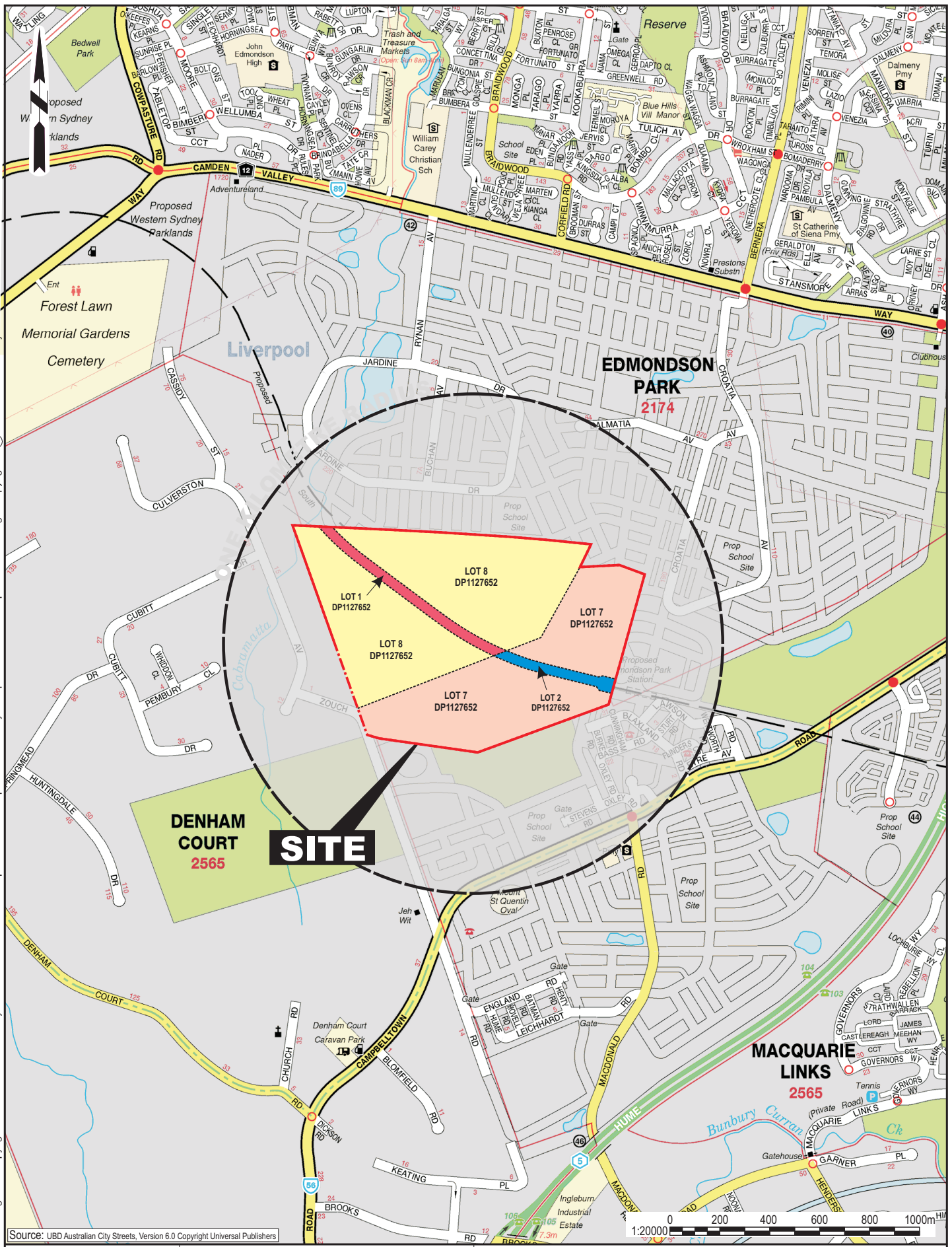





APPENDIX A

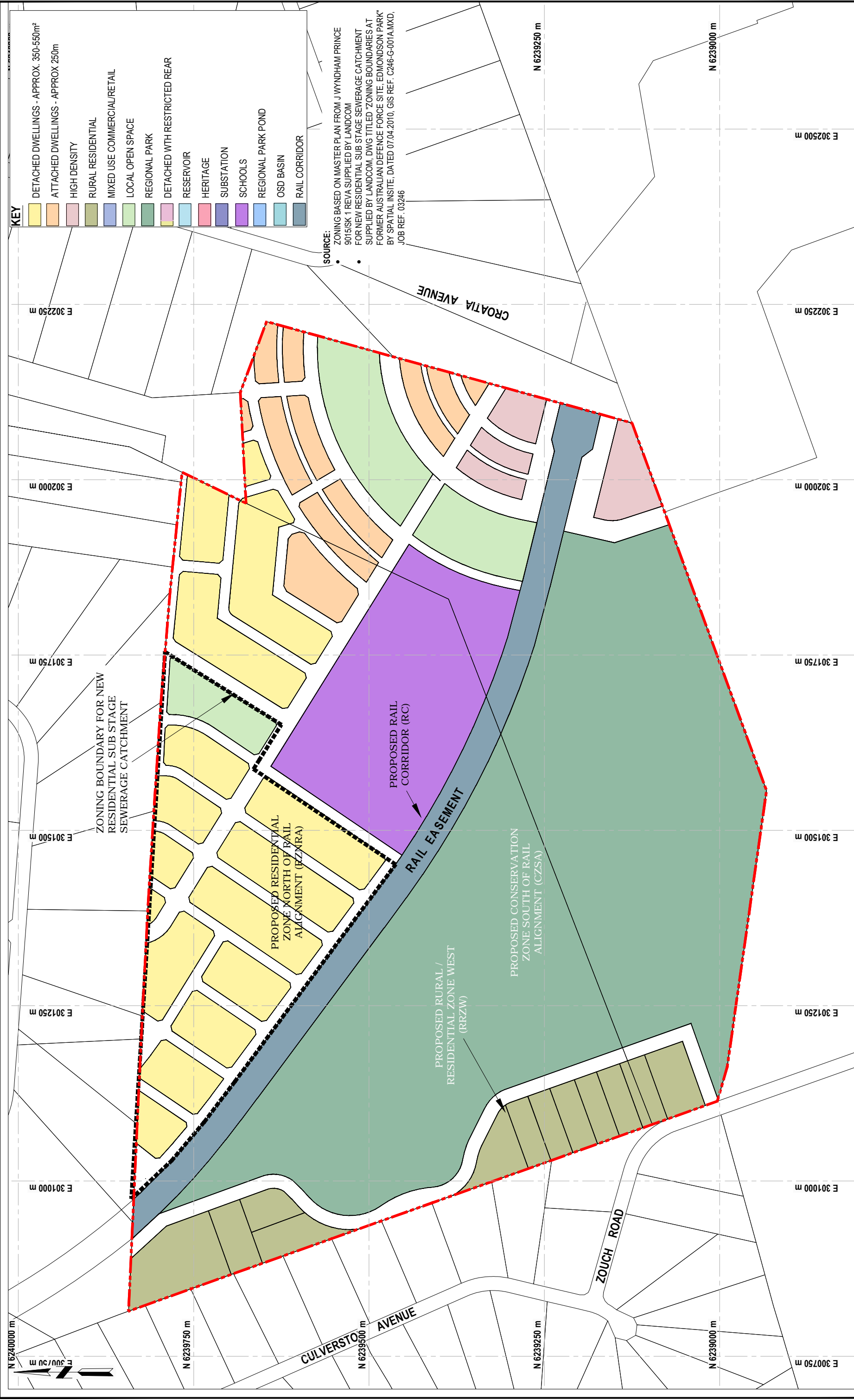
Figures

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 <p>www.golder.com GOLDER ASSOCIATES PTY LTD</p>	CLIENT	LANDCOM		PROJECT	REMEDIACTION ACTION PLAN - ZOUC ROAD, EDMONDSON PARK					
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	CHECKED	GJF	DATE	27.08.2010						
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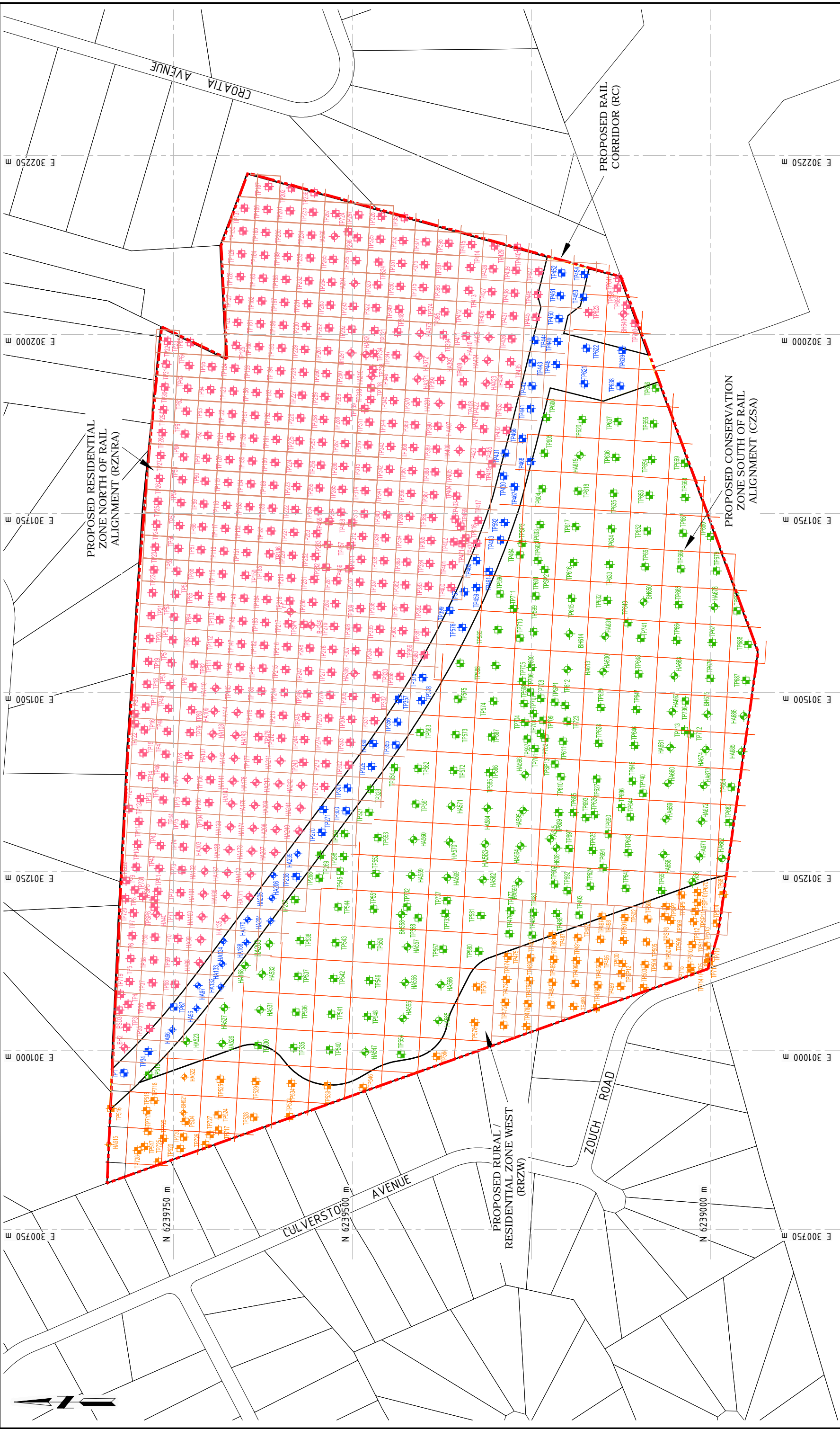


KEY

[Yellow Box]	DETACHED DWELLINGS - APPROX. 350-550m ²
[Orange Box]	ATTACHED DWELLINGS - APPROX 250m
[Pink Box]	HIGH DENSITY
[Green Box]	RURAL RESIDENTIAL
[Blue Box]	MIXED USE COMMERCIAL/RETAIL
[Light Green Box]	LOCAL OPEN SPACE
[Dark Green Box]	REGIONAL PARK
[Light Blue Box]	DETACHED WITH RESTRICTED REAR
[Light Purple Box]	RESERVOIR
[Red Box]	HERITAGE
[Dark Blue Box]	SUBSTATION
[Purple Box]	SCHOOLS
[Light Blue Box]	REGIONAL PARK POND
[Light Green Box]	OSD BASIN
[Dark Blue Box]	RAIL CORRIDOR

SOURCE:
 ZONING BASED ON MASTER PLAN FROM J WYNDHAM PRINCE
 9015/SK 1 REVA SUPPLIED BY LANDCOM
 FOR NEW RESIDENTIAL SUB STAGE SEWERAGE CATCHMENT
 SUPPLIED BY LANDCOM, DWG TITLED 'ZONING BOUNDARIES AT
 FORMER AUSTRALIAN DEFENCE FORCE SITE, EDMONDSON PARK'
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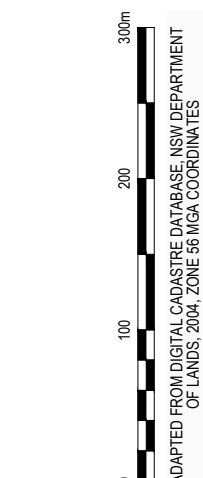
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CHECKED BY GJF	DATE 27.08.2010	PROPOSED DEVELOPMENT AREAS
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1:5,000		FIGURE 2



LEGEND

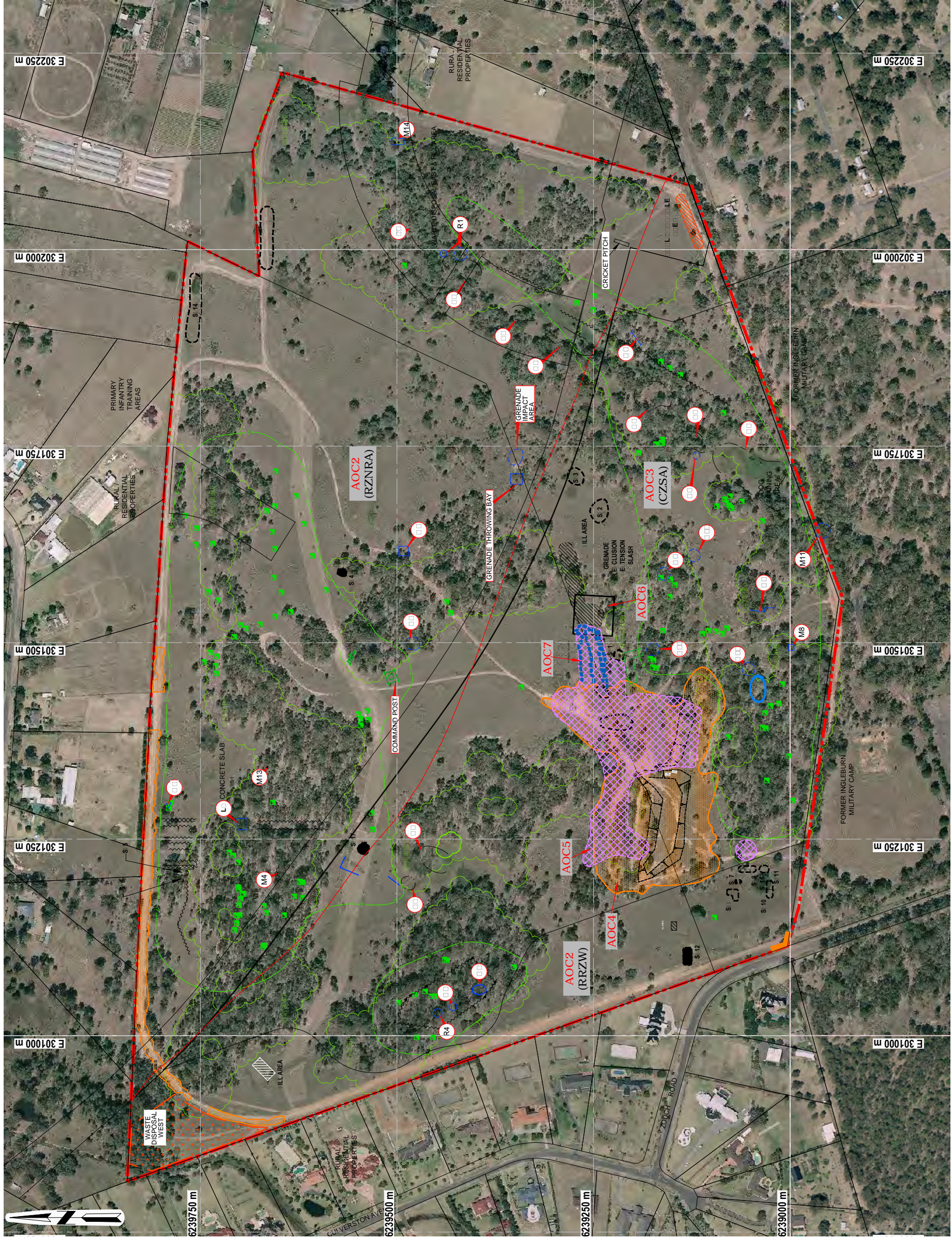
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- BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RESIDENTIAL ZONE NORTH OF RAIL ALIGNMENT]
- BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RAIL CORRIDOR (RC)]
- BOREHOLE AND TEST PIT LOCATIONS, 2005 [CONSERVATION ZONE SOUTH OF RAIL ALIGNMENT (CZSA)]
- SAMPLING GRID @ 32 x 32m
- SAMPLING GRID @ 50 x 50m

SITE BOUNDARY
 BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RURAL / RESIDENTIAL ZONE WEST (RRZW)]
 BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RESIDENTIAL ZONE NORTH OF RAIL ALIGNMENT]
 BOREHOLE AND TEST PIT LOCATIONS, 2005 [PROPOSED RAIL CORRIDOR (RC)]
 BOREHOLE AND TEST PIT LOCATIONS, 2005 [CONSERVATION ZONE SOUTH OF RAIL ALIGNMENT (CZSA)]
 SAMPLING GRID @ 32 x 32m
 SAMPLING GRID @ 50 x 50m



