical habitat or a threatened species, population or ecological community, or*
- (d) *development for which another State environmental planning policy or a regional environmental plan requires development consent, or*
- (e) *carried out or to be carried out in an area or zone to which any classifications to the following effect apply under an environmental planning instrument:*
 - (i) *coastal protection,*
 - (ii) *conservation or heritage conservation,*
 - (iii) *habitat area, habitat protection area, habitat or wildlife corridor,*
 - (iv) *environment protection,*
 - (v) *escarpment, escarpment protection or escarpment preservation,*
 - (vi) *floodway,*
 - (vii) *littoral rainforest,*
 - (viii) *nature reserve,*
 - (ix) *scenic area or scenic protection,*
 - (x) *wetland, or*
- (f) *carried out or to be carried out on any land in a manner that does not comply with a policy made under the contaminated land planning guidelines by the council for any local government area in which the land is situated (or if the land is within the unincorporated area, the Western Lands Commissioner).*

GHD has not carried out a detailed planning assessment, however as far as the “remediation work” is concerned, to the best of our knowledge none of the above apply to the site. On this basis the remediation work is considered to be Category 2.

GHD considers the remediation work is ancillary to the proposed development of the site for a health services facility. On this basis clause 15 (1) is considered applicable, which states in relation to category 2 remediation:

- (1) *A remediation work that would of itself be a category 2 remediation work but which is ancillary to designated development that requires development consent may, as an applicant chooses:*
 - (a) *be made part of the subject of the development application for the designated development instead of being made the subject of a separate development application, or*
 - (b) *be treated as a category 2 remediation work.*

As the proposed redevelopment works will require development consent with associated conditions, it is considered unlikely that any separate approvals would be required for the remediation/soil management. It is understood that HI will determine (in consultation with their planners and the approving authority) how they wish to treat the remediation work in relation to clause 15 of SEPP 55.

If the remediation work is treated as category 2 remediation work, notice must be given to Maitland City Council at least 30 days prior to the commencement of the work, in accordance with clause 16 of SEPP 55. Regardless of category, a notice of completion of the remediation work must be given to Council within 30 days after completion of the work, in accordance with clauses 17 and 18 of SEPP 55.

12.3 Maitland City Council requirements

MCC does not have a specific policy related to contaminated land. The requirements of SEPP55 would apply in relation to notification of remediation works.

It is considered that MCC will address any particular concerns relating to site contamination as part of the development approval process.

12.4 Asbestos removal regulations and code of practice

HI has a legal obligation under the Work Health and Safety (National Uniform Legislation) Act 2011, (the WHS Act) and prescribed in the Work Health and Safety (National Uniform Legislation) Regulations 2012, to ensure the work health and safety of its workers, subcontractors and visitors.

In 2003 the National Occupational Health and Safety Commission (NOHSC), declared a prohibition on all uses of asbestos. However, the prohibition does not extend to the removal of asbestos containing materials and these must be appropriately managed to ensure that the risks of exposure to airborne asbestos are minimised.

Primary legislative requirements detailing BSC’s obligations regarding the presence of asbestos on the Site are listed as follows:

- Work Health and Safety Act 2011(NSW)
- Work Health and Safety Regulations 2011 (NSW)
- How to Manage and Control Asbestos in the Workplace, 2011. Safe Work Australia (approved under Section 274 of the Work Health and Safety Act 2011 NSW)

- How to Safely Remove Asbestos, 2011. Safe Work Australia (approved under Section 274 of the Work Health and Safety Act 2011)

It is recommended that the remediation of the asbestos impacted materials on site be undertaken by an asbestos removalist contractor with a current friable asbestos removal licence (Class A) in case friable asbestos is identified.

WorkCover NSW must be notified five days before licensed asbestos removal work is commenced.

12.5 Protection of the Environment Operations Act 1997

The proposed remediation/management activities are not required to be licensed under the Protection of the Environment Operation Act 1997 since the works do not involve: treatment otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil originating exclusively from the site, or disturb more than an aggregate area of 3 hectares of contaminated soil originating exclusively from the site.