CLIENT		LANDCOM	
DATE	DATE	DATE	DATE
27.08.2010	27.08.2010	12.05.2010	12.05.2010
CHECKED BY	CHECKED BY	CHECKED BY	CHECKED BY
GJF	GJF	GJF	GJF
SCALE	SCALE	SCALE	SCALE
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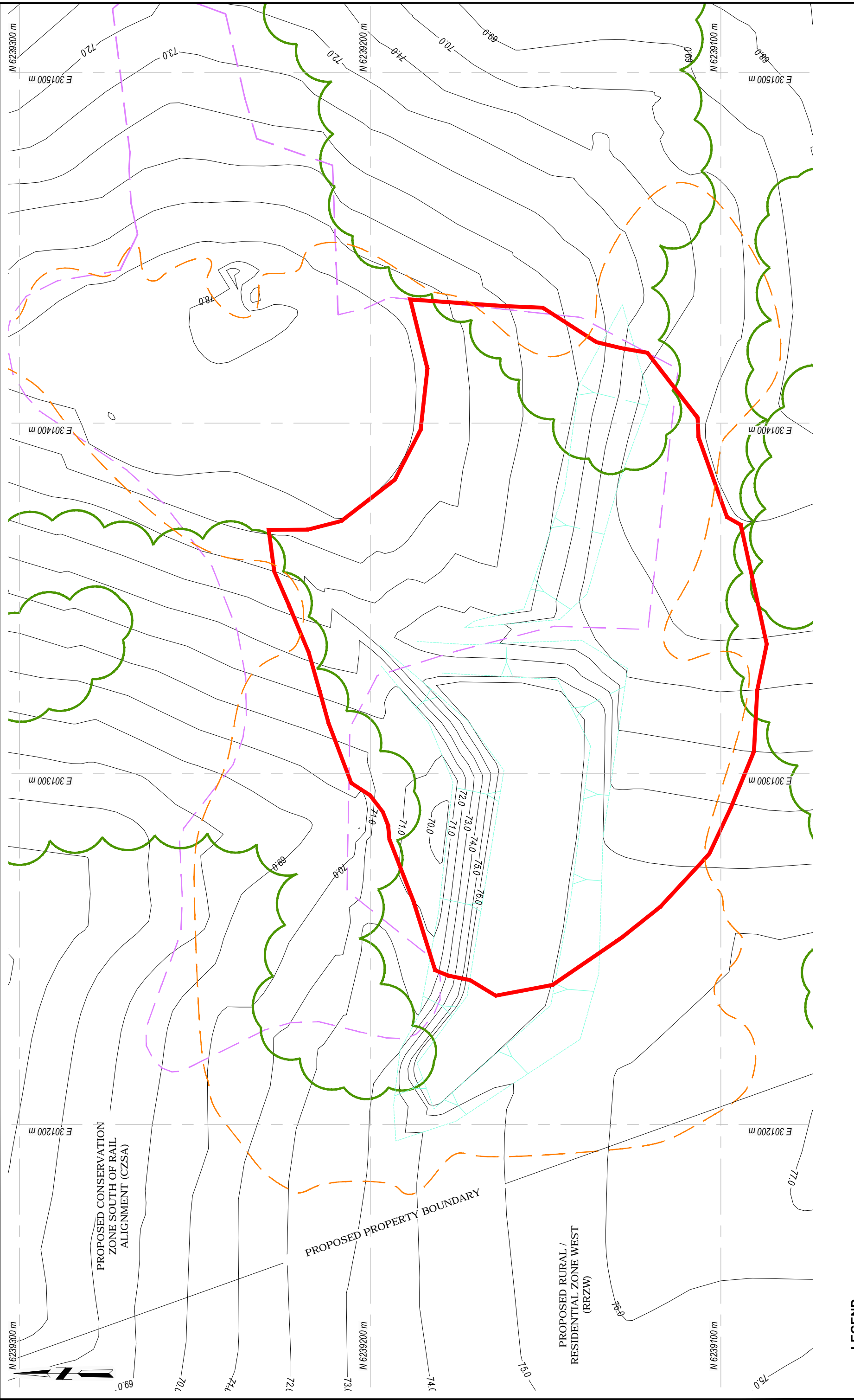
- M1 M2 M3 M4 M5 M6 M7 M8 M9 R1 R2 M6 BT-B9 M7 M8 M9 R3 M11 M12 M13 L1-L2 R4 M14 SP5
- CONCERTINA WIRE COMPOUND (PRISONER CAMP)
- STOCKPILE OF CONCERTINA WIRE
- CONCERTINA WIRE
- INFANTRY TRENCH
- INFANTRY TRENCH
- INFANTRY TRENCH
- WEAPONS PITS
- GENERAL RUBBISH / ASBESTOS PIPES
- GENERAL RUBBISH (USED CAR TYRES)
- INFANTRY TRENCH / COMMAND POST
- BLACKBERRY INFESTATION
- RAISED PLATFORM / FORMER STRUCTURE
- CONCRETE SLAB / FORMER STRUCTURE
- GENERAL RUBBISH / CAR PARTS
- GENERAL RUBBISH
- OBSTACLE COURSE
- OBSTACLE COURSE
- BUILDING FACADE
- FORMER LATRINE
- GENERAL RUBBISH
- WASTE DISPOSAL TRENCH SP5
- STOCKPILE
- LEAD PARTICULATE AREA (MILSEARCH 1999 TO 1993)
- REMEDIATION OF ASBESTOS AREA (AOC 5)
- WASTE BURIAL TRENCHES (MILSEARCH 1999 TO 2003)
- SITE BOUNDARY
- RAZOR WIRE
- HEAVILY VEGETATED AREAS
- TRAINING AREA
- MILITARY ITEMS (CONCERTINA WIRE, OBSTACLE COURSE, ETC.)
- UXO AND SAA (RESIDENTIAL, COMMERCIAL AND SPECIAL USE AREAS)
- UXO AND SAA (CONSERVATION AREAS)
- LEAD IMPACTED SOILS
- ASBESTOS CONTAINING MATERIALS
- PAH CONTAMINATED SOIL
- WASTE DISPOSAL PIT

CLIENT		LANDCOM		PROJECT	
DRAWN BY	DATE	DRAWING TITLE	PROJECT No	DOC TYPE	FIGURE No
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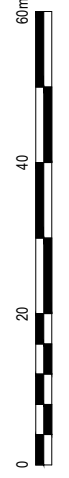



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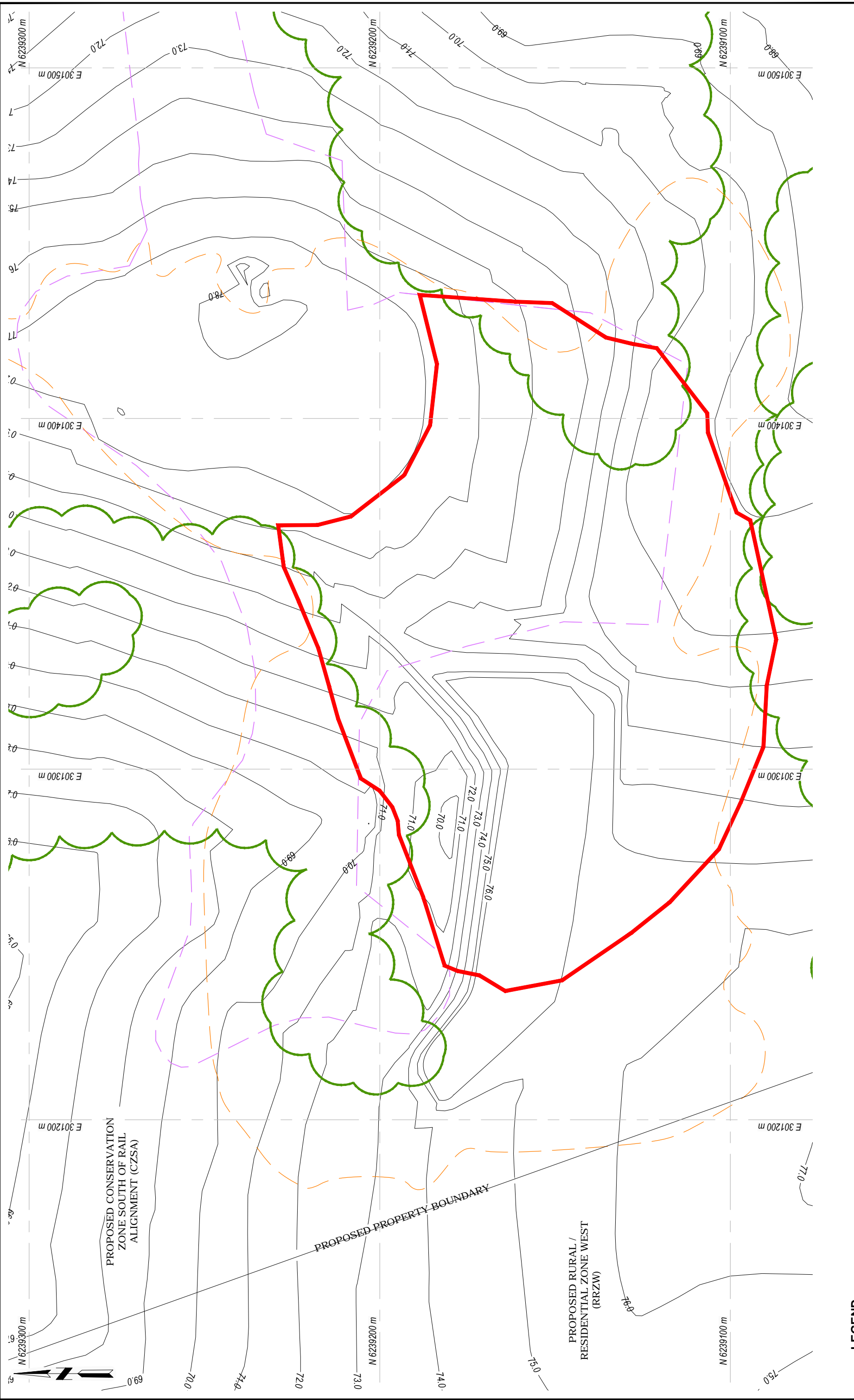
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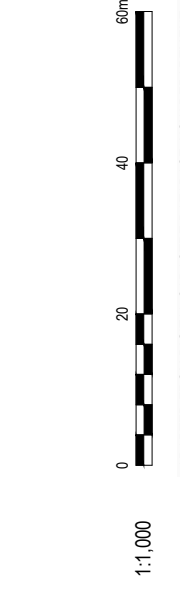
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 - - - LEAD PARTICULATE AREA
 - - - REMEDIATION OF ASBESTOS AREA
 - HEAVILY VEGETATED AREAS




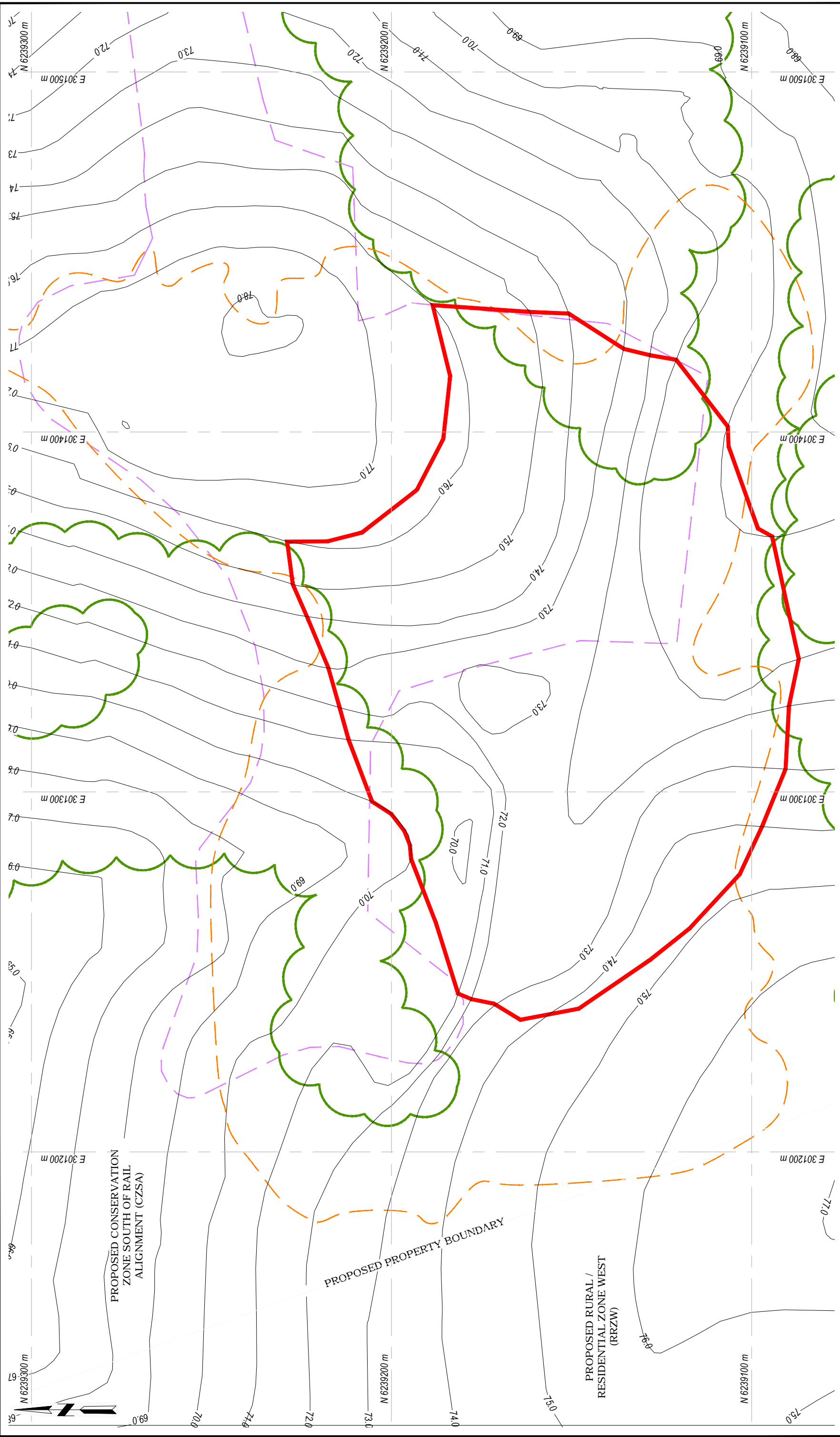
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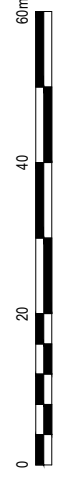
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 - - - REMEDIATION OF ASBESTOS AREA
 - HEAVILY VEGETATED AREAS




 <small>www.golder.com</small> GOLDER ASSOCIATES PTY LTD	CLIENT LANDCOM	PROJECT REMEDIATION ACTION PLAN - ZOUCR ROAD, EDMONDSON PARK
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SCALE 1:1000	SHEET SIZE A3	DOC No. 001
		DOC TYPE R
		FIGURE No. F0007A
		REVISION 0
		FIGURE 7A



- LEGEND**
- PROPOSED CAPPED AREA - FOOTPRINT
 - - - LEAD PARTICULATE AREA
 - - - REMEDIATION OF ASBESTOS AREA
 - HEAVILY VEGETATED AREAS



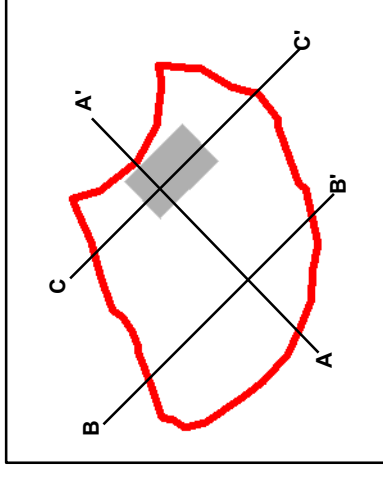
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CHECKED BY GJF	DATE 10.05.2010	PROJECT No. 107623047
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		FIGURE No. 0
		REVISION F0007B
		FIGURE 7B







PROJECT NAME

LANDCOM

CAPPED AREA CROSS SECTIONS



LEGEND

-  ACM Burial Pit
-  Virgin Ground
-  Re-engineered Material
-  Clay Cap
-  Top Soil
-  Current RL - Lead Particulate

NOTES

Insert additional information here.

COPYRIGHT

Insert COPYRIGHT information here.

Vertical Exaggeration 1:2

PROJECT: 107623047

DATE: 27-08-2010

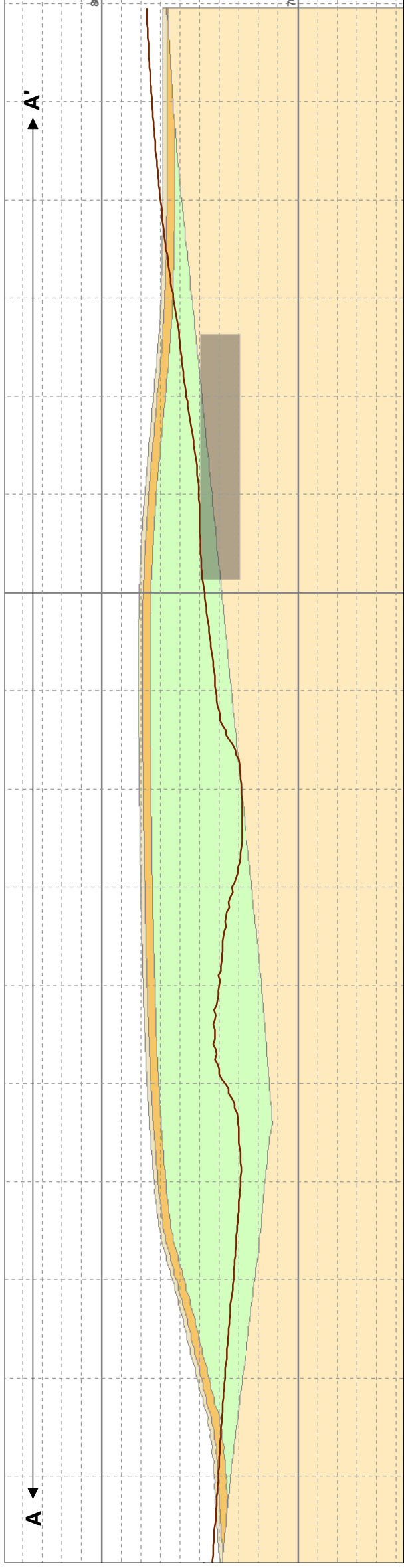
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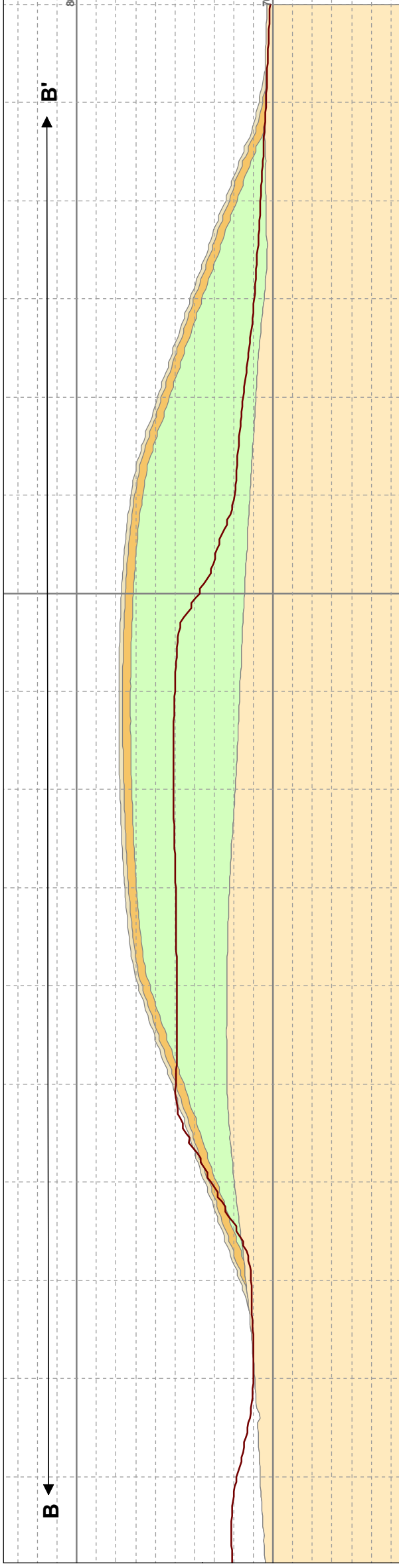
FIGURE 8



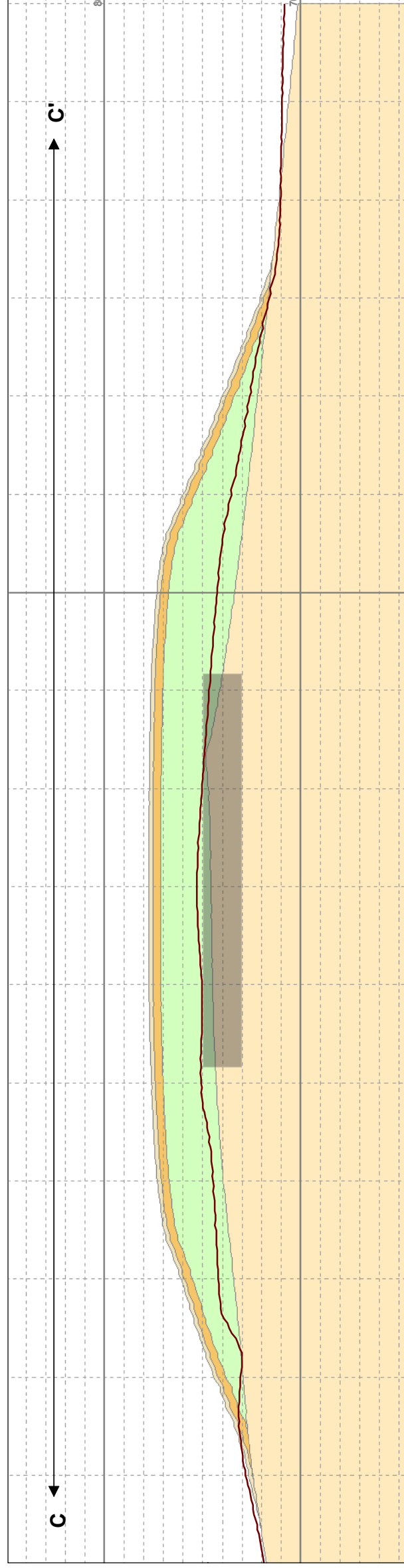
Section A



Section B



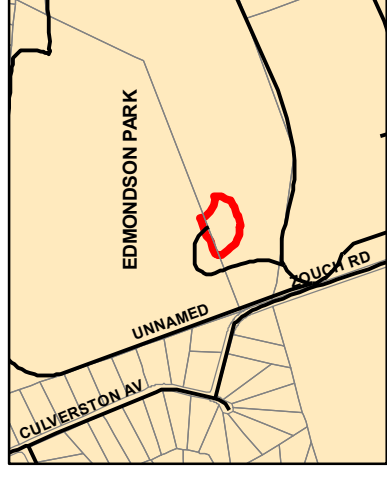
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PROJECT NAME

LANDCOM

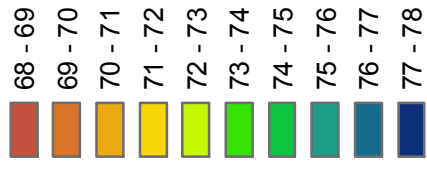
3D FINAL SURFACE LEVEL REPRESENTATION



LEGEND

— Cell Boundary

Elevation (mAHD)



NOTES

Insert additional information here.

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SCALE (at A3) 1:0

DATUM GDA 94, PROJECTION MGA Zone 55

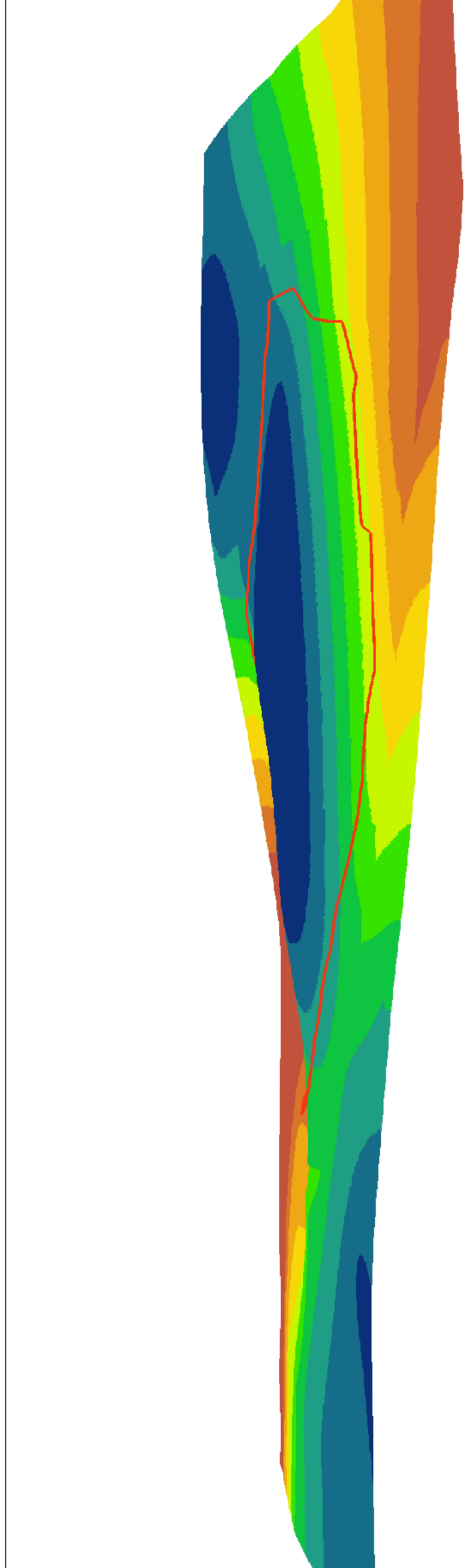
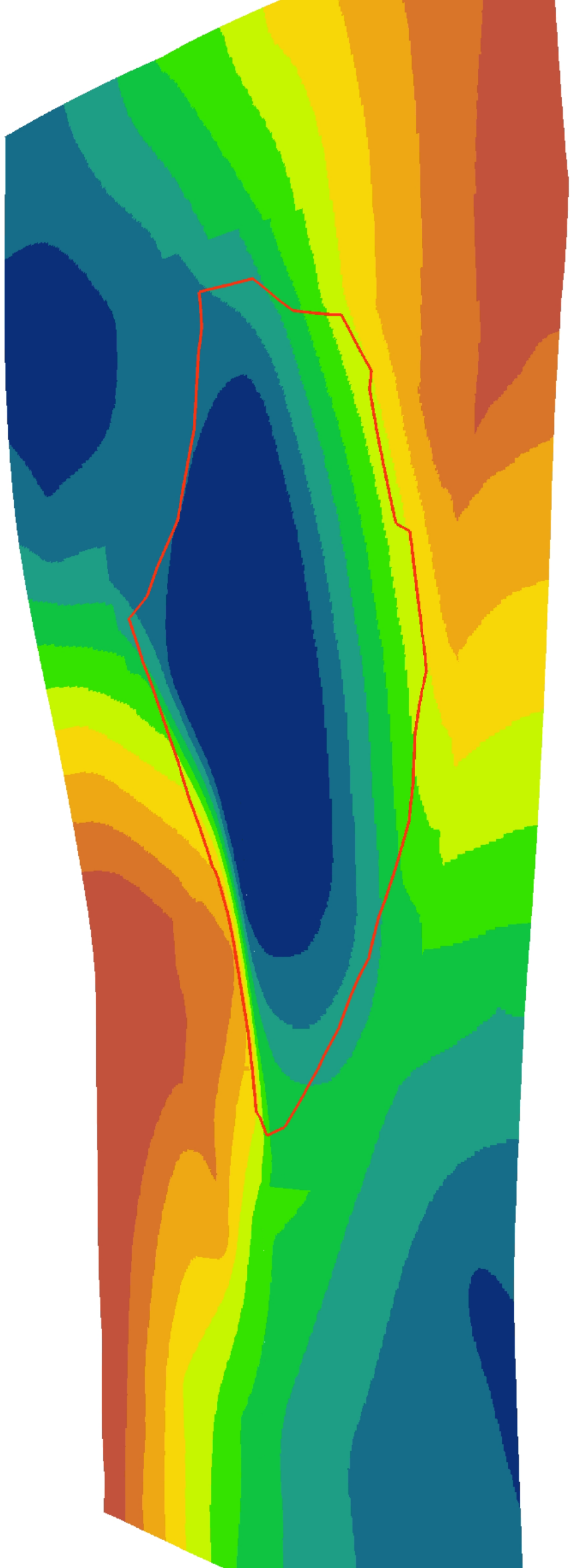
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DRAWN: AJW

CHECKED: AP

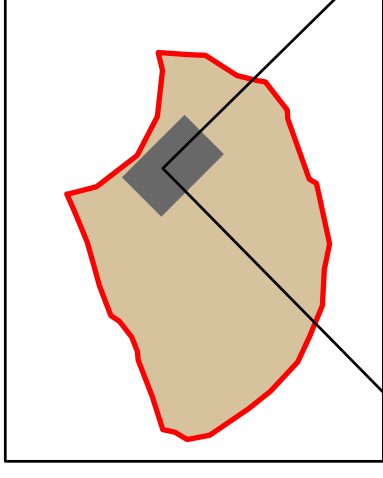
FIGURE 9









PROJECT NAME

LANDCOM

3D SURFACE



LEGEND

-  Top Soil
-  Capping
-  Cell
-  Current RL
-  Virgin GL
-  Depository Cell

Vertical Exaggeration 1:2

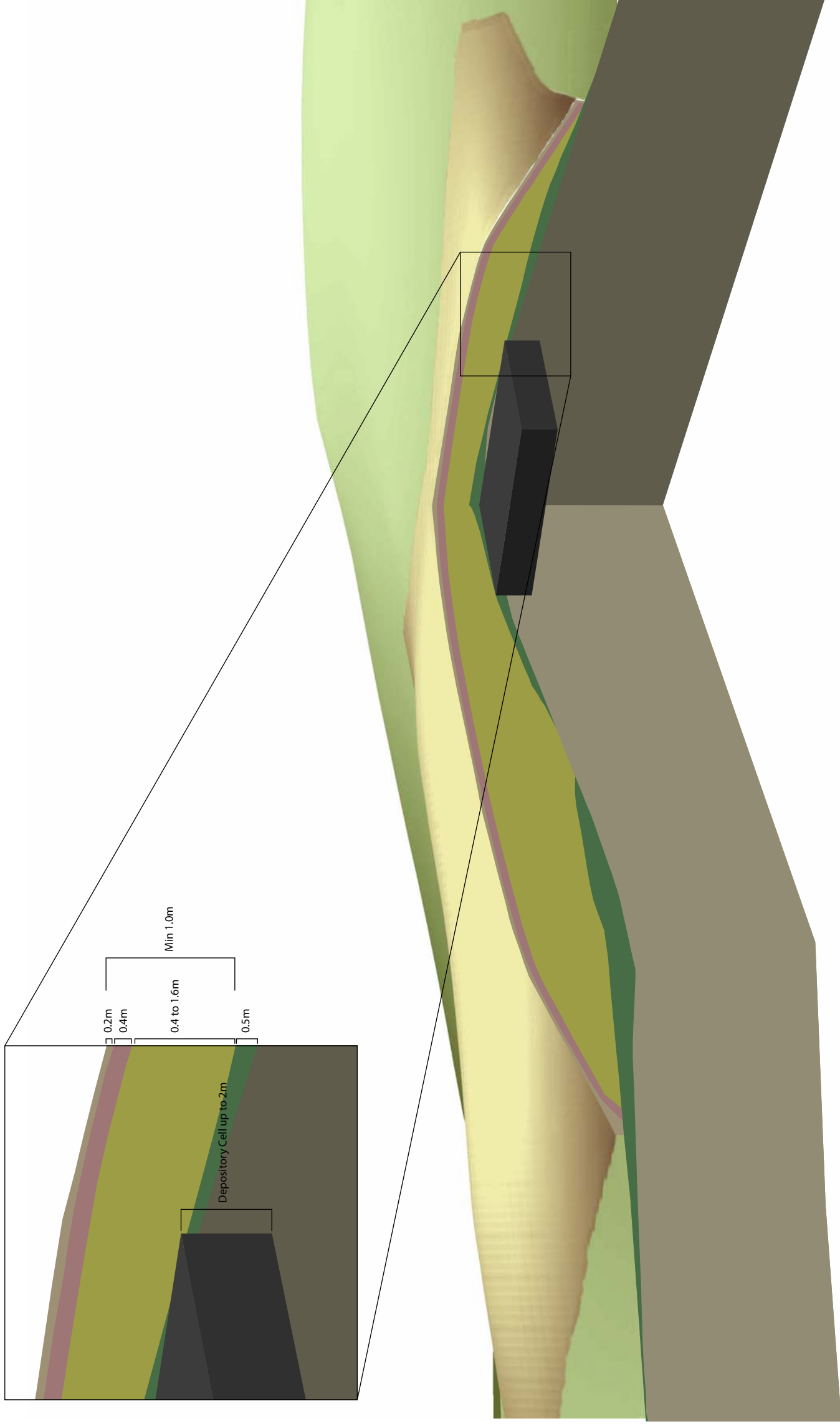
PROJECT: 107623047

DATE: 5/5/2010

DRAWN: AJW

CHECKED: GF

FIGURE 10





APPENDIX B

Draft Interim Advice #3 (Environ 2005a)

ENVIRON

Interim Advice #3

Zouch Road, Edmondson Park, NSW

for

Landcom



September 2005

Ref: 31-0163



8 September 2005

Ref: 31-0163

Landcom
c/o APP Corporation Pty Ltd
Level 1, 53 Berry Street
North Sydney NSW 2060

Attn: Scott Johnston

Dear Scott,

Interim Advice #3 – Zouch Road, Edmondson Park, NSW

I have pleasure in submitting Interim Advice #3 for the subject site. The Audit was commissioned by Landcom ultimately to assess the suitability of the site for its intended residential and conservation use. This Site Audit is not currently required by regulation or legislation and therefore a non-statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

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	Attachment 3: Groundwater Contours
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LIST OF ABBREVIATIONS

AOC	Area of Concern
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ASET	Australian Safer Environment and Technology Pty Ltd. (Laboratory)
ANZECC	Australian and New Zealand Environment and Conservation Council
BACTEC	BACTEC SE Asia Pty Ltd
BaP	Benzo(a)pyrene
BGL	below ground level
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic aromatic Hydrocarbons)
DP	Deposited Plan
DQO	Data Quality Objectives
EPA	Environment Protection Authority (NSW)
Golder	Golder Associates Pty Ltd
ha	Hectare
km	Kilometres
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
m BGL	Metres below ground level
µg/L	Micrograms per Litre
Milsearch	Milsearch Pty Ltd
NATA	National Association of Testing Authorities
ng/L	Nanograms per Litre
NEHF	National Environmental Health Forum
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OCPs	Organochlorine Pesticides
OPPs	Organophosphorus Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PB	Parsons Brinkerhoff Australia Pty Ltd
PCBs	Polychlorinated Biphenyls
PID	Photoionisation Detector
PQL	Practical Quantitation Limit
pH	a measure of acidity, hydrogen ion activity
QA/QC	Quality Assurance/Quality Control
REM	Remediation Area
RPD	Relative Percent Difference
SAA	Small Arms Ammunition
SILs	Soil Investigation Levels
SVOCs	Semi Volatile Organic Compounds
TPHs	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
UXO	Unexploded Ordnance
VENM	virgin excavated natural material
VHC	Volatile Halogenated Compounds
-	On tables is "not calculated", "no criteria" or "not applicable"

1 INTRODUCTION

A site contamination audit is being conducted for Landcom relating to property at Zouch Road, Edmondson Park, formerly occupied by the Department of Defence (Defence).

The audit is being conducted ultimately to provide an independent review of whether the land is suitable for any specified use or range of uses by an EPA Accredited Auditor i.e. an Audit under Section 47 (1) (b) (iia) of the NSW *Contaminated Land Management Act 1997* (the CLM Act).

The Audit is being conducted in stages, with initial investigations conducted by Milsearch Pty Ltd (2000 to 2003) focussing on the military history of the site and the potential for contamination by munitions. Parsons Brinkerhoff Australia Pty Ltd (2004) then prepared a *Sampling, Analysis and Quality Plan for Detailed Site Assessment*, which covered munitions issues as well as soil and groundwater contamination issues. Golder Associates Pty Ltd (2005) have recently completed and reported on the *Detailed Contamination Site Investigation* of the site. The munitions aspects of this most recent assessment were conducted by BACTEC SE Asia Pty Ltd (BACTEC).

Advice has previously been provided by the Auditor throughout the audit, as follows:

- Stage 1 - Initial Advice, 7 February 2003;
- Interim Advice #2, 8 July 2003; and
- Various comments on the Sampling Analysis and Quality Plan, 21 April to 19 May 2004.

Consistent with Department of Environment and Conservation (DEC and formerly NSW EPA) requirements for staged "sign off" of sites that are the subject of progressive assessment, remediation and validation, I am required to advise that:

- This opinion letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation that will conclude as to the suitability of the site for its intended purposes.
- In the final Site Audit Report this interim advice will be documented.

Details of the audit are:

Requested by:	Alan Lalich & Associates, on behalf of Landcom
Request/Commencement Date:	24 January 2003
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of work completed to date for the audit and covered by this Interim Advice includes:

- Review of the following reports:
 - Report “*Stage 1 Preliminary Contamination Investigation. Zouch Road Ingleburn 92 Ha Site*”. By Milsearch Pty Ltd (Milsearch). Prepared for Landcom, September 2000; and
 - Draft Report “*Draft Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002*”. By Milsearch. Footer date 30 June 2002.
 - Report “*Final Stage 2 Munitions Contamination Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre). 21 January – 6 April 2002*”. By Milsearch. Footer date 30 June 2002.
 - Report “*Stage 2 Munitions Contamination Investigations, Additional Investigations. Landcom 92 Ha Site, Zouch Road, Ingleburn (Former Army Infantry Centre)*”. 14-16 January & 9 February 2003, 30 April-2 May 2003, 21-22 May 2003. By Milsearch. Footer date 10 June 2003.
 - Draft Report “*For Discussion – Sampling, Analysis and Quality Plan (SAQP), Detailed Site Assessment, Zouch Road, Ingleburn*”. By Parsons Brinkerhoff Australia Pty Ltd (PB). Date March 2004.
 - Draft Report “*For Discussion – SAQP, Detailed Site Assessment, Zouch Road, Ingleburn*”. By PB. Date April 2004.
 - Report “*SAQP, Detailed Site Assessment, Zouch Road, Ingleburn*”. By PB. Date May 2004.
 - Draft Report “*Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW*”. By Golder Associates Pty Ltd (Golder). Date May 2005 (2005a).
 - Report “*Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW*”. By Golder. Date August 2005 (2005b).
- Site visits by the Auditor or representative on 31 January 2003 and 1 March 2005.
- Discussions with the Client (Landcom) and Consultants (Milsearch, PB and Golder) who undertook the investigation.

2 SITE DETAILS

2.1 Location

The site is located on the north and west extremity of the Ingleburn Military Camp, which is located on Campbelltown Road running south west from Liverpool. The site location is shown in Attachment 1, Appendix A.

Further details follow:

Street address:	Zouch Road, Edmondson Park NSW 2171
Identifier:	Lot 1, DP 807460 (54.67 ha) Lot 2, DP 807461 (38.14 ha)
Local Government:	Liverpool City Council
Owner:	Landcom (NSW Government)
Site Area:	92.81 ha (Golder report area as "about 94 ha")

A survey plan of the site has not been provided. If this Summary Site Audit were used for statutory purposes the surveyed site boundaries would be required.

2.2 Zoning

According to the Stage 1 Milsearch report, the previous site zoning status is 5(a) Military and the current zoning is 1(a) Rural.

The proposed future zoning for the site is 2(a) Residential, however, a large portion of the site is proposed to be used for a conservation (open space) area.

2.3 Adjacent Uses

The site has frontage to only one public road, Zouch Road, for only a short distance in the south west corner of the site.

Adjacent site uses are as follows:

- Well-developed semi-urban acreages which front away from the site to Culverston Avenue are located to the **west**;
- A series of small agricultural blocks which also front away from the site are located to the **north** and **east**, fronting onto Jardine Drive and Croatia Avenue, respectively;
- Low cost housing which was formerly Army Married Quarters are located to the **south east**; and
- The now disused Ingleburn Military Camp is located to the **south**.

None of the surrounding land uses were identified as having the potential to cause significant contamination at the site.

2.4 Site Condition

The majority of the following description is summarised from the Milsearch Stage 1 report (2000), with some additional comments from the Golder investigation (2005). Attachment 2, Appendix A, shows the site layout and key features as identified by Golder in their investigation.

Information prepared for the site and referenced by Milsearch, but not reviewed by the Auditor, includes:

- *Preliminary Flora and Fauna Study*. Pelican Environmental Surveys, March 1999;
- July – August 2001 studies of Cumberland Land Snail colonies by Gunninah Environmental Consultants;
- Topographical surveys of the site, August – September 2001; and
- National Parks and Wildlife Service Section 91 licence providing approval for vegetation slashing to proceed, October 2001.

The site is described as open grassed land with several separate stands of protected Cumberland Plain Woodlands (Grey Box). A number of protected Land Snail colonies are located primarily in nine areas of protected woodland. Although readily accessible areas of grassland are reportedly slashed on a regular basis as a fire protection measure, vegetation overgrowth is extensive at the site, with common blackberry infestations (shown on Attachment 2, Appendix A).