The provisions of the POEO Act and Regulations will apply to offsite transport and disposal of soils, including immobilisation approval, if required. There are not expected to be any licences required for on-site treatment if required.

As discussed in Section 6.7, the regulatory provisions governing the management of waste generally apply to transport, treatment, disposal or receipt of waste, and hence only come into effect if the waste is removed from the site and/or received from another site. The requirements of the POEO Act and associated regulations relating to handling, disposal and/or licensing of waste do not apply to contaminated soils (including chemical or asbestos contamination) that remain on site.

13. Conclusion

GHD was engaged by HI to prepare a Remedial Action Plan / Contamination Management Plan (referred to herein as the RAP) for Lot 7314 DP 1162607 (the site), being the proposed Stage 1 Development Area for a health services facility, including hospital (the New Maitland Hospital), at the former CSR/PGH clay mine and brickworks, Metford Road, Metford, NSW.

Redevelopment of the site is proposed to involve a change of land use to include a health care facility comprising long term care (hospitals, child care, aged facilities, hospices), commercial/industrial land use (training facilities, administration and ancillary buildings) and open spaces (gardens, play areas).

This RAP provides a summary of identified site contamination issues, and description of the proposed remediation and soil management programs, procedures and standards which are to be followed during the course of the redevelopment, to ensure the successful remediation of the site and consequently the protection of the environment and human health.

As a general principle in redevelopment of the site, HI has committed to using best endeavours to manage contamination on site, where appropriate. The types of contaminants identified at the Site (primarily TRH, PAH, asbestos-containing materials and aesthetic impacts) cannot readily be destroyed, and soil treatment methods that reduce contaminant concentrations are not considered suitable for the contamination at the site. Therefore, the following remediation methods are considered appropriate for the Site:

- Physical removal and disposal of asbestos-containing materials that may be disturbed by the site works is the preferred initial remediation strategy and is consistent with regulatory requirements for PACM. Further, it is understood that CSR has committed to removal of any identified areas of ACM prior to bulk excavation works commencing. Any further remediation of ACM should be limited to “unexpected finds” as per Section 7.
- Visual screening and segregation of unacceptable materials (foreign inclusions, aesthetic impacts, PACM, hydrocarbon contaminated materials, potentially combustible materials) to address contamination impacts within stockpiles and across the general site area.
- Capping and containment as a conservative soil management option for segregated materials (as above) where contamination will not be subject to exposure under normal foreseeable use of the site (eg. burial at depths greater than 2 m below design structure levels or beneath permanent infrastructure as part of the redevelopment).
- Re-use of uncontaminated materials (VENM, screened overburden and fill) for bulk fill subject to geotechnical requirements or constraints.

The particular methods to be used for each material / source should be agreed with HI and their designers for the development in conjunction with finalisation of design, to account for any particular geotechnical requirements, optimise earthmoving and minimise the potential for future disturbance of contaminated or problematic materials. It is anticipated this will take the form of a material re-use schedule, to be prepared as part of final design and consistent with the principles described in this RAP. A CQA plan will be required as a basis for verifying and documenting the appropriate implementation of this RAP and final design documentation. These documents (including relevant aspects of the final design, specifications, material re-use schedule and CQA plan) shall be reviewed by the Environmental Consultant and Site Auditor prior to the commencement of remediation to confirm that they are consistent with the principles of this RAP.

It is understood that HI is developing a Contamination Finds Protocol as part of commercial negotiations with CSR. This protocol should also be taken into account in implementation of this RAP.

Interim management of the site is required between the date of this RAP and commencement of redevelopment activities, to minimise the potential for additional contamination to occur from activities such as illegal dumping, or for changes to site characteristics to occur from on-site remediation activities in other areas of the CSR property that may affect the site

A Long Term Site Management Plan (LTSMP) will be required following completion of the development earthworks, to record the placement of any contaminated or combustible material on site, and provide procedures to be used in the event that it should be disturbed.

GHD considers that the site can be made suitable for the proposed use (Health Services Facility, including hospital) subject to implementation of this RAP during earthworks undertaken for development of the site.