The topography of the site is described as gently undulating. The site elevation ranges from 50 to 70 m with reference to Australian Height Datum (AHD) with the highest point in the southwest corner of the site. Key site features described include:

- a low ridge line in the north;
- a small hill in the south east;
- a man-made stop butt as part of a small arms firing range in the south west;
- various earth roads cross the site;
- well-constructed 9m wide dirt perimeter road;
- major creek lines and dams on site are as follows:
 - Cabramatta Creek runs across the north west corner of the site and receives runoff from the north west area;
 - originating on site, in the east running from south to north, exiting in the north east of the site, Dam 1 is on this creek;
 - feeder creek to the above, south east of the stop butts, Dam 3 is on this feeder creek;
 - originating off-site, in the east, running northerly then easterly, exiting in the north east, Dam 2 is on this creek;
 - all three dams were dry in 2000; and
 - Dam 3 was dry and Dams 1 and 2 had a small amount of water in 2005.

A number of additional observations relevant to the contamination assessment were made by Milsearch and Golder, as follows:

- Expended blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training. SAA may be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas.
- There are a number of areas on site that have been used for disposal of building and domestic waste, with some illegal dumping:
 - Trenches in high ground to the north east of the small arms firing range;
 - Piles in the extreme north west corner of the site, including soil, bonded asbestos sheeting and building rubble;
 - Pile 100m north east of the entrance gate; and
 - Piles in numerous other locations on site.
 - Golder identified 15 stockpile locations on Attachment 2, Appendix A.
- There are numerous areas of concertina barbed wire located at the site, which were formerly used as practice obstacles.
- There is a high concentration of concertina barbed wire at a prisoner of war camp simulation area in the central west of the site. General rubbish including whitegoods, scrap metal and vehicle parts were also present in the western part of this compound. Weapons pits less than 1m deep were also observed within the area.
- Slit trenches are common across the site, especially on the slopes of the high ground in the north. Many trenches have been partially filled and are likely to contain some star pickets, corrugated iron and possibly expended training ammunition.
- Golder identified numerous weapons pits across the site, as shown on Attachment 2, Appendix A.
- There are two former underground command posts in the north central portion of the site, fenced off by barbed wire. One was filled with water in 2000 and 2005.
- A few concrete building foundations indicating the former presence of structures are located on site, primarily in two zones:
 - In the south east near Dam 2, possibly former dog kennels; and
 - On the north west wooded ridgeline, including two foundations, a latrine and evidence of other wood frame buildings.
- A coal stockpile is located on high ground to the north east of the small arms firing range (about 200 m³) and in the south east corner of the site (about 150 m³).
- Car bodies are located in numerous locations, some burnt areas were found where the bodies had evidently been removed.

- Bonded asbestos materials were observed on site as follows:
 - A short length of bonded asbestos 4" water conduit was observed south of the small arms firing range, possibly imported with building rubbish;
 - Five piles of asbestos sheeting and building rubble were present north of the small arms firing range, close to the access road;
 - Two more piles are present on the crest of the hill north of the small arms firing range;
 - Golder identified a large area overlapping the small arms firing range of fragmented pieces of bonded asbestos sheeting scattered across the ground surface;
 - Asbestos was noted in the waste dumps in the extreme north west corner of the site; and
 - Golder identified a stockpile of asbestos pipes in the east of the site.

The Auditor's observations during the site inspection were consistent with the site conditions described by the Consultants.

2.5 Proposed Development

Golder (2005) provides a summary of the proposed development for the site. The site forms part of the Edmondson Park Release Area, and is currently the subject of a rezoning proposal. Key features of the proposed development include:

- A proposed rail line from the south east to north west corner of the site;
- Approximately 38 ha of Conservation Zone and riparian protection park south of the proposed rail alignment; and
- Approximately 55 ha of development including elements of a town center and residential districts in the northern and western parts of the site.

For the purposes of this audit, the "residential with gardens and accessible soil" and "open space" land use scenarios will be assumed.

Golder has divided the site into four areas for assessment purposes:

- Residential zone north of rail alignment (RZNRA);
- Residential zone south west corner (RZSWC);
- Residential zone north west corner (RZNWC); and
- Conservation zone south of rail alignment (CZSRA).

3 SITE HISTORY

Milsearch compiled site history information from the following sources:

- Literature search including Gavin Lang’s history of the Second World War; various unit histories and war diaries; and a magazine produced at Ingleburn Camp during the period of the universal National Service Scheme (1950-1959);
- Archival material from National Archives, Canberra; National Archives, NSW and from the Australian War Memorial Public Documents Archive;
- Interviews with serving and former soldiers who had trained at Ingleburn camp at some time during their careers, or who could have knowledge of the camp’s history;
- Review of records and drawings held by the Defence Property Office NSW and information from the period Defence Hirings Register, made available by the Defence Regional Office Sydney;
- Examination of the Defence 1996 Unexploded Ordnance (UXO) Assessment for Ingleburn Military Camp along with supporting Explosive Ordnance Incident Reports (EOIR) from 1996 to 2000;
- Review of available aerial photographs from 1947 to 1998; and
- Site inspection.

Golder undertook additional site history investigations which included the following:

- Review of aerial photographs from 1947, 1956, 1961, 1965, 1970, 1978, 1986, 1991, 1994, 1998 and 2002;
- Review of historical title information; and
- Review of Section 149 certificates from Liverpool City Council.

The Auditor has summarised the site history provided by Milsearch and Golder in Table 3.1.

Table 3.1 – Site History

Date	Activity
1819	Original land grant, private ownership, farming usage likely.
1939	Defence hired ‘vacant land’ near Ingleburn Camp as a ‘manoeuvre area’. Usage by Defence continued through the WW2 period.
1953	<p>Purchased by Commonwealth of Australia. Land within the wider Ingleburn area was acquired by the Army and used to establish camps and to conduct training for wartime expansion. Site was used primarily for infantry training purposes.</p> <p>First features developed at the site were the Small Arms Firing Range, Golf Course, grenade throwing bay and impact zone and cricket pitch.</p>

Date	Activity
	<p>The grenade range was located in the center of the site and was used for live grenade throwing practices and possibly also mortar practice bombs for up to 30 years.</p> <p>The firing range, located in the south west of the site, was also used for up to 30 years.</p>
<p>Between 1956 and 1961</p>	<p>Golf course is disused.</p> <p>Dams 1 to 3 are present. The dams may have been used for disposal of unwanted munitions.</p>
<p>Between 1970 and 1978</p>	<p>Small arms Firing Range has been reconfigured to fire in the opposite direction. The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s.</p> <p>Vegetation cover at the site is increasing from this time.</p>
<p>Between 1978 and 1986</p>	<p>Three disposal trenches have been excavated, located in high ground to the north east of the firing range. The pits were reportedly filled by the former disposal practices of the 'Boards of Survey' of 'burn, bash and bury'. This area would contain general stores materials which were damaged or surplus to requirements.</p>
<p>1990</p>	<p>Purchased by NSW Land and Housing Corporation (Landcom). Usage by Defence ceased.</p>

In the Auditor's opinion, the site history review has been detailed and the major potential contamination issues on site have been identified. Some uncertainty remains with respect to the potential for:

- additional waste disposal trenches;
- additional areas of lead particulate;
- the location of slit trenches that may have been backfilled; and
- unexpended (live) blank SAA possibly disposed during tactical training exercises.

4 CONTAMINANTS OF CONCERN

Milsearch identified a number of potential contaminants at the site. Based on the reviewed reports, site history and site condition, the potential contaminants of concern in the opinion of the Auditor are as shown in Table 4.1 below.

Table 4.1 – Contaminants of concern

Activity	Area	Contaminants of concern
Live grenade throwing practices and possibly also mortar practice bombs	Grenade range	UXO and grenade explosion residues
Small arms firing range	Firing range stop butts Roadways where reengineered stop butt material was placed Dam 3 (runoff)	Lead particulate and other heavy metals
Possible munitions disposal	Dams 1, 2 and 3	UXO
Waste disposal in trenches	3 burial trenches, NE of small arms firing range Possible additional unknown locations	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
Waste disposal in piles, including building rubble	Extreme north west corner of the site 100m north east of the entrance gate South of small arms firing range 5 piles north of small arms firing range 2 piles on crest of hill north of small arms firing range Potential locations across entire site	Unknown, could include heavy metals, petroleum hydrocarbons, pesticides, asbestos, household chemicals
In-ground structures used for infantry minor tactical training	Known slit trench locations Underground command posts Possible additional unknown locations	Physical objects such as star pickets and corrugated iron Unknown, possibly heavy metals (significant contamination would not be expected with this type of material, removal would be desirable for aesthetic purposes)
Infantry minor tactical training	Entire site, especially near slit trenches	Expended SAA, small percentage live (unexpended) SAA
Pest and weed control	Entire site	Pesticides, herbicides, arsenic, mercury
Runoff of contaminants	All waterways on site	Lead particulate primarily Pesticides, herbicides, arsenic, mercury
Building products and treatments	Former building	Pesticides, asbestos, lead
Storage and distribution of coal	Coal stockpile	Coal dust Possibly PAH, phenols
Practice obstacles	Numerous locations	Barbed wire physical hazard
Car body disposal and burning	Numerous locations	PAH, heavy metals, petroleum hydrocarbons

Activity	Area	Contaminants of concern
Car body disposal, surface dumping and practice obstacles	Numerous locations	Physical objects including cars and barbed wire Unknown, possibly PAH, heavy metals, petroleum hydrocarbons (significant contamination would not be expected with these types of surface dumpings, removal would be desirable for aesthetic purposes)

This table was adopted by PB for the SAQP and was subsequently also adopted by Golder as the basis for their investigation.

An additional issue identified by Golder during their investigations was the asbestos impact area that overlaps the small arms range, where fragmented pieces of bonded asbestos sheeting were scattered across the ground surface;

According to Milsearch, while live blank SAA ammunition constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering.

Although the waste types likely to be encountered in the burial trenches or surface dumpings are likely to vary, the classes of contaminants of concern likely to be associated with waste disposal are well known, and are listed in Table 4.1, above.

5 STRATIGRAPHY AND HYDROGEOLOGY

Subsurface conditions at the site were investigated by Golder (2005) by the following:

- 628 test pits to between 0.3 and 4.3 m Below Ground Level (BGL) (generally less than 1 m BGL)
- 112 hand auger locations to between 0.5 and 1 m BGL
- 10 drilled boreholes to between 8 and 16.3 m BGL
- 13 test pits into stockpiled material to between 0.6 and 1.8 m BGL

The Auditor has compiled the following summary of the site stratigraphy and hydrogeology following review of the Golder (2005) report.

5.1 Stratigraphy

The regional geology comprises Bringelly Shale of the Wianamatta Group which comprises shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff. This shale would be expected to be underlain by Ashfield Shale and then Hawkesbury Sandstone.

The stratigraphy of the Site is summarised in Table 5.1.

Table 5.1 – Stratigraphy

Unit	Depth (m BGL)	Description
Topsoil	To between 0.05 and 0.5	Clayey silt/ silt, brown, dry to moist, trace fine gravel
Fill (total 80 locations) Occurs in general stockpiles, small arms range, disposal trenches and northwest disposal area	To between 0.1 and 3.4m	General fill is silty/ gravelly clay, low to medium plasticity, brown, red and grey Small arms range – silty clay, red grey, fine to medium ironstone gravels, pieces of lead particulate Disposal trenches – described in Section 9.7. Northwest disposal area – silty/ gravelly clay, concrete blocks, bricks, timber, general building waste
Residual	Between topsoil/ fill and bedrock	Silty clay, medium to high plasticity, moist, some fine to medium ironstone gravels
Bedrock	From between 0.2 and 3.2	Shale, weathered, grey brown. A weathered, sandy shale outcrop was observed in the south west corner of the site.

5.2 Hydrogeology

Limited groundwater investigations have been undertaken at the site. Ten deep boreholes were drilled and wells were installed in the seven locations that encountered groundwater. Groundwater was present at between 2.54 and 14.6 m BGL, occurring within the shale/ sandstone bedrock. The equivalent reduced levels for groundwater at the site were 46.15 to 54.8 m AHD.

Perched water was encountered in three test pits at the eastern end of the waste disposal trenches (TP598, 706 and 708). The standing water level in these pits was about 0.5 m BGL and the water had a foul odour.

Golder expected perched groundwater to occur within alluvial deposits near main drainage lines and dams, flowing in the direction of the ground slope. The regional groundwater flow direction was inferred as likely to flow in an east to north easterly direction towards the Georges River.

The measured groundwater levels indicate that true groundwater flows in two directions away from the ridgeline in the centre of the site to the northwest and southeast directions. The inferred groundwater contours are shown on Attachment 3, Appendix A.

The nearest registered bores in the area are located approximately 1.5km from the site.

6 EVALUATION OF QUALITY ASSURANCE AND QUALITY CONTROL

A detailed Sampling, Analysis and Quality Plan (SAQP) was prepared by PB. The Auditor provided review comments on draft versions of this document.

6.1 Munitions

Data Quality Objectives in relation to the assessment of munitions contamination, including UXO, were not specifically addressed by Milsearch. The Auditor has assessed QA/QC for these investigations by considering the adequacy of investigation for each issue/ impact identified and the qualifications of personnel involved in the munitions investigation. The investigations undertaken are discussed in Section 9 and were found to be generally reliable for the purposes of the audit.

The methodology for the recent UXO investigation and remediation works undertaken by BACTEC was defined in the PB SAQP. Works were undertaken in accordance with the SAQP with the following two exceptions:

- The method for remediation of the REM 5 area was defined in the SAQP as mechanical screening, however, this method was not considered appropriate and was changed to a metal detector search to 300mm depth (two man team at 1m line spacings) with concurrence from the Auditor.
- Areas where geophysics found metallic anomalies were not investigated by 10m transects as proposed in the SAQP due to restrictions on disturbing vegetation in the areas with the highest readings. As an alternative, a visual inspection was undertaken with concurrence from the Auditor.

Quality control and calibration requirements for UXO remediation works are specified by BACTEC in their report. Key elements of QA/QC were as follows:

- Remediation searches were extended 4-5m outside the REM boundary areas to ensure full coverage of the areas.
- Searches comprised both a visual search and metal detector search.
- All detection equipment was calibrated daily over a prepared test pit. BACTEC reported that the test pit was established at the site with two targets, representative of the targets to be located during the project, buried at different depths.

6.2 Soil and Groundwater

The Auditor has assessed the overall quality of the soil and groundwater data by review of the information presented in the referenced reports, supplemented by field observations. The recent Golder detailed investigations were conducted largely in accordance with the approved SAQP, except as noted below.

The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1 – QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Sampling Pattern and Locations	<p>Soil: Investigation locations were spaced on a systematic grid to gain coverage of the entire site. Further judgemental locations were targeted to features such as drainage lines, stockpiles and areas of contaminant observations. The grid spacings were defined according to the proposed usage of each area. The grid spacings were 32m for residential and 50m for conservation areas. The total number of sampling locations was 741 systematic and 92 judgemental.</p> <p>Locations could not be placed in areas of protected vegetation or blackberry infestations. Where possible, nearby alternate locations were found. The lack of investigation locations in those specific areas is not considered by the Auditor to affect the findings of the investigations. It was also necessary to slightly move locations from their proposed grid position due to the proximity of trees, military objects or other access restrictions. Further grid locations were shifted to intercept nearby areas of potential contamination such as fill/ stockpiles, training pits or drainage channels.</p> <p>In the Auditor's opinion the soil investigation locations adequately characterise general areas of the site and target the main areas of concern.</p> <p>Digital GPS was used to locate investigation locations and remediation areas.</p> <p>Groundwater monitoring wells were located in judgemental locations to gain coverage of upgradient and downgradient conditions, and to provide a broad indication of groundwater quality, particularly in the vicinity of contaminating activities.</p>
Sampling Density	<p>Soil: The EPA (1995) <i>"Sampling Design Guidelines"</i> does not provide guidance on the minimum number of sampling locations for sites larger than 5 ha, however, the selected grid spacing for the residential areas, 32m, is comparable to the minimum hotspot diameter recommended for sites of over 2 hectares. The Auditor considers that the adopted sampling densities for both the residential and conservation areas are appropriate.</p> <p>The proposed usage of one area, RZNWC, was changed following completion of the field works, therefore the grid spacing in this area is larger than for the other residential areas, and is not in accordance with the SAQP. Given the lack of contaminant detections in general areas of the site and the large volume of data for the site as a whole, the reduced density of sampling in this area is not considered by the Auditor to be significant.</p> <p>The analytical program was designed in the SAQP to assess the various contaminants of concern at appropriate sampling densities.</p> <p>The frequency of analysis was generally as follows:</p>

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	<ul style="list-style-type: none"> ■ Heavy metals – all samples ■ PAH, TPH, BTEX – 16 to 26% of samples ■ OCP, OPP, PCB, Explosives – 11 to 16% of samples ■ Asbestos – 20-30% of samples <p>The Auditor considers that the adopted sampling and analysis program was adequate to characterise the primary contaminants on site.</p> <p>Groundwater: A total of 10 groundwater wells were installed at the site, however, three of these wells were dry upon completion and could not be sampled. Three other wells were extended deeper, in consultation with the Auditor, to ensure groundwater was encountered in key locations.</p> <p>In addition, three samples of perched water collected within trenches in the waste disposal area were also collected.</p> <p>All groundwater and trench water samples were analysed for all target contaminants.</p> <p>The Auditor is satisfied with the adopted groundwater investigation density and analytical program.</p>
Sample depths	<p>Subsurface conditions were investigated by the following:</p> <ul style="list-style-type: none"> ■ Test pits - 0.3-4.3 mBGL ■ Hand auger holes - 0.5-1.0 mBGL ■ Boreholes - 8 to 16.3 mBGL ■ Test pits in stockpiles - 0.6-1.8 mBGL ■ Hand auger holes in ACM area - 0.5 mBGL <p>Soil samples were collected from the surface (0-0.1m), 0.1-0.3m, 0.3-0.5m, 1m then 1m intervals or at visual/ olfactory signs of contamination or changes in lithology.</p> <p>The following number of samples were collected:</p> <ul style="list-style-type: none"> ■ Minimum 3 samples per hand auger hole ■ Minimum 4 samples collected per test pit/ borehole <p>Samples were selected for analysis from all material types encountered. The analytical program included analysis of at least one sample per investigation location.</p> <p>The most common sample intervals selected for laboratory analysis were the surface layer, then the immediate subsurface (to 0.3 or 0.5m BGL). The deepest sample analysed was to 3.7 mBGL in TP625 from the small arms range/ lead particulate area.</p> <p>Locations were extended 0.5m into natural soil or 0.5m beyond the extent of observed contamination.</p> <p>In the Auditor's opinion, this sampling strategy was appropriate and adequate to characterise the primary material types present on site.</p>
Well construction	<p>A total of 10 groundwater wells were installed at the site, seven to 8m BGL and 3 to around 15 m BGL. Three of the shallow wells were dry upon completion. Remaining wells contained sufficient water to sample. For all of these wells,</p>

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	<p>the top of water table occurs within the screened interval. Wells were constructed of Class 18 50mm uPVC pipe. A 1.5mm graded sand filter pack was used with a bentonite seal of at least 1m.</p> <p>All groundwater level measurements were taken on the same day except for BH2 (5 days later).</p>
Sample Collection Method	<p>Soil: Soil samples were collected as follows:</p> <ul style="list-style-type: none"> ■ Test pits – Stainless steel trowel from the test pit walls or the centre of the excavator bucket for pit depths of greater than 1m. ■ Hand auger holes - 75mm hand auger, sample collected directly from the auger flights. ■ Boreholes - Truck mounted drill rig, 100mm solid flight auger, samples collected directly from the auger flights. Attempts to collect undisturbed samples with a split spoon sampler were not successful. <p>The collection of soil samples from the auger flights is not ideal as it can result in loss of volatiles and sample cross contamination. However, given the limited number of samples required to have been collected in this way, and given the key contaminants at the site are heavy metals and PAH, this deficiency is not considered to be of great significance.</p> <p>Sample compositing was not undertaken.</p> <p>Test pits were loosely backfilled with excavated material on completion</p> <p>Groundwater: Wells were installed in boreholes that were auger drilled and cored at depth. Wells were developed and samples were collected with a dedicated disposable plastic bailer.</p>
Decontamination Procedures	<p>Soil: All sampling equipment was reportedly cleaned with detergent, rinsed twice in clean tap water. Augers were reportedly decontaminated between sample locations since soil sampling was directly from the auger flights. The use of high pressure water for cleaning of augers was not discussed.</p> <p>Groundwater: Dedicated sampling equipment was used for each well. The report does not state the decontamination method for groundwater meters.</p>
Sample handling and containers	<p>All samples were placed into appropriately prepared and preserved sampling containers provided by the laboratory. Samples were chilled during storage and subsequent transport to the laboratories.</p> <p>Samples to be analysed for heavy metals were field filtered with a 0.45µm filter.</p>
Chain of Custody	<p>Completed chain of custody forms were provided in the report.</p>
Detailed description of field screening protocols including calibration	<p>Field screening of soil samples for volatiles was undertaken using a PID. The PID screening procedure was provided. Half filled plastic bag samples were shaken and allowed to stand</p>