14. Limitations

This Remedial Action Plan (RAP) for the New Maitland Hospital Stage 1 Development Area Metford Road, Metford (the Site), (the "Report"):

- has been prepared by GHD Pty Ltd ("GHD") for NSW Health Infrastructure (HI).
- may be used and relied on by HI.
- may be used by and provided to the Site Auditor acting as an agent of HI in this respect.
- may be used by and provided to the NSW EPA and the relevant planning authority for the purpose of meeting statutory obligations in accordance with the relevant sections of the CLM Act 1997 or the Environment Planning and Assessment (EP&A) Act 1979.
- may only be used for the purpose as stated in Section 1 of the Report (and must not be used for any other purpose).

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than HI arising from or in connection with this RAP.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the RAP are excluded unless they are expressly stated to apply in this RAP.

The services undertaken by GHD in connection with preparing this Report:

- were limited to those specifically detailed in Section 1.5 of this Report and GHD proposal emailed on 25 May 2016 .
- were undertaken in accordance with current professional practice and by reference to relevant environmental regulatory authority and industry standards, guidelines and assessment criteria in existence as at the date of this RAP and any previous site investigation and assessment reports referred to in the RAP

The opinions, conclusions and any recommendations in this RAP are based on assumptions made by GHD when undertaking the services mentioned above and preparing the RAP ("Assumptions"), as specified throughout this RAP.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the RAP, the opinions, conclusions and any recommendations in this RAP are based on conditions encountered and information reviewed at the time of preparation of this RAP and are relevant until such times as the site conditions or relevant legislations changes, at which time, GHD expressly disclaims responsibility for any error in, or omission from, this RAP arising from or in connection with those opinions, conclusions and any recommendations.

This RAP is based solely on the investigations and findings contained in the reports referenced in the RAP (Section 15) and on the conditions encountered and information reviewed at the time of each referenced report. This RAP should be read in conjunction with the referenced reports. It is also subject to all the limitations and recommendations in the referenced reports.

GHD has prepared this Report on the basis of information provided by HI and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked ("Unverified Information") beyond the agreed scope of work.

GHD expressly disclaims responsibility in connection with the Unverified Information, including (but not limited to) errors in, or omissions from, the RAP, which were caused or contributed to by errors in, or omissions from, the Unverified Information.

The opinions, conclusions and any recommendations in this RAP are based on information obtained from, and testing undertaken at or in connection with, specific sampling points and may not fully represent the conditions that may be encountered across the site at other than these locations. Site conditions at other parts of the site may be different from the site conditions found at the specific sampling points.

Investigations undertaken in respect of this RAP were constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this RAP.

GHD has considered and/or tested for only those chemicals specifically referred to in this RAP and makes no statement or representation as to the existence (or otherwise) of any other chemicals.

Site conditions (including any the presence of hazardous substances and/or site contamination) may change after the date of this RAP. GHD expressly disclaims responsibility:

- Arising from, or in connection with, any change to the site conditions.
- To update this RAP if the site conditions change.

Except as otherwise expressly stated in this RAP GHD makes no warranty or representation as to the presence or otherwise of asbestos and/or asbestos containing materials (“ACM”) on the site. If fill material has been imported on to the site at any time, or if any buildings constructed prior to 1970 have been demolished on the site or material from such buildings disposed of on the site, the site may contain asbestos or ACM.

Subsurface conditions can vary across a particular site and cannot be exhaustively defined by the investigations carried out prior to this RAP. As a result, it is unlikely that the results and estimations expressed or used to compile this RAP will represent conditions at any location other than the specific points of sampling. A site that appears to be unaffected by contamination at the time of the RAP may later, due to natural causes or human intervention, become contaminated.

Except as otherwise expressly stated in this RAP, GHD makes no warranty, statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use, development or re-development of the site.

These Disclaimers should be read in conjunction with the entire RAP and no excerpts are taken to be representative of the findings of this RAP.

15. References

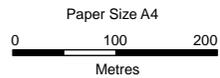
- ANZECC 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. ANZECC and ARMCANZ, October 2000.
- DLA 2014a. *Phase 2 Detailed Environmental Site Assessment, CSR/PGH Maitland, Metford Road, Metford NSW 2323*. DLA Environmental, January 2014.
- DLA 2014b. *Remediation Action Plan, CSR/PGH Metford*. DLA Environmental, May 2014.
- DP 2015a. *Suggested Scope of Work for Geotechnical Investigation, Proposed Maitland Hospital, Metford*. Douglas Partners, September 2015.
- DP 2015b. *Report on Geotechnical Investigation, Proposed New Maitland Hospital, Metford Road, Metford*. Douglas Partners, November 2015.
- Environment Canada 2013. *Ecological Screening Assessment Report on Perfluorooctane Sulfonate, Its Salts and Its Precursors that Contain the C8F17SO2 or C8F17SO3, or C8F17SO2N Moiety*.
- EA 2011. *Preliminary Contamination Assessment, PGH Site, Metford NSW*. Environmental Auditors, February 2011.
- Friebel, E and Nadebaum, P, 2011. *Health screening levels for petroleum hydrocarbons in soil and Groundwater. Summary*, CRC CARE Technical Report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia, September 2011.
- LeVert 2011. *Stage 2 Soil Investigation, CSR/PGH Maitland NSW*. September 2011.
- NEPC 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), National Environment Protection Council, May 2013.
- NHMRC. 2011. *Australian Drinking Water Guidelines (updated March 2015)*.
- NSW DEC 2006. *Contaminated sites: Guidelines for NSW site Auditor Scheme, (2nd Edition)*. New South Wales Department of Environment and Conservation, 2006.
- NSW DEC 2007. *Contaminated sites: Guidelines for the Assessment and Management of Groundwater Contamination*. New South Wales Department of Environment and Conservation, 2007.
- NSW EPA 2015. *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*. New South Wales Environment Protection Authority, 2015.
- NSW EPA 1995. *Contaminated sites: Sampling Design Guidelines*. New South Wales Environment Protection Authority, 1995.
- NSW OEH 2011. *Contaminated sites: Guidelines for Consultants Reporting on Contaminated sites*. New South Wales Office of Environment and Heritage, 2011.
- US EPA 2009a. *Provisional Health Advisories for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS)*, US EPA Region 4, US EPA 2009.
- US EPA 2009b. *The Toxicity of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS), Office of Solid Waste and Emergency Response, Memorandum*, 2009.
- US EPA 2015. *Regional Screening Level (RSL) Summary Table*. June 2015 (revised).
- VG 2015. *Closure Mine Operation Plan for: Metford Clay Mine ML 1523, 5848, 4865, and 5090*. March 2015.