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	<p>for at least 5 minutes prior to measurement of vapours. The PID was reported to have been calibrated prior to use. Calibration certificates were provided.</p> <p>PID readings are provided on borehole logs, tabulated in the appendix and are discussed in the results section of the report. The highest PID concentration was 18.6 ppm, in HA99/2. This sample was not submitted for analysis, but there were no contaminant indicators in this natural clay sample. The cause of this elevated reading is not known, but is not considered likely to be a contamination impact. The vast majority of PID concentrations were less than 5 ppm indicating a general lack of impact by volatile contaminants at the site.</p> <p>Groundwater field parameters including temperature, pH, electrical conductivity (Ec) and Total Dissolved Solids (TDS) were measured during well sampling and development. Meters were reported to have been calibrated prior to use each day. Calibration certificates were provided.</p>
Sampling Logs	<p>Soil logs are provided within the report, indicating sample depth, PID readings and lithology.</p> <p>Separate sample registers were also provided for each area.</p> <p>Groundwater field sampling records were not provided, although measured field parameters are included in the report.</p>

Table 6.2 – QA/QC – Field and Lab Quality Assurance and Quality Control

Field and Lab QA/QC	Auditor Comments
Field quality control samples	<p>Field quality control samples including intra- and inter-laboratory duplicates, trip blanks, trip spikes and wash blanks were undertaken.</p> <p>Individual soil analyte duplicate frequencies for each area generally met the targets of 10% for intra-laboratory (blind) duplicates and 5% for inter-laboratory (split) duplicates.</p> <p>The exception to this was that no intra-laboratory duplicate samples were analysed for asbestos samples from the entire site. However, inter-laboratory duplicate samples were analysed for asbestos at an overall frequency of 10%, exceeding the target of 5%.</p> <p>The groundwater duplicate sampling rates were 10% for intra-laboratory (blind) duplicates and 10% for inter-laboratory duplicates.</p> <p>The overall sampling numbers were as follows:</p> <ul style="list-style-type: none"> ■ 1107 primary soil samples ■ 10 primary groundwater samples ■ 172 duplicate samples ■ 20 trip blanks and 19 trip spikes

Field and Lab QA/QC	Auditor Comments
	<ul style="list-style-type: none"> ■ 34 wash blanks <p>The overall duplicate frequency exceeded the 15% target. The frequency of field QA/QC sampling and analysis is considered by the Auditor to be acceptable for the purposes of the investigation.</p>
Field quality control results	<p>The results from all <i>trip blank samples</i> were appropriate. Some <i>trip spike samples</i> returned recoveries below the desirable range of 70-130%. These minor variations are not considered significant given the lack of volatile organic detections in all soil and water samples from the site.</p> <p>Low levels of zinc were commonly detected in the <i>wash blank samples</i> with a maximum of 0.1 mg/L detected. Golder investigated this occurrence and was advised by the laboratory that rinsate water outside of a specific holding time can return detectable concentrations of zinc. However, Golder reportedly obtained rinsate water regularly from the laboratory and the laboratory would not confirm if the supplied water was out of holding time. Golder argued and the Auditor accepts that this issue is not reflective of poor decontamination practices and does not affect the findings of the investigation due to the following:</p> <ul style="list-style-type: none"> ■ no other metals were reported in the wash blank samples; and ■ few elevated concentrations of zinc were reported in the soil samples. <p>The results of all organic <i>duplicate</i> analyses for soil and groundwater (inter- and intra-laboratory duplicates) were non-detect in both the primary and secondary samples, therefore duplicate results were acceptable.</p> <p>Inorganic duplicate results are discussed below.</p> <p>Soil:</p> <p>For duplicate sample pairs for which RPDs could be calculated, over 8% of analyses returned RPDs outside the target of 50%, and 1.5% were over 100%. RPDs could not be calculated for sample pairs with non-detections.</p> <p>Golder concluded that these results "...indicate an adequate level of repeatability...". Golder did not undertake any further assessment of the findings and did not utilise the higher duplicate results in their assessment of results.</p> <p>Upon closer examination of the findings, a number of duplicate results were found to potentially affect the findings of the investigation. While it is acknowledged that these discrepancies would most likely be due to sample heterogeneity, the results still require consideration.</p> <p>Significant findings from duplicate analyses for inorganics were as follows:</p> <ul style="list-style-type: none"> ■ Several inter-laboratory duplicate samples pairs were non-detect (<0.05mg/kg) for mercury in the primary sample, but low level mercury detections (0.05-0.07mg/kg) were made in the duplicate sample.

Field and Lab QA/QC	Auditor Comments
	<p>Results were also occasionally inconsistent between intra-laboratory duplicates, however it was far more common with the inter-laboratory samples, with Labmark commonly reporting detections where SGS did not. Due to the low concentrations involved, this does not affect the findings of the investigation, however, it should be recognised as a potential indication of underestimation of mercury and possibly other metals concentrations by the primary laboratory (SGS).</p> <ul style="list-style-type: none"> ■ In the CZSRA, one intra-laboratory duplicate and one inter-laboratory duplicate exceeded the phototoxicity/ open space human health criterion for lead of 600 mg/kg while the primary samples were less than the criterion. These samples were both of fill from within known areas of contamination – the open trench and small arms range. The need for remediation in these areas has already been identified, therefore these findings do not affect the conclusions of the investigation. ■ In the CZSRA, one inter-laboratory duplicate exceeded the phototoxicity criterion for copper while the primary sample was below this criterion. This sample was from within a known area of contamination – the small arms range. The need for remediation in this area has already been identified, therefore this finding does not affect the conclusions of the investigation. ■ One board sample analysed for asbestos was identified as containing chrysotile asbestos by the primary laboratory (SGS) however the secondary laboratory (ASET) identified this sample as containing chrysotile and amosite asbestos. Remedial action is planned in the affected area based on the presence of asbestos with no regard for the type of asbestos, therefore this finding does not affect the conclusions of the investigations. <p>The above issues are not considered likely to affect the overall data useability due to the large volume of data and the generally low concentrations, therefore having a lower potential to change conclusions in the event of laboratory error.</p> <p>Groundwater:</p> <p>Two groundwater duplicate samples were analysed – one intra-laboratory duplicate and one inter-laboratory duplicate. Seven of the 16 individual analyte pairs exceeded the target with RPDs of between 40 and 173%. Three of these were found to potentially affect the conclusions of the investigation, all from the inter-laboratory duplicate of sample BH291 as follows:</p> <ul style="list-style-type: none"> ■ Mercury was detected at the detection limit of 0.0001 mg/L in the duplicate sample when all other sample results for the site were non-detect. This detection

Field and Lab QA/QC	Auditor Comments
	<p>exceeds the threshold value of 0.00006 mg/L.</p> <ul style="list-style-type: none"> ■ The duplicate sample exceeded the threshold values for nickel and zinc, with the zinc detection being the highest made at the site. <p>The Auditor has considered these findings in the context of the overall groundwater results (refer Section 10) and they do not affect the conclusions of the groundwater investigation.</p>
<p>NATA registered laboratory and NATA endorsed methods</p>	<p>The primary laboratory utilised for the project was SGS Environmental Services (SGS Australia Pty Ltd). All analyses were conducted internally with the exception of explosives analyses which were analysed by MGT Victoria.</p> <p>The SGS certificates were NATA stamped however they noted that the accreditation does not cover the identification of Synthetic Mineral Fibre via asbestos analysis. SGS also reported the accreditation number for MGT Victoria.</p> <p>The secondary laboratory utilised for inter-laboratory duplicate sampling was LabMark Pty Ltd. Duplicate asbestos analyses were reportedly undertaken by ASET. The LabMark certificates for groundwater were NATA stamped. LabMark certificates for asbestos were not included in the report, nor were the ASET certificates.</p>
<p>Analytical methods and holding times</p>	<p>For SGS, the analytical methods used were described in the laboratory test certificates with the exception of the MGT analyses (explosives).</p> <p>In-house analytical methods were included in the LabMark laboratory test certificates.</p> <p>Golder report that the methods used conform to the NEPM where guidelines are available (excluding asbestos).</p> <p>Golder reported that required holding times have been met for all data. Due to the volume of data, the Auditor has not undertaken a full review of COCs against laboratory certificates to check that the holding times had been met. However, spot checks have been undertaken and indicate holding time compliance.</p>
<p>Practical Quantitation Limits (PQLs)</p>	<p>Not all PQLs for the groundwater assessment were sufficiently low, with the following PQLs exceeding the relevant trigger values:</p> <ul style="list-style-type: none"> ■ Mercury 0.0001, trigger value 0.00006 mg/L ■ Some PAHs (anthracene, benzo(a)pyrene) ■ Some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) <p>These discrepancies are not considered significant due to the following:</p> <ul style="list-style-type: none"> ■ No soil contamination by mercury was detected that could be a potential source of impact to groundwater. ■ No PAH were detected in any groundwater samples and only limited soil detections were made. ■ No OCP or OPP were detected in any soil or groundwater samples.
<p>Laboratory quality control</p>	<p>For SGS, laboratory quality control samples including blanks,</p>

Field and Lab QA/QC	Auditor Comments
samples	<p>matrix spikes and duplicates were undertaken at appropriate frequencies.</p> <p>Laboratory quality control could not be reviewed for LabMark since laboratory certificates for soils were not provided.</p>
Laboratory quality control results	<p>The laboratory quality control results reviewed are considered acceptable given the limited number of results outside desirable ranges and the large bulk of analytical data for the project.</p>
Data Quality Objectives and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	<p>Predetermined data quality objectives (DOOs) were defined in the PB SAQP document and were developed based on the seven step data quality process.</p> <p>Golder undertook an assessment of QA/QC for each of the investigation areas and for groundwater. Individual conclusions were provided in the appendix, however, an overall conclusion was not provided within the body of the report. The individual conclusions were all as follows:</p> <p>"The field QA/QC and internal laboratory QA/QC results indicate an acceptable reproducibility, precision and accuracy. Therefore Golder considers that overall the data quality objectives have been met and the data generated is sufficient to support the interpretation of results."</p>

In considering the data as a whole the Auditor concludes that the data is likely to be reliable and useable for the purpose of this audit.

7 ENVIRONMENTAL QUALITY CRITERIA

7.1 Munitions

There are currently no EPA endorsed environmental quality criteria for UXO or SAA (live or blank). The Auditor recommended that reference should be made to "The assessment and management of land contaminated with unexploded ordnance" by Ranald Scott published in the National Environmental Health Forum Fourth Workshop Proceedings on the Health Risk Assessment and Management of Contaminated Lands (1998). It was also recommended that the Consultant should benchmark with similar sites in Australia and overseas to determine appropriate environmental quality criteria for these types of contaminants.

Grenade and Mortar Impact Areas

According to Milsearch, it is generally accepted throughout the military and UXO remediation community that around 3% of any conventional munitions that are fired or projected will fail to function as intended and will remain as UXO. It follows that around 33 grenades on average would need to be detonated in an area to generate a single UXO. Discovery of a large number of detonated grenades would indicate a high risk for UXO to be present.

When assessing potentially contaminated zones of this nature, Milsearch has differentiated 'impact points' from areas where fragmentation alone exists. Detonation of a grenade spreads fragmentation in a radial pattern. The effective killing or injury zone is a 5-10m radius, but heavy fragments, such as base filling plugs, may travel as far as 150m. Identification of a grenade impact point is generally associated with finding fuze well portions which tend to remain closer to the point of detonation and are non-ferrous and therefore corrode more slowly. However, this method is not precise since fuze wells can also be projected away from the detonation point. According to Milsearch, the finding of a single fuze well is not conclusive evidence that a grenade has detonated at that point. An appropriate conclusion would be that at least one grenade, or a very small number of grenades, had detonated in the vicinity if other portions of a grenade were also found. Supporting evidence would include fuze striker spring assemblies and other light weight non-ferrous portions or a large amount of smaller ferrous fragmentation. If only heavier ferrous fragments were found, this would indicate that grenades had been utilised nearby (within 150m) but have not detonated in that location. During the course of investigations, isolated finds of grenade fragmentation have been used as a trigger for further investigations and closer examination.

Due to strict controls of activities and the need for protection of personnel by site preparation and planning, Milsearch has argued that detonation of thrown hand grenades at the site for training purposes would have most likely been on a concentrated basis rather than in isolated use.

According to Milsearch (2003, page 8) *"There are currently no nationally or internationally defined and objective criteria for what constitutes a grenade impact area requiring remediation. Without the benefit of established criteria, such decisions are currently based on judgement, experience and training"*. Generally

speaking, the density of fragmentation present will increase with the number of grenades that have been detonated. This represents a fragmentation 'signature' that can be related to the potential for UXO to be present. In assessing the various impacts identified at the site, the Consultants used the fragmentation 'signature' and other evidence to determine the need for remediation based on the relative potential for UXO to be present.

The remediation approach and environmental quality criteria applied by the Consultants to date relating to grenade and mortar impacts appear to be generally appropriate. Further remediation works are proposed with regards to potential UXO impacts. Further information is required in the Remedial Action Plan (RAP) regarding the proposed acceptance/ validation criteria for remediation of UXO.

Blank SAA

According to Milsearch, while live blank SAA constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous.

Milsearch previously proposed that a very low density of SAA occurrence would be less than 250/ha and a low density would be between 250 and 500/ha. A "threshold" blank SAA density of 250/ha was developed based on the likelihood of live and expended blank SAA to be found for residential block sizes of 700m² (Milsearch, 2003, pages 18-19). The Auditor is not necessarily in agreement with the defined threshold limit due to a number of reasons that were discussed in my Interim Advice #2 dated July 2003.

Golder (2005b) reported that similar projects have typically had a zero tolerance threshold criteria for SAA within residential developments. Similar projects within conservation areas were not identified. Further remediation works are proposed with regards to potential SAA impacts. Further information is required in the Remedial Action Plan (RAP) regarding the proposed acceptance/ validation criteria for remediation of SAA.

7.2 Soil

The Auditor has assessed the soil data provided by Golder in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL) in EPA (1998) *Guidelines for the NSW Site Auditor Scheme*:

- SIL Column 1 – "residential with gardens and accessible soil";
- SIL Column 3 – "parks, recreational open space"; and
- SIL Column 5 – "provisional phytotoxicity-based investigation levels".

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results. These guidelines relate to sensitive land uses and are therefore appropriate for the site.

There are no EPA-endorsed guidelines for asbestos in soil. The EPA states that the position of the Health Department is that there should be no asbestos in surface soil.

7.3 Groundwater

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for fresh waters. Trigger values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and “trigger” further investigation.

There are no reliable Australian criteria for TPH in groundwater. The current NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some polycyclic aromatic hydrocarbons.

8 EVALUATION OF MUNITIONS INVESTIGATION RESULTS

8.1 Investigations Undertaken

Investigations have been conducted in a number of fieldwork stages, as follows:

- Milsearch
 - a. **Stage 1:** September 2000;
 - b. **Stage 2A:** 21 January to 5 February, 12 to 19 February, 5 to 8 March, 2 to 6 April 2002; and
 - c. **Stage 2B:** 14 to 16 January 2003, 9 February 2003, 30 April 2003 to 2 May 2003, 21 to 22 May 2003.
- Golder/ BACTEC
 - d. **Detailed Contamination Site Assessment:** 24 January to 18 February 2005.

Stage 1 comprised coarse preliminary instrumented sampling program with metal detector transects at 50m intervals over the entire site. The field work allowed for the detection of surface and near-surface metallic items and was found to be effective over 65-70% of the site (the remainder being inaccessible). Stage 2A and B comprised several sub-investigations to target issues identified during Stage 1. Table 8.1 within the Auditor's Interim Advice # 2 (July 2003) summarises the various methodologies adopted for the different stages and objectives of the munitions investigations undertaken by Milsearch.

The key munitions issues identified by the Stage 1 and 2 investigations were summarised in the Auditor's Interim Advice # 2 (July 2003) as follows:

- Grenade range and impact zones (Remediation Area (REM) 1 to 3, 5)
- Additional grenade and mortar impacts including Anti Tank Rocket impact zone (REM 4)
- Small Arms Ammunitions (SAA)

The Detailed Contamination Site Assessment included the following scope of work for munitions:

- 100% search and remediation of identified areas REM 1 to 5 (refer Section 11)
- 100% search and remediation of additional identified areas (refer Section 11):
 - e. Inert 81mm practice mortar (REM 6)
 - f. Anti Tank training mine (REM 7)
- Clearance of contamination sampling locations over 2x2m area using visual search and Minelab Metal Detector. Groundwater well locations were searched using a Forester Magnetometer which is capable of detecting ordnance to a depth of over 3 m.

- Contamination sampling locations were on a 50x50m or 32x32m grid.
- Visual sweep between contamination sampling locations.

The results of the munitions investigations are discussed in the following sections and issues requiring remediation are discussed further in Section 11. Areas of lead particulate including the small arms range and waste disposal trenches were also investigated by Milsearch, however, the results for these issues are discussed in Section 9.

8.2 Grenade range and impact zones (REM 1 to 3, 5)

A range was used for live grenade throwing practices and possibly also mortar practice bombs. Investigation of this zone was initially undertaken over a 6.5 ha "Grenade Exclusion Zone" area. Evidence of grenade impact points was found, as well as a single practice 81mm mortar bomb. Extensions to this initial area were made during the course of investigations to delineate the extent of the grenade impact area.

Three grenade impact areas were identified as requiring remediation, as follows:

- IA1 (REM 1) – rectangular area in the north, six impact points.
- IA2 (REM 2) – central portion, 30 impact points, 19 within the dense bursting zone. A zone within IA2 was found to be the main bursting zone (REM 5).
- IA3 (REM 3) – south, four impact points.

An additional 1ha zone to the south west of IA2 was investigated as the final task of Stage 2B ('grenade exclusion extension slash' on Attachment 2, Appendix A). Investigation of this area was undertaken due to tentative indications of possible grenade impact identified during Stage 2B investigations, including nil-data SAA validation. This was also the general direction from which the sole practice 81mm mortar bomb found during Stage 2A was thought to have been fired. While numerous heavy grenade base plugs were located, no further indications of grenade impact areas were found and no additional practice 81mm mortar bombs were found. It was concluded that this additional 1ha zone was not a recognizable target area and that remediation of this zone was not justified. It was recognized, however, that it was quite possible that additional practice 81mm mortar bombs may exist on site since they do not leave a fragmentation 'signature'. Milsearch concluded it was likely that additional items would be present, most likely within the central portion of the site.

8.3 Anti Tank Rocket impact zone (REM 4)

During the Stage 1 and 2 investigations, numerous grenade or mortar impacts were located outside the "expected" zones of impact, being primarily the main grenade range and also the dams. The majority of these were isolated, and did not indicate an additional area that required remediation, however, remediation of one such area was required.

A target area for 3,5" anti-tank practice rocket projectiles was found, with 19 pieces of fragmentation in a 1m line encompassing an apparent target and drop short

area. The area appeared to have been searched and partially cleared, however potential existed for some inert rocket heads to be below-ground. While they present no hazard, this issue was identified as an aesthetic issue that requires remediation. Further investigations were conducted in Stage 2B to delineate this area for the purposes of remediation.

8.4 Inert 81mm practice mortar (REM 6) and Anti Tank training mine (REM 7)

During the clearance of 763 contamination sampling locations recently completed by BACTEC as part of the Detailed Site Investigation, two items of interest were located between investigation locations. These were:

- Inert 81mm practice mortar (REM 6) located near TP580; and
- Anti Tank training mine (REM 7) located near TP549.

Further investigation and remediation of these impacts was undertaken during the Detailed Site Investigation.

8.5 Small Arms Ammunitions (SAA)

Expendable blank small arms ammunition (SAA) litters the site as a product of infantry minor tactical training. The investigation of SAA has followed two approaches:

1. Analogue metal detector transects including investigation of contacts and collection of identified items (Milsearch and BACTEC).
2. Digital detector sampling surveys to map and measure the density of expended SAA blank ammunition (Milsearch). The detector used was the TM5 EMU computer assisted large coil metal detector which had been demonstrated in laboratory tests to detect surface and near surface blanks at a typical carrying height and at a fast walking speed. Digital metallic densities were recorded for a network of 'cells' or 'tiles' across the site. A number of additional investigations were undertaken to validate these densities with analogue equipment by closer inspection of certain cells. During validation, it was found that extraneous metallic material such as barbed wire and domestic rubbish interfered to some degree with the detector method used. The validation process utilised was found to be an effective site-wide check of unexpected potential metallic ordnance contamination, but did not provide a reliable relationship for the estimation of SAA density.

The various blank SAA densities estimated throughout the course of the investigations as interpreted by the Auditor based on review of the relevant reports are detailed in Table 8.1, below. The number of live ammunition found in each area, where recorded, is also provided.

Table 8.1 – Estimated Blank SAA Densities Through Various Investigation Stages

Location	Investigation Objective/ Stage	Area (ha)	Estimated SAA blank density (blanks/ ha)	No. live ammunition recovered
Grenade Exclusion	Stage 2A (Milsearch)	6.5	1500	15

Location	Investigation Objective/ Stage	Area (ha)	Estimated SAA blank density (blanks/ ha)	No. live ammunition recovered
Zone (includes REM 1,2,3 and 5)	Grenade impact delineation.			
REM 1, 2 (excl. REM 5) and 3 (grenade impact areas)	DSI (BACTEC) 100% remedial search	3.47	123	0
REM 5 (grenade bursting zone)	DSI (BACTEC) 100% remedial search)	0.16	3550	0
REM 4 (3.5" practice rocket)	DSI (BACTEC) 100% remedial search	2.625	7	0
Grid across entire site	DSI (BACTEC) Clearance of 751 investigation locations, 2x2m area each	0.3	107	0
Blank SAA cells subject to validation	Stage 2A (Milsearch) Validation of blank SAA density - first round	0.3 (validation of 29 cells)	1600 - 1800	NR (estimated as 2% of expended numbers)
Blank SAA cells subject to validation	Stage 2A (Milsearch) Validation of blank SAA density - second round	0.41 (validation of 41 cells)	NE	1
Non-data Blank SAA cells (4 or more)	Stage 2B (Milsearch) Identification of unexpected impacts	0.38	363	NR
Nil-very low content Blank SAA cells	Stage 2B (Milsearch) Validation of nil blank SAA density	0.3	156	NR

DSI Detailed Site Investigation

NR not recorded

NE not estimated

The types of SAA encountered include brass and plastic, intact (at surface) and degraded (buried). Milsearch found the SAA to be of higher density associated with slit trenches in the west and north of the site, in Cumberland Plain Woodland areas. Golder concluded that the SAA was concentrated within areas identified as primary

training areas (associated with weapons pits and military obstacles) located within the northern, south eastern, southern and western parts of the site.

Milsearch calculated the site average inferred blank density to be 702/ha, based on an arithmetic average of the various densities determined in various investigation stages. Golder concurred that this density seemed realistic. The Auditor has further considered an area-weighted average based on all data in Table 8.1 which yields an average of 820/ha. Golder estimate the SAA density across the site as follows:

- Primary training areas – range 50 to 2500/ha, average approximately 700/ha.
- Remainder of site – 5 to 500/ha, average approximately 250/ha.

Milsearch estimated approximately 2% of the SAA was likely to be live (unexpended). Although no live SAA was encountered by BACTEC during the recent investigations, they estimated a more realistic live SAA proportion that would be expected to be encountered on site would in the order of 5 to 10%.

8.6 Exclusions/ Areas Not Investigated

A number of areas were excluded from all stages of the investigations, as follows:

2. Areas of protected vegetation.
3. Areas of blackberry infestations.
4. Areas where geophysics found metallic anomalies. 10m transects were proposed to investigate these in the SAQP, however, the highest readings were in areas of protected vegetation and therefore this process was not completed (with Auditor concurrence). As an alternative, a visual inspection was undertaken at this stage.

8.7 Conclusion

Grenade and Mortar Impacts

During all investigation stages at the site, no live UXO has been found. Consistent with the known site history, the items found have all been practice/ inert infantry weapons. The Auditor considers the likelihood for live UXO to be present on site to be very low. While these practice items do not present an explosive hazard, their discovery on site would be alarming to any future workers or occupants at the site.

During the munitions investigations, significant grenade or mortar impacts were located outside the initial “expected” zones of impact, which were primarily the main grenade range and also the dams. Consideration must therefore be given to the adequacy of overall site investigative coverage to identify these “unexpected impacts”. The unexpected impacts were primarily identified during the Stage 2A validation exercises which focused on cells of high metallic density as determined by digital metal detector. Following completion of those works, Milsearch found that (2003, page 16) “it cannot be stated with certainty that all areas of indicated higher metallic density have been checked” and recommended additional work in the form of remedial searches in order to provide confidence that “the vast majority of potential UXO hazard has been addressed on the site”.

Further investigations undertaken at the site in 2005 have included clearance of 763 locations and pathways between. During this process, only two “unexpected impacts” were found by BACTEC, indicating that their occurrence is becoming less common, providing a greater assurance of having identified “unexpected impacts”.

However, the ongoing identification of “unexpected impacts”, the scale of the site and the various limitations on the investigations undertaken to date (refer Section 8.6) indicate that the possibility of further “unexpected impacts” being present on site is likely. Further remediation works are therefore required and are proposed by Golder (refer Section 11).

SAA

The average SAA densities estimated for the site are approximately 700/ha in high intensity usage training areas and approximately 250/ha in remaining areas of the site. The proportional occurrence of live blank SAA has been estimated at between 2 and 10%.

According to Milsearch, while live blank SAA constitutes a lesser hazard than live ball ammunition, blanks can still cause significant injury, particularly eye damage, if detonated through tampering. Brass blank ammunition is understood to be particularly dangerous. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.

Further remediation works are evidently required with respect to SAA and are proposed by Golder (refer Section 11). Golder (2005b) has reported that similar projects have typically had a zero tolerance threshold criteria for SAA within residential developments. The Auditor has previously commented that a threshold concentration of 250 SAA/ha is not considered appropriate.

9 EVALUATION OF SOIL ANALYTICAL RESULTS

9.1 Investigations Undertaken

Soil investigations including test pits, hand auger holes and drilled boreholes were undertaken in the four areas of the site as summarised in Table 9.1, below. Locations were spaced on a grid, with additional targeted locations for features such as drainage lines, stockpiles and areas of contaminant observations. The grid spacings were originally defined according to the proposed residential or conservation usage of each area. However, the proposed usage of one area, RZNWC, was changed following completion of the field works, therefore the grid spacing in this area is larger than for the other residential areas, and is not in accordance with the SAQP. This issue was discussed in Section 6 and is not considered by the Auditor to be significant.

Soil sampling locations are shown on Attachment 4, Appendix A.

Table 9.1 – Soil Investigation Summary

Area	Approximate Area (ha)	Number of Locations	Grid spacing (m)
RZNRA ⁴	43	479	32
RZSWC ^{1, 2, 4}	4	49	32
RZNWC ^{1, 4}	8	43	50
CZSRA ^{1, 3, 4}	38	192	50

- 1 includes small arms range/ lead particulate area
- 2 includes waste disposal trenches
- 3 includes asbestos impact area
- 4 includes stockpiles

Soil samples were analysed for a variety of contaminants including:

- Heavy metals (arsenic, cadmium, chromium (total and VI), copper, lead, mercury, nickel and zinc)
- Total petroleum hydrocarbons (TPH)
- Benzene, toluene, ethylbenzene and xylenes (BTEX)
- Polycyclic aromatic hydrocarbons (PAH)
- Speciated phenols
- Volatile halogenated compounds (VHC)
- Asbestos
- Explosives
- Organochlorine and organophosphorous pesticides (OCP/ OPP)
- Polychlorinated biphenyls (PCBs)

The results have been assessed against the proposed land use criteria (Section 7):

- SIL Column 1 – “residential with gardens and accessible soil”;
- SIL Column 3 – “parks, recreational open space”; and
- SIL Column 5 – “provisional phytotoxicity-based investigation levels”.

The results of the investigations are discussed in the following sections for each of the four areas, with a further discussion of results for identified contamination impacts including small arms range/ lead particulate area, waste disposal trenches, asbestos impact area and stockpiles.

9.2 Residential Zone North of Rail Alignment (RZNRA)

Table 9.2 – Summary of Soil Analytical Results – RZNRA (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	6	Min-5.1	6.2	-	-	-
Arsenic	641	563	28	-	0	1
Cadmium	641	0	<0.5	-	0	0
Total Chromium	641	641	42	-	0	641 ¹
Chromium VI	6	0	<1	-	0	0
Copper	641	640	55	-	0	0
Lead	641	641	210	0	0	0
Mercury (inorganic)	641	74	0.14	-	0	0
Nickel	641	641	40	-	0	0
Zinc	641	641	810	-	0	3
TPH (C6-C9)	105	0	<20	0	-	-
TPH (C10-C36)	105	2	800	0	-	-
BTEX	105	0	<0.5	0	-	-
Phenols	6	0	<0.5	-	0	-
VCH	5	0	<0.5	-	-	-
Total PAHs	105	1	0.1	-	0	-
Benzo(a)pyrene	105	0	<0.1	-	0	-
OCP/ OPP	83	0	<0.1	-	0	-
PCBs	83	0	<0.1	-	0	-
Explosives	101	0	<1	-	-	-
Asbestos	125	1	-	-	-	-

n number of samples
- No criteria available/used
1 Chromium VI criteria

No samples from the Residential Zone North of Rail Alignment exceeded human health guidelines (SIL Column 1).

A limited number of metals detections exceeded the phytotoxicity guidelines (SIL Column 5), as follows:

- Arsenic was detected in one sample (BH249/3, 0.6-1.05m) at 28 mg/kg compared to the guideline of 20 mg/kg. This was a sample of deeper natural material from a borehole in the centre of the area.
- Zinc was detected in three samples exceeding the guideline of 200 mg/kg with concentrations of 470, 720 and 810mg/kg. These samples were of natural soil from the surface or near surface from locations near a building footing (HA140/1) and in the grenade range (TP469/1 and TP471/2).

The above detections are unlikely to effect vegetation growth at the site due to their very infrequent occurrence.

- All 641 samples analysed for total Chromium exceeded the guideline of 1 mg/kg for Chromium VI. However, these results were well below the Chromium III guideline of 400 mg/kg, with a maximum of 42 mg/kg. Chromium VI analyses were performed on six samples containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

One PAH compound was detected in one sample at a concentration equivalent to the detection limit and well below the human health guidelines (SIL Column 1) of 20 mg/kg.

Heavy end TPH in the C15 to C36 range was detected in two samples at 260 and 800 mg/kg, compared to the EPA guideline of 1000 mg/kg. Both samples were of surface soil and had no other contaminant detections. One was from a borehole near the track in the north west (BH2/1) and the other from the central east of the zone (TP285/1). The source of these detections is not known, but may be due to road runoff of vehicle contaminants in the case of BH2.

The above minor organic detections do not present a risk to human health or indicate the presence of widespread contamination in the zone.

No other organic compounds were detected in any samples from this zone, including TPH C6-C9, BTEX, Phenols, VCH, OCP, OPP, PCB and explosives.

There was one detection of chrysotile asbestos in soil from a stockpile (TPSP6/1). A further detection of Synthetic Mineral Fibre was noted by the laboratory in TP9/1, along the northern boundary, however this was not reported by Golder.

The sampled soils from this zone were mildly acidic, with a pH range of 5.1 to 6.2.

In conclusion, the RZNRA area of the site is considered to have been adequately characterised for the purposes of site remediation planning.

9.3 Residential Zone South West Corner (RZSWC)

Table 9.3 – Summary of Soil Analytical Results – RZSWC (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	2	Min-5.4	5.5	-	-	-
Arsenic	67	49	13	-	0	0
Cadmium	67	1	0.6	-	0	0
Total Chromium	67	67	40	-	0	67 ¹
Chromium VI	3	0	<1	-	0	0
Copper	67	67	52	-	0	0
Lead	67	67	72	0	0	0
Mercury (inorganic)	67	2	0.06	-	0	0
Nickel	67	67	37	-	0	0
Zinc	67	67	97	-	0	0
TPH	14	0	<50	0	-	-
BTEX	14	0	<0.5	0	-	-
Total PAHs	14	0	<0.2	-	0	-
Benzo(a)pyrene	14	0	<0.1	-	0	-
OCP/ OPP	12	0	<0.1	-	0	-
PCBs	12	0	<0.1	-	0	-
Explosives	12	0	<1	-	-	-
Asbestos	20	0	-	-	-	-

n number of samples

- No criteria available/used

1 Chromium VI criteria

No samples from the Residential Zone South West Corner exceeded human health guidelines (SIL Column 1).

Metals detections exceeding the phytotoxicity guidelines (SIL Column 5) were all samples analysed for Total Chromium. These exceeded the guideline of 1 mg/kg for Chromium VI however they were well below the Chromium III guideline of 400 mg/kg, with a maximum of 40 mg/kg. Chromium VI analyses were performed on three samples containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

No organic compounds were detected in any samples from this zone, including TPH, BTEX, PAH, OCP, OPP, PCB and explosives.

There were no detections of asbestos in the zone.

The sampled soils from this zone were mildly acidic, with a pH range of 5.4 to 5.5.

In conclusion, the RZSWC area of the site is considered to have been adequately characterised for the purposes of site remediation planning.

9.4 Residential Zone North West Corner (RZNWC)

Table 9.4 – Summary of Soil Analytical Results – RZNWC (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	1	-	5.5	-	-	-
Arsenic	66	36	11	-	0	0
Cadmium	66	0	<0.5	-	0	0
Total Chromium	66	66	24	-	0	66 ¹
Chromium VI	1	0	<1	-	0	0
Copper	66	66	50	-	0	0
Lead	66	66	110	0	0	0
Mercury (inorganic)	66	3	0.11	-	0	0
Nickel	66	66	16	-	0	0
Zinc	66	66	77	-	0	0
TPH	13	0	<50	0	-	-
BTEX	13	0	<0.5	0	-	-
Phenols	6	0	<0.5	-	0	-
VHC	2	0	<0.5	-	-	-
Total PAHs	13	0	<0.1	-	0	-
Benzo(a)pyrene	13	0	<0.05	-	0	-
OCP/ OPP	6	0	<0.1	-	0	-
PCBs	6	0	<0.1	-	0	-
Explosives	7	0	<0.5	-	-	-
Asbestos ²	21	0	-	-	-	-

- n number of samples
- No criteria available/used
- 1 Chromium VI criteria
- 2 soil and sheeting samples

No samples from the Residential Zone South West Corner exceeded human health guidelines (SIL Column 1).

Metals detections exceeding the phytotoxicity guidelines (SIL Column 5) were all samples analysed for Total Chromium. These exceeded the guideline of 1 mg/kg for Chromium VI however they were well below the Chromium III guideline of 400 mg/kg, with a maximum of 40 mg/kg. Chromium VI analysis was performed on one sample containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

No organic compounds were detected in any samples from this zone, including TPH, BTEX, PAH, OCP, OPP, PCB and explosives.

There were no detections of asbestos in the zone.

One soil sample from this zone was mildly acidic, with a pH of 5.5.

In conclusion, the RZNWC area of the site is considered to have been adequately characterised for the purposes of site remediation planning, despite the usage of a larger grid spacing than for other proposed residential areas at the site.

9.5 Conservation Zone South of Rail Alignment (CZSRA)

Table 9.5 – Summary of Soil Analytical Results – CZSRA (mg/kg).

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 3 (EPA 1998)	n > SIL Column 5 (EPA 1998)
pH	17	Min-5.2	8.6	-	-	-
Arsenic	311	231	24	-	0	1
Cadmium	311	2	4	-	0	1
Total Chromium	311	311	73	-	0	311 ¹
Chromium VI	3	0	<1	-	0	0
Copper	311	311	410	-	0	8
Lead	311	311	1578	10	5	5
Mercury (inorganic)	311	19	0.08	-	0	0
Nickel	311	311	48	-	0	0
Zinc	311	311	910	-	0	2
TPH (C6-C9)	89	0	<20	0	-	-
TPH (C10-C36)	89	2	80	0	-	-
BTEX	89	0	<0.5	0	-	-
Phenols	14	0	<0.5	-	0	-
VHC	19	0	<0.5	-	-	-
Total PAHs	89	8	43	-	1	-
Benzo(a)pyrene	89	6	5.6	-	1	-
OCP/ OPP	51	0	<0.1	-	0	-

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 3 (EPA 1998)	n > SIL Column 5 (EPA 1998)
PCBs	51	0	<0.1	-	0	-
Explosives	35	0	<0.5	-	-	-
Asbestos ²	104	11	-	-	-	-

- n number of samples
- No criteria available/used
- 1 Chromium VI criteria
- 2 soil and sheeting samples

Five primary samples from the Conservation Zone South of Rail Alignment exceeded the human health guideline (SIL Column 3) for lead of 600 mg/kg. The samples ranged in concentration from 620 to 1578 mg/kg compared to the guideline of 600 mg/kg. Four of these samples were of fill up to 2.7 m deep from the small arms range (TP642/2, TP646/1, TP691/4 and TP693/1) and one sample was of natural soil from within Dam 3, located downgradient to the south east of the small arms range (TP713/3, 0.3-0.5 m). A further two duplicate samples exceeded this guideline, with detections of 780 and 1000mg/kg compared to the primary sample concentrations of 440 (TP723/1) and 87mg/kg (HAAS5/2), respectively. These samples were from within the open waste trench adjacent to the small arms range area and from within the small arms range itself.

A number of metals detections also exceeded the phytotoxicity guidelines (SIL Column 5), as follows:

- Arsenic was detected in one sample (HA AS9/1, 0-0.1 m) at 24 mg/kg compared to the guideline of 20 mg/kg. This was a sample of surface fill from within the small arms range/ asbestos impact area.
- Cadmium was detected in one sample (TP723/1, 0-0.1 m) at 4 mg/kg compared to the guideline of 3 mg/kg. This was a sample of surface fill from within the open waste trench adjacent to the small arms range area.
- Copper was detected in eight primary samples exceeding the guideline of 100 mg/kg with concentrations ranging from 110 to 410 mg/kg. These were samples from a range of depths from the small arms range/ asbestos impact, waste disposal pits and Dam 3 areas. A further duplicate sample from within this area also exceeded this guideline, although the primary sample did not.
- The above lead SIL Column 3 exceedences also exceed the phytotoxicity guideline for lead which is also 600 mg/kg.
- Zinc was detected in two samples exceeding the guideline of 200 mg/kg with concentrations of 410 and 910 mg/kg. These samples were of surface fill from within the open waste trench adjacent to the small arms range area (TP723/1, 0-0.1m) and in a waste disposal pit (TP704/3, 1-1.1 m).

The above detections are unlikely to effect vegetation growth at the site due to their infrequent occurrence and common occurrence in areas that will be subject to remedial action (small arms range, waste disposal pits).

- All 311 samples analysed for Total Chromium exceeded the guideline of 1 mg/kg for Chromium VI. However, these results were well below the Chromium III guideline of 400 mg/kg, with a maximum of 73 mg/kg. Chromium VI analyses were performed on three samples containing relatively high Total Chromium concentrations and Chromium VI was not detected. Further, there is nothing in the site history to indicate the Chromium VI form would be present, therefore these detections are not considered to represent a risk to vegetation at the site.