Appendices

Appendix A – Figures



Google Earth
Image © 2015 Sinclair Knight Merz



LEGEND

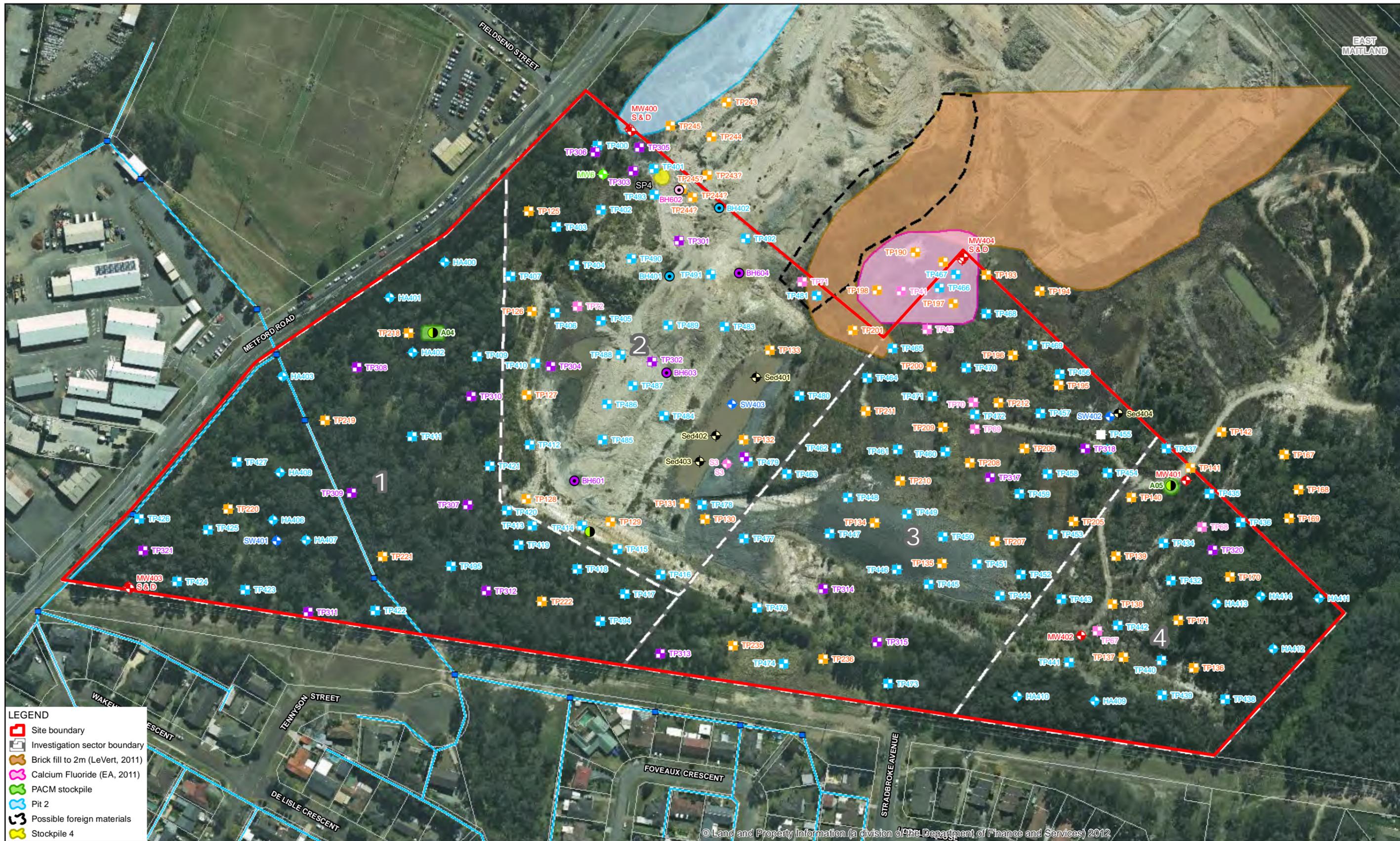
- Site Boundary
- 1 Area No.



Health Infrastructure
New Maitland Hospital, Metford
Stage 1 Development Area
Phase 2 ESA
Site Location

Job Number	22-18003
Revision	C
Date	19 Nov 2015

Figure 1



LEGEND

- ▭ Site boundary
- ▭ Investigation sector boundary
- ▭ Brick fill to 2m (LeVert, 2011)
- ▭ Calcium Fluoride (EA, 2011)
- ▭ PACM stockpile
- ⊕ Pit 2
- ⊕ Possible foreign materials
- ⊕ Stockpile 4

Paper Size A3
0 10 20 40 60 80
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

▭ Cadastre	⊕ Existing monitoring well	⊕ GHD Sediment sample	⊕ LeVert soil sample
⊕ DLA Test pit	⊕ GHD / DP soil bore	⊕ GHD Soil bore	⊕ LeVert test pit
⊕ DP / GHD test pit	⊕ GHD Hand auger	⊕ GHD Surface water sample	⊕ PACM
⊕ DP Soil bore	⊕ GHD Monitoring wells	⊕ GHD Test pit	⊕ Sewer pit
			— Sewer main



Health Infrastructure
New Maitland Hospital, Metford
Stage 1 Development Area
Phase 2 ESA
Sampling Locations

Job Number 22-18003
Revision C
Date 19 Nov 2015

Figure 2