One sample (TP599/1) exceeded the human health guidelines (SIL Column 3) for PAH with detections as follows:

- Total PAH of 43 mg/kg compared to the guideline of 40 mg/kg; and
- Benzo(a)pyrene of 5.6 mg/kg compared to the guideline of 2 mg/kg.

This sample is located at the eastern end of the waste disposal pits and was also impacted by Copper above the phytotoxicity guidelines and contained a TPH detection (see below). A further seven samples contained minor PAH detections at concentrations below the guidelines. These samples were from the two coal stockpile areas (six samples) and one sample from a drainage line near Dam 3. The occurrence of minor PAH detections in soils from around the coal stockpiles would be expected.

Heavy end TPH in the C15 to C36 range was detected in three samples at 52, 56 and 80 mg/kg, compared to the EPA guideline of 1000 mg/kg for C10 to C36. These samples were of fill from within the small arms range (BH608/1) and at the waste disposal pits (TP599/1, TP707/3).

No other organic compounds were detected in any samples from this zone, including TPH C6-C9, BTEX, Phenols, VCH, OCP, OPP, PCB and explosives.

There were 11 asbestos detections at this zone, nine in samples of sheeting suspected as containing asbestos, and two in soil from the same location as sheeting samples in the asbestos impact area. These results are discussed further in the sections below.

The sampled soils from this zone were generally mildly acidic to neutral, with a pH range of 5.2 to 7.6, and a measurement of 8.6 in TP723/1. Fill samples were generally less acidic than natural samples.

In conclusion, the CZSRA area of the site is considered to have been adequately characterised for the purposes of site remediation planning.

9.6 Small Arms Range and Lead Particulate

The original stop butt material, which contained lead particulate, was spread about the range and built into roads at the site in the 1970s. The extent of impact by lead particulate in the small arms range and track areas was delineated by digital detector survey during previous investigations by Milsearch. External limits of the impact areas were confirmed by analogue follow-up investigations with an F1A4 mine detector.

The Milsearch investigations delineated the extent of lead-impacted material at the site as follows:

- A 4.1 ha area surrounding the stop butts. Delineation was successful except for defining the exact extent in the high ground to the east. Since this area is also impacted by broken asbestos sheeting and coal dust from the stockpile, this poor definition was not considered significant since remediation of this area would already be required.
- A 0.65 ha area of the north west perimeter road.
- Two small tip truck back dumpings north west of the stop butt area, approximately 4 to 5 m³ each pile.
- In the road formation at the Zouch Road entrance gate.

Golder identified the lead particulate material to comprise lead fragments and bullet fragments between 5 and 10mm in size. The depth of occurrence ranged from 0.1 to 4.5m BGL with an average of about 0.8m BGL, and the quantity of material was estimated by Golder as approximately 35,000m³.

The small arms range is the source of the majority of contamination detections from within the Conservation Zone South of Rail Alignment. The five lead exceedences of the human health guideline (SIL Column 3) were within the small arms range area, and within Dam 3 which has apparently been impacted by runoff from the small arms range. Based on 86 samples from within the small arms range area, Golder calculated the 95% upper confidence limit (UCL) on the average lead concentration as 118 mg/kg. Phytotoxicity exceedences for Arsenic, Copper and Zinc can also be attributed to activities within the small arms range area. A minor heavy end TPH detection was also made in the area, but well below the relevant guidelines.

The elevated metals detections in the small arms range were further assessed by the analysis of seven samples with the highest lead and zinc concentrations by the Toxicity Characteristics Leaching Procedure (TCLP) under acidic, saline and deionised water conditions. Findings from these tests were as follows:

- Lead and zinc were the only metals with leachable concentrations;
- Zinc was much more readily leached than lead (all samples versus only three samples).
- Even low concentrations of zinc leached under all conditions, while lead only leached under acid and deionised water conditions, not saline conditions.
- The highest leached lead concentrations were not recorded from the sample with the highest total concentration.
- The maximum leached lead concentration was 1.1 µg/L under acid conditions, total concentration 1187 mg/kg.
- The maximum leached zinc concentration was 4.7 µg/L under acid conditions, total concentration 910 mg/kg.

Golder report that based on the TCLP results and average lead concentrations, the lead impacted material would be classified as Inert Waste following the NSW EPA (1999) *“Environmental Guidelines: Assessment, Classification and Management of Liquid & Non-Liquid Wastes”*. Golder also note that there is potential for leaching of lead to impact on surrounding soil and groundwater.

During reengineering of the stop butts in the 1970s, lead particulate material was distributed at some of the boundary tracks on site. The extent of this impact was delineated by geophysical techniques during previous investigations by Milsearch, however, the degree of contamination was not assessed. Total lead analyses from the tracks did not identify any lead concentrations exceeding the site assessment criteria. However, in addition to analyses for total lead and TCLP concentrations, an additional 10 samples (PSD1 to 10) were collected and subject to sieving to assess the quantity of lead particulate within the soil. These samples were collected from the track in the north (four samples), the track in the south west (one sample) and the small arms range (five samples).

Soil samples were around 15 kg (dry weight), and the weight of lead particulate was as follows:

- Northern track: average 1.7g, equivalent 0.01%
- Small arms range: average 3.4g, equivalent 0.02%

No lead particulate was recorded in the south west track sample.

The samples were selected randomly from areas where lead particulate was visible. A possible target zone of concentrated lead particulate could not be identified within the small arms range during the investigations due to the mixing of lead particulate within the fill during reengineering of the small arms range. Golder identifies that there may be areas within the stop butt of the small arms range where the quantity of lead particulate may vary significantly from the samples analysed.

9.7 Waste Disposal Trenches

Three parallel pits were delineated by Milsearch using a digital detector survey. The pits run downhill to the east away from the coal stockpile. The combined area of the pits was determined to be 0.25ha. The length of each pit was found to be (from the north), 64, 72 and 71m long. The average width was 6 m and the average depth was 2.5 m. 500mm wide trench cross sections were excavated by Milsearch to the bottom of the pits at 10m intervals. The pit contents were found to include:

- Bonded asbestos sheeting;
- Building waste (including bricks, pipes, concrete blocks, guttering, downpipes);
- Household waste (including fridges, water heaters, metal cabinets); and
- Foul water was encountered when the crust of the pits was broken through.

Golder excavated a further six test pits that encountered waste material (TP598, 704 and 706-709). Similar observations regarding the content of the pits were made by Golder, however, water was only encountered in the eastern most testpits at the end of each disposal pit. Foul water inflow occurred in these testpits (TP598, 706 and 708) with a standing water level of 0.5 m BGL.

No munitions were observed in the pits. It was determined that buildings demolished in the departure of the Infantry Centre to Singleton in the early 1990's were placed in the pits. The pits were observed to be terminated in clay. Large metal wastes were observed on the ground surface in the vicinity of the pits.

Golder identified an open trench containing scrap metal and rubbish to the south of the buried waste trenches. TP723 was excavated beneath the waste dumped here, and a further location TP612 was placed downhill to identify any impact from runoff through the waste.

Golder also identified an area of disturbed soil to the east of the trenches, where excavated soil was apparently stockpiled prior to being pushed back over to cap the buried waste. Four locations were placed to investigate this area (TP599, 705, 710 and 711). Fill remains in this area, comprising excess residual soil from excavation of the trenches.

The waste disposal trenches are another source of contamination detections from within the Conservation Zone South of Rail Alignment.

The Total PAH and Benzo(a)pyrene exceedences of the human health guidelines (SIL Column 3) were made in a sample from the eastern end of the waste disposal pits. There was no waste in this location (TP599) and the source of this detection is not clear. A Human Health exceedence for Lead and Phytotoxicity exceedences for Cadmium, Copper, Lead and Zinc can also be attributed to activities within this area, including the open waste trench to the south of the buried pits. Minor heavy end TPH detections were also made in the area, but well below the relevant guidelines.

9.8 Asbestos Impact Area

The asbestos impact area overlaps with the small arms range and is contained entirely within CZSRA. Fragmented pieces of bonded asbestos sheeting were observed scattered across the ground surface in this area. The area of impact is around 25,500 m², and the quantity of material was estimated by Golder as approximately 2,500 m³.

Grid based testpits samples from this area were analysed for asbestos, and a further 12 locations (AS1 to 12) were investigated specifically to assess this area of impact. Samples of collected sheeting were analysed to confirm the presence of asbestos.

Around 30 locations from this area were analysed for asbestos. In eight locations, samples of both sheeting as well as soil were analysed. There were 11 asbestos detections at this zone, nine in samples of sheeting suspected as containing asbestos, and two in soil from the same location as sheeting samples. The findings from these analyses were as follows:

- Sheeting and soil pairs were collected from locations HA AS1, 2, 3, 4, 5, 6, 8 and 11. Further sheeting samples were collected from HA AS7 and TP723.
- Chrysotile asbestos was detected in five sheeting samples (HA AS4/1, 5/1, 8/1, 11/1, TP723/4).
- Chrysotile and amosite asbestos were detected in four sheeting samples (HA AS1/1, 2/1, 3/1, 6/1).
- One sheeting sample did not contain asbestos (HA AS7/1).
- Chrysotile asbestos was detected in soil in two samples from the sheeting and soil pairs (HA AS3 and 5). No other detections were made of asbestos from within soil from this area.

One of the board fragments confirmed as asbestos (AS6) was collected from a location outside the small arms range/ asbestos impact area. This area was logged as having yielded 8 fragments of asbestos from a 2 x 2 m area.

9.9 Stockpiles

Stockpiles occur in all areas at the site. Golder identified 16 stockpiles, as shown on Attachment 2, Appendix A. Stockpiled soils were observed to consist of silty/ gravelly clays. Numerous wastes including building rubble and asbestos were also associated with stockpiles, as described in Section 2.4.

A number of grid based test pits were located to assess stockpiled materials, and a further 13 locations (SP1 to 13) were investigated specifically to assess these materials. A large number of stockpiles were clustered in the north west corner of the site, identified by Golder as the 'waste disposal west' area.

The only contaminant detection made in stockpile samples was the detection of chrysotile asbestos in surface soil from TPSP6, located on the northern boundary of the site in RZNRA. This was the only detection of asbestos in soil at the site outside the asbestos impact area discussed above.

There are two coal stockpiles at the site, one between the small arms range and disposal pits, and one in the south east corner of the site. Both are within CZSRA. Two test pits were excavated into the main stockpile (TP702 and 703), with a maximum depth of 1.1m coal encountered. Coal was found on the groundwater surface surrounding this stockpile to depths of up to 0.4m BGL at distances of around 25 m. Three test pits were excavated into the south east stockpile (TP698 to 700), with a maximum depth of 0.5m coal encountered. Coal was not found at nearby locations. A number of low level PAH detections were associated with samples from these two stockpile areas.

9.10 Acid Sulphate Soils

Eight samples collected from low points on the site were collected and analysed for Peroxide Oxidation Combined Acidity and Sulphate (POCAS). The results indicated the presence of little or no oxidisable sulphur, however, over half of the samples exceeded the action criteria for Total Potential Acidity (TPA) due to the presence of organic acidity. The potential for Acid Sulphate Soils (ASS) to be present on site was assessed to be low due to the site elevation of 50 to 70 m AHD. Golder assessed the sampled soils to have a mild organic acid generating capacity and they were not considered as potential acid Sulphate soils (PASS).

9.11 Conclusion

In the Auditor's opinion, the soil analytical results are consistent with the site history and field observations. Minimal contaminant detections were made in the general site areas, with only limited detections exceeding human health guidelines made in known areas of contamination such as the small arms range and waste disposal pits. The Auditor is satisfied that the general site areas are free of contamination and that significant contamination detections are restricted to areas of known contamination where remedial action is proposed (refer Section 11).

10 EVALUATION OF GROUNDWATER ANALYTICAL RESULTS

10.1 Investigations Undertaken

Groundwater samples were collected from seven wells and three trenches in February and March 2005.

Groundwater samples were analysed for a variety of contaminants including heavy metals, TPH/ BTEX, PAH, OCP/ OPP, PCB, Explosives, Phenols and VHCs.

The analytical results for true groundwater are tabulated below in Table 10.1, while the perched trench water results are summarised in Table 10.2. Results from field testing for temperature, pH, electrical conductivity (Ec) and Total Dissolved Solids (TDS) are also included in these tables. Laboratory testing was conducted for pH and Ec for the groundwater wells and results were similar to the field measurements.

Groundwater well locations are shown on Attachment 3, Appendix A and sampled trench locations (TP598, 706 and 708) are shown on Attachment 4, Appendix A.

10.2 Groundwater Well Results

Table 10.1 - Evaluation of Groundwater Well Analytical Results – Summary Table.

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n > ANZECC Fresh (2000)
Temperature	°C	7	7	21.0	23.8	BH558	-
pH	-	7	7	6.8	7.2	BH675	0
Ec	µV	7	7	9 210	14 270	BH291	-
TDS	mS	7	7	4.53	7.18	BH291	-
Arsenic	mg/L	7	7	0.004	0.12	BH2	1 ¹
Cadmium	mg/L	7	0	-	<0.0002	-	0
Total Chromium	mg/L	7	7	0.007	0.014	BH608	7 ²
Copper	mg/L	7	5	<0.001	0.004	BH608	3
Lead	mg/L	7	7	0.002	0.012	BH675	6
Mercury (inorganic)	mg/L	7	0	<0.0001	0.0001	BH291 (Dup)	1 ³
Nickel	mg/L	7	7	0.002	0.022	BH675	4
Zinc	mg/L	7	3	<0.001	0.07	BH291 (Dup)	2
TPH (C6-C9)	mg/L	7	0	-	<0.04	-	-
TPH (C10-C36)	mg/L	7	0	-	<0.5	-	-
BTEX	mg/L	7	0	-	<0.001	-	0
Phenols	µg/L	7	0	-	<0.5	-	0
VHC	µg/L	7	0	-	<5	-	0

Analyte	Units	n	Detections	Minimum	Maximum	Max Well	n >ANZECC Fresh (2000)
PAHs	µg/L	7	0	-	<0.5	-	0 ⁴
OCP/ OPP	µg/L	7	0	<0.01	<0.2	-	0 ⁵
PCBs	µg/L	7	0	-	<0.1	-	-
Explosives	mg/L	7	0	-	<0.005	-	-

- n number of samples
- No criteria available/used
- 1 Arsenic III criteria
- 2 Chromium III criteria
- 3 Detection limit (0.0001 mg/L) for primary samples is above guideline (0.00006 mg/L)
- 4 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines
- 5 Detection limits for some OCP/OPP (Aldrin, Dieldrin, Chlorpyrifos) are above guidelines

Groundwater from wells at the site was found to be approximately neutral and saline.

All heavy metals except cadmium and mercury were detected at concentrations exceeding the guidelines in at least one groundwater well at the site. Heavy metal exceedences were distributed across all wells at the site. Exceedences were detected in both upgradient and downgradient wells. It is possible that the presence of heavy metals in groundwater is due to those metals naturally occurring within the rock aquifer. Elevated metals concentrations are commonly detected within Wianamatta Shale aquifer.

There is one area of the site where there is an apparent correlation between heavy metal detections and contaminant sources. The highest metals concentrations were commonly detected in wells BH608 and BH675 which are in the vicinity of the small arms range, disposal trenches and nearby Dam 3, where the majority of soil metals exceedences were detected. One of the two zinc exceedences for the site was also detected in well BH608, in the small arms range. It is possible that these activities have locally increased the heavy metal loading in groundwater, but this increase is not considered to be substantially more than the concentrations which appear to be naturally occurring at the site.

No organic compounds were detected in any of the groundwater well samples from the site, including TPH, BTEX, PAH, Phenols, VHC, OCP, OPP, PCB and explosives.

10.3 Trench Water Results

Table 10.2 - Evaluation of Trench Water Analytical Results – Summary Table.

Analyte	Units	n	Detections	Minimum	Maximum	Max Loc'n	n >ANZECC Fresh (2000)
Temperature	°C	3	3	22.6	23.1	Trench 3	-
pH	-	3	3	6.9	7.1	Trench 3	0
Ec	µV	3	3	780	1100	Trench 3	-
TDS	mS	3	3	4.68	4.9	Trench 2	-
Arsenic	mg/L	3	3	0.001	0.001	-	0
Cadmium	mg/L	3	0	-	<0.0002	-	0
Total Chromium	mg/L	3	2	0.001	0.002	Trench 1	0 ¹
Copper	mg/L	3	2	0.002	0.003	Trench 3	2
Lead	mg/L	3	1	<0.001	0.002	Trench 3	0
Mercury (inorganic)	mg/L	3	0	-	<0.0001	-	0 ²
Nickel	mg/L	3	3	0.004	0.01	Trench 3	0
Zinc	mg/L	3	3	0.002	0.041	Trench 3	2
TPH (C6-C9)	mg/L	3	0	-	<0.04	-	-
TPH (C10-C36)	mg/L	3	0	-	<0.5	-	-
Benzene	mg/L	3	0	-	<0.001	-	0
Toluene	mg/L	3	1	<0.001	0.002	Trench 3	0
Ethylbenzene	mg/L	3	0	-	<0.001	-	0
Xylenes	mg/L	3	0	-	<0.003	-	0
Phenol	µg/L	3	2	<10	11	Trench 1,2	0
M/p-Cresol	µg/L	3	3	13	17	Trench 1	-
2-Nitrophenol	µg/L	3	1	<5	10	Trench 1	-
4-Nitrophenol	µg/L	3	1	<5	21	Trench 1	-
Other Phenols	µg/L	3	0	-	<5	-	0
PAHs	µg/L	3	0	-	<0.5	-	0 ³
OCP/ OPP	µg/L	3	0	-	<0.2	-	0 ⁴
PCBs	µg/L	3	0	-	<0.1	-	-
Explosives	mg/L	3	0	-	<0.01	-	-

n number of samples

- No criteria available/used

1 Chromium III criteria

2 Detection limit (0.0001 mg/L) is above guideline (0.00006 mg/L)

3 Detection limits for some PAHs (anthracene, benzo(a)pyrene) are above guidelines

- 4 Detection limits for OCP/OPP (Heptachlor, Aldrin, Dieldrin, Chlorpyrifos) are above guidelines
Trench 1 = TP598; Trench 2 = TP706; Trench 3 = TP708

The occurrence of heavy metal exceedences in the perched trench water was much less common than in the true groundwater, further suggesting that the metals are naturally occurring rather than derived from contamination at the site. The trench water had exceedences for copper and zinc only, both occurring within Trench 2 and 3 (TP706 and 708). Trench 3 (TP708) most commonly contained the highest heavy metals concentrations. It appears likely that the identified exceedences are due to contamination from the buried waste materials encountered in each location.

The BTEX compound Toluene was also detected in Trench 3, at a very low concentration close to the detection limit and well below the guideline. Four different phenol compounds were detected in the Trenches, also well below the guidelines. These low level organic detections would most likely be due to contamination from buried hydrocarbon wastes within the trenches.

No other organic compounds were detected in any of the trenches, including TPH, PAH, Phenols, VHC, OCP, OPP, PCB and explosives.

10.4 Conclusion

In the Auditor's opinion, the groundwater and trench water analytical results are consistent with the site history and field observations. There is evidence of only minor contamination of groundwater by heavy metals in the vicinity of the small arms range. The majority of heavy metals exceedences detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor is satisfied that groundwater at the site is free of levels of contamination that would negatively impact on the proposed development or the surrounding environment.

The trench water displayed low levels of contamination by copper, zinc, toluene and phenols. This contamination is likely due to leaching of contaminants from the buried waste materials encountered in each location. The perched water is considered likely to be restricted to a small area in the vicinity of the waste pits. The water was perched due to the presence of natural clay that restricted downward migration of waters. For this reason, impact on the underlying groundwater due to this contamination is unlikely. Management of the perched water in conjunction with the surrounding waste material will be required to prevent any impact on the proposed development.

11 EVALUATION OF REMEDIATION

11.1 Remediation Already Completed

Remediation of seven areas has already been undertaken with respect to munitions, as summarised in Table 11.1. Based on the works undertaken, BACTEC has provided certification that the seven remediation areas described below are free of UXO.

During the course of all munitions investigations, all SAA/ weapons fragments were collected and documented. Golder reported that all of the collected training ordnance such as 81mm mortars and anti tank mines were disposed offsite by Department of Defence personnel. Remaining items such as SAA and grenade base plugs were stockpiled on site for later disposal.

Table 11.1 – Summary of Remediation Undertaken

Impact	Area(s)	Remediation Method	Items Found *
36M grenade impact areas	REM 1 (IA1) REM 2 (IA2, excluding REM 5) REM 3 (IA3) Total 3.47ha	100% remedial searching for 36M UXO Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found. A water filled depression in the eastern part of REM 2 was drained to allow remediation.	No live ordnance found 54x36M grenade base plugs 100xSpent 303 SAA 428xSpent blank SAA star pickets, scrap metal, steel pipes, wire, general rubbish
36M grenade bursting zone	REM 5 (within IA2) 0.16ha	100% remedial searching for 36M UXO Metal detector search to 300mm depth (two man team at 1m line spacings). The previously proposed method of mechanical screening (in SAQP) was changed and agreed to by the Auditor. Collection and documentation of all items found.	No live ordnance found 105x36M grenade base plugs 64x36M grenade fragments 48xSpent 303 SAA 568xSpent blank SAA star pickets, scrap metal, steel pipes, wire, general rubbish
3.5" anti-tank (A-Tk) rocket warheads	REM 4 2.625ha	Aesthetic issue only, impact is inert 100% remedial searching for practice 3.5" A-Tk rockets Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found.	No live ordnance found 3xpractice UK M29 rocket motors and fuzes (fired) 1xpractice fuze (L5 Mk2) assembly (fired) 12xpractice rocket fragments
Inert	REM 6	100% remedial search.	No live ordnance found

Impact	Area(s)	Remediation Method	Items Found *
81mm practice mortar	1.5ha (100x150 m)	Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found.	9xInert 81mm practice mortars 6xSpent blank SAA
Anti-tank training mine	REM 7 0.015ha (10x15 m)	100% remedial search. Metal detector search to 300mm depth (two man team at 1m line spacings). Collection and documentation of all items found.	No live ordnance found 1xpractice British Mk5 Anti tank mine

* BACTEC reported that all items found were sporadic and not confined to a specific area within the remediation zone except for REM 2 where the majority of items were found within the grenade target area, 30m from the grenade throwing bay and REM 6 where the mortars were found in the centre of the search area.

11.2 Remediation Proposed

Golder has identified a number of areas at the site requiring remediation, defined as "Areas of Concern" (AOC). These are summarised by the Auditor in Table 11.2, below. Attachment 5, Appendix A, shows the location of the various AOC.

Table 11.2 – Summary of Proposed Remediation

Area of Concern	Description/ Location	Comments
AOC 1	Military associated objects: Concertina wire; weapons pits; former structure/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site	Removal of all stockpiles is also required, particularly in the northwest corner of the site (RZNWC) where numerous stockpiles are concentrated.
AOC 2	SAA in proposed residential zones (RZNRA, RZSWC and RZNWC)	Could be present in all areas not subject to searching to date (ie, not at grid locations or within remediation zones). Anticipated to be higher in concentration in previously identified areas of high metallic concentration.
AOC 3	SAA in proposed conservation zone (CZSRA)	Could be present in all areas not subject to searching to date (ie, not at grid locations or within remediation zones). Anticipated to be higher in concentration in previously identified areas of high metallic concentration.

Area of Concern	Description/ Location	Comments
AOC 4	Lead impacted material – small arms range and northern tracks (refer Section 9.5) (RZNRA, CASRA, RZNWC and RZSWC)	Remediation of south western track area not required based on laboratory analysis.
AOC 5	Area of asbestos sheeting fragments (refer Section 9.7) (CZSRA)	
AOC 6	PAH impact at TP599 (CZSRA)	The Auditor notes that the lateral extent and immediate source of impact has not been determined.
AOC 7	Waste disposal pits (CZSRA)	Excavation is considered necessary because of unknown contents and contaminated water.

The Auditor agrees with the identified AOCs requiring remediation, considering the comments made above in Table 11.2.

A Remediation Action Plan (RAP) is required to define the remedial requirements for the site.

12 CONTAMINATION MIGRATION POTENTIAL

The potential for off-site migration of munitions related contaminants is considered to be very low. No trace explosives were detected in any soil or groundwater samples from the site.

Minimal contaminant detections were made in soils and drainage sediments from the general site areas. The potential for offsite migration of contamination in surface water or groundwater from these areas is therefore very low. The potential for the generation of dust in general areas of the site would also be very low due to the heavy vegetation cover.

There were a limited number of detections exceeding human health guidelines in known areas of contamination such as the unsealed tracks impacted by lead particulate in the north of the site and the small arms range, asbestos impact area and waste disposal pits in the south of the site. These areas have less vegetation cover than general areas of the site. The potential for offsite migration of contaminants in dust or surface water from these areas is currently considered to be low to moderate. Remediation of these areas as proposed will remove the potential for generation of contaminated dusts or surface water impacts.

There is evidence of only minor contamination of groundwater by heavy metals in the vicinity of the small arms range. The majority of heavy metals exceedences detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor is satisfied that groundwater at the site is free of levels of contamination that would negatively impact on the surrounding environment.

The trench water displayed low levels of contamination due to leaching of contaminants from the surrounding buried waste materials. The perched water would be restricted to a small area in the vicinity of the waste pits, with a very low potential for impact on the underlying groundwater.

In the Auditor's opinion, there is no evidence of significant offsite migration of contamination and little potential for future migration provided the proposed remediation works are implemented.

13 ASSESSMENT OF RISK

Based on assessment of results against relevant guidelines and consideration of the overall investigation and proposed remediation, it is the Auditor's opinion that:

13.1 Munitions

- The risk of live UXO being encountered on site is very low. None has been found to date during the course of extensive investigations.
- There is a moderate risk of additional 'unexpected' inert grenade or mortar impacts to be present in general areas of the site. These items are difficult to locate due to the lack of fragmentation 'signature'. While these practice items do not present an explosive hazard, their discovery on site could be alarming to any future workers or occupants. Further remediation works are therefore required and are proposed by Golder (refer Section 11).
- There is a higher risk of such 'unexpected' impacts to be present in areas of the site that have not previously been accessed (refer Section 8.6).
- The risk of live ball ammunition being encountered on site is very low. None has been found to date during the course of extensive investigations.
- Blank expended ammunition is present on site at an estimated 700 items/ha in high intensity usage training areas and 250 items/ha in remaining areas of the site. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.
- The proportional occurrence of live blank SAA has been estimated at between 2 and 10% however a lesser proportion than this has actually been found on site. Live blank ammunition can cause injury, particularly eye damage, if detonated through tampering.
- Further remediation works are required and with respect to SAA and are proposed by Golder (refer Section 11).

13.2 Soil and Groundwater

- Low levels of soil contamination and physical waste materials including asbestos have been identified in a number of areas of the site. Contamination detections were expected in these areas and remedial action is proposed (refer Section 11). Since the site is currently unoccupied and fenced, the risk posed by these issues is low, however, the risk to human under the proposed residential or conservation landuse would be high if remediation were not undertaken.
- There is considered to be a very low risk of undetected soil contamination being present in general areas of the site outside of the known areas of contamination.
- Groundwater investigations have identified possible minor contamination by heavy metals in the vicinity of the small arms range. The majority of heavy

metals exceedences detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor considers the risk to human health, the proposed development or the surrounding environment due to groundwater contamination is very low.

- Perched water within the waste disposal trenches contains low levels of contamination by copper, zinc, toluene and phenols. The perched water is considered likely to be restricted to a small area in the vicinity of the waste pits and is unlikely to influence deeper groundwater or the environment. However, this water could pose a risk to human health if accessed by site occupants. This could occur since the perched water occurs at a depth of around 0.5m BGL. Remedial action for the waste disposal trenches is proposed (refer Section 11) and should address this issue.

14 COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

The Auditor has used guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997*.

The investigation was generally reported in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The checklist included in that document has been completed and is kept on file. The EPA's *Checklist for Site Auditors using the EPA Guidelines for the NSW Site Auditor Scheme 1998* (December 1999) has also been completed and is kept on file.

The regulatory approvals and licences obtained for works at the site included:

- Section 91 License from Department of Industry, Planning and Natural Resources (DIPNR). This did not permit disturbing vegetation within Class 1 and 2 areas (Threatened Species/ Community Classification) due to the presence of Cumberland Woodland threatened species.
- Golder (2005) does not state whether well licences were obtained from DIPNR.

15 CONCLUSIONS AND RECOMMENDATIONS

Golder considers that "The use of the site for residential and conservation land uses is considered acceptable subject to the implementation of the recommendations made below with respect to the AOC's listed above, and the limitations discussed in this report".

The Auditor considers that the investigations documented in Milsearch and Golder's reports have been adequate to identify the major contamination issues at the site for the purposes of remediation planning. Golder has identified seven AOC's requiring remedial action and the Auditor concurs with these items, with comments as noted in Section 11.2. Preparation of a RAP is now required to address these items.

APPENDIX A

ATTACHMENTS

ATTACHMENT 1: Site Location

ATTACHMENT 2: Site Layout and Key Features

ATTACHMENT 3: Groundwater Contours

ATTACHMENT 4: Investigation Locations

ATTACHMENT 5: Proposed Remediation Areas



APPENDIX C

Draft Interim Advice #4 (Environ 2005b)

21 October 2005

Ref: 31-0163

Landcom
c/o APP Corporation Pty Ltd
Level 1, 53 Berry Street
North Sydney NSW 2060

Attn: Scott Johnston

Dear Scott,

Interim Advice #4 – Zouch Road, Edmondson Park, NSW Draft Remediation Action Plan

1 INTRODUCTION

A site contamination audit is being conducted for Landcom relating to property at Zouch Road, Edmondson Park, formerly occupied by the Department of Defence.

The audit is being conducted ultimately to provide an independent review of whether the land is suitable for any specified use or range of uses by an EPA Accredited Auditor i.e. an Audit under Section 47 (1) (b) (iia) of the NSW *Contaminated Land Management Act* 1997 (the CLM Act).

The Audit is being conducted in stages, with initial investigations conducted by Milsearch Pty Ltd (2000 to 2003) focusing on the military history of the site and the potential for contamination by munitions. Parsons Brinkerhoff Australia Pty Ltd (2004) then prepared a *Sampling, Analysis and Quality Plan for Detailed Site Assessment*, which covered munitions issues as well as soil and groundwater contamination issues. Golder Associates Pty Ltd (2005) undertook *Detailed Contamination Site Investigation* of the site and recently completed a Draft Remediation Action Plan (RAP) for the site. The munitions aspects of the more recent assessment were conducted by BACTEC SE Asia Pty Ltd (BACTEC).

Advice has previously been provided by the Auditor throughout the audit, as follows:

- Stage 1 - Initial Advice, 7 February 2003;
- Interim Advice #2, 8 July 2003;
- Various comments on the Sampling Analysis and Quality Plan, 21 April to 19 May 2004; and
- Interim Advice #3, 8 September 2005.

Consistent with Department of Environment and Conservation (DEC and formerly EPA) requirements for staged "sign off" of sites that are the subject of progressive assessment, remediation and validation, I am required to advise that:

- This opinion letter does not constitute a Site Audit Report or Site Audit

Statement.

- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation that will conclude as to the suitability of the site for its intended purposes.
- This interim advice will be documented in the final Site Audit Report.

The scope of work completed for this Interim Advice since the completion of the previous Interim Advice (#3) includes:

- Review of the following reports:
 - Draft Report "*Remediation Action Plan, Landcom Project No: 12619, Zouch Road, Edmondson Park, NSW*". By Golder Associates Pty Ltd (Golder). Date October 2005.
- Discussions with the Client (Landcom) and Consultant (Golder) who prepared the RAP.

This Interim Advice provides a review of the RAP and associated issues only. The reader is referred to previous Interim Advice from the Auditor regarding the site background information and a detailed review of investigations.

2 PROPOSED DEVELOPMENT

Details of the proposed development for the site have changed slightly since the previous Interim Advice (#3). According to the RAP (Golder, 2005), key features of the proposed development include:

- A proposed rail line transecting the site from the south east corner to north west corner of the site;
- Approximately 38 ha of Conservation Zone, riparian protection park south of the proposed rail alignment;
- Approximately 47 ha of development including elements of a town centre and residential districts in the northern and south western parts of the site; and
- Approximately 8 ha of residential zone with limited development and clearing of vegetation in the north western corner of the site (known as 1G Land).

Golder (2005) note that the proposed location of the rail alignment could change during the development planning stages, however, it would only move toward the north and not encroach on the proposed open space area. If this occurred, the proposed remediation for the affected area would be conservative since it would be based on remediation criteria for a more conservative land use (residential) than that required for open space land use.

3 EVALUATION OF REMEDIATION

3.1 Remediation Already Completed

Remediation of seven areas has already been undertaken with respect to munitions, as detailed in the previous Interim Advice (#3). Based on the works undertaken, BACTEC provided certification that the seven remediation areas are free of Unexploded Ordnance (UXO).

During the course of all munitions investigations, all Small Arms Ammunition (SAA)/ weapons fragments were collected and documented. Golder reported that all of the collected training ordnance such as 81mm mortars and anti tank mines were disposed offsite by Department of Defence personnel. Remaining items such as SAA and grenade base plugs were stockpiled on site for later disposal.

3.2 Remediation Strategy and Methodology

Golder has identified a number of areas at the site requiring remediation, defined as "Areas of Concern" (AOC). These areas, the Consultant's preferred remediation method for each area and the Auditor's Comments are summarised by the Auditor in Table 3.1.

The preferred remediation approach is considered by the Auditor to be appropriate. Comments and recommendations are noted in Table 3.1.

Golder divided the site into four areas for the detailed site assessment. The following codes have been used by the Auditor in Table 3.1.

- Residential zone north of rail alignment (RZNRA);
- Residential zone south west corner (RZSWC);
- Residential zone north west corner – 1G land (RZNWC); and
- Conservation zone south of rail alignment (CZSRA).

The following key issues are noted with respect to the preferred remedial options:

- All proposed remediation works require initial preparation of technical specifications.
- A Site Management Plan (SMP) will be required for some areas.

Table 3.1 – Summary of Proposed Remediation

Area of Concern	Description/ Location	Remediation Proposed	Auditor Comments
AOC 1	<p>Military associated objects: Concertina wire; weapons pits; former structures/ slabs; general rubbish; scrap metal; asbestos piping Located in all areas of the site</p>	<p>Collection and offsite disposal Visual site inspection and removal of all objects</p>	<p>Imported fill may be required to backfill pits in residential areas.</p>
-	<p>Stockpiled materials: North west corner disposal area - silty/ gravelly clay, concrete blocks, bricks, timber, general building waste (Waste Disposal West) (RZNNWC). General stockpiles in all areas of the site. Soils were observed to consist of silty/ gravelly clays. Golder consider these to be clean fill with the exception of SP6 on the northern boundary (contains bricks and asbestos fibre detection). Two coal stockpiles – small arms firing range (about 200 m³) and in the south east corner of the site (about 150 m³) (CZSRA).</p>	<p>Waste Disposal West and SP6 - Excavation and off-site disposal Excavate impacted material Off-site disposal at approved landfill Remaining stockpiles – Use as backfill in pits</p>	<p>Action regarding coal stockpiles is not specified in the RAP and is required. Suitability for re-use of stockpiles as backfill is questionable since detailed characterisation has not been undertaken. If stockpiles are observed to be a consistent soil material with no evidence of contamination, reuse in the conservation zone is considered acceptable. Further characterisation should be considered before re-use in the residential zones and before re-use in the conservation zone if there are any indications of contamination. If further characterisation is not undertaken to support re-use on site, material should be disposed off-site.</p>
AOC 2	<p>UXO/ SAA in proposed residential zones (RZNNRA, RZSWC)</p>	<p>Zero tolerance – 100% removal Vegetation reduction to 0.1 m 100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar) Two-man teams, 1 m line spacing Documentation/ removal of all contacts</p>	<p>Action in response to contacts found during 10% validation check is not clear. Is repeat search/ removal for all residential areas proposed if validation fails?</p>

Area of Concern	Description/ Location	Remediation Proposed	Auditor Comments
AOC 2a	UXO/ SAA in proposed 1G part protected residential zone (RZNWC)	<p>Combination 100% removal and visual clearance</p> <p>Vegetation reduction in grassed/ non protected areas to 0.1 m</p> <p>100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar)</p> <p>Two-man teams, 1 m line spacing</p> <p>Visual UXO/ SAA search in protected areas</p> <p>Four to six-man teams, 5 to 10 m lane spacing</p> <p>Documentation/ removal of all contacts</p> <p>Management via SMP</p>	<p>The procedure for implementation of SMP at individual residential block level will require clarification.</p> <p>Is any quality control validation proposed for visual clearance areas?</p>
AOC 3	UXO/ SAA in proposed conservation zone (CZSRA)	<p>Visual clearance</p> <p>Visual UXO/ SAA search</p> <p>Four to six-man teams, 5 to 10 m lane spacing</p> <p>Documentation/ removal of all contacts</p> <p>Management via SMP</p>	<p>Is any quality control validation proposed for visual clearance areas?</p>
-	<p>Areas of blackberry infestation</p> <p>Numerous affected areas, current area estimate 1.3 ha (CZSRA, RZSRA)</p> <p>No investigation for UXO/ SAA to date.</p> <p>Contamination assessment considered sufficient.</p>	<p>Zero tolerance – 100% removal</p> <p>Vegetation removal (qualified arborist)</p> <p>100% UXO/ SAA shallow detector search (300mm range, Minelab F3 or similar)</p> <p>Two-man teams, 1 m line spacing</p> <p>Documentation/ removal of all contacts</p>	
AOC 4	Lead impacted material – small arms firing range and northern tracks (RZSRA, CZSRA, RZNWC and RZSWC)	<p>Re-engineer and construct sealing layer to preclude access and minimise infiltration</p> <p>Prepare level area to accept ACM</p> <p>Emu-pick ACM and place in containers in prepared area</p>	<p>Comparison to landfill liner requirements are not considered relevant. The Auditor considers the proposed capping and specifications to be appropriate.</p> <p>What is the proposed thickness of topsoil?</p>
AOC 5	Area of asbestos sheeting fragments (CZSRA)	<p>Excavate asbestos from waste disposal pits and place in prepared area</p> <p>Vegetation removal</p> <p>Re-engineer/ re-shape the western part of the former small arms firing range to match the surrounding</p>	<p>The required chemical quality of capping layer varies in the RAP – Section 10.3 references inert waste and open space criteria; Section 11.1.3 states VENM, with analysis for a selection of heavy metals, TPH and BTEX. Clarification is required.</p>

Area of Concern	Description/ Location	Remediation Proposed	Auditor Comments
		<p>topography Re-locate lead particulate from the access tracks to the small arms firing range area Construct a clay sealing separation layer of 0.4m, including a marker layer Clay specifications provided in Section 10.3 of RAP Construct a layer of topsoil and seed with native grasses Management via SMP</p>	<p>Methodology to validate placement of capping is not clear.</p>
AOC 6	PAH impact at TP599 (CZSRA)	<p>Excavation and off-site disposal Excavate impacted material Off-site disposal at approved landfill</p>	<p>The Auditor notes that the lateral extent and immediate source of impact has not been determined. Delineation of the impact before or during remediation is required.</p>
AOC 7	<p>Waste disposal pits (CZSRA) Contain ACMs as well as building demolition waste, scrap metal, machine parts, furniture and foul water</p>	<p>Excavation and off-site disposal Vegetation removal Excavate ACM and waste material Off-site disposal at approved landfill</p>	<p>Justification for preferred option incorrectly describes buried waste as "surficial" (Section 10.5.1 of RAP). Proposed action with regards to ACM (off-site disposal) conflicts with remedial action for AOC 4/5 (excavate asbestos from waste disposal pits and place in prepared area). Remedial action needs to consider management/ disposal of foul water during excavation.</p>

3.3 Evaluation of Remedial Action Plan

The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The RAP was found to address the required information for most items, as detailed in Table 3.2, below.

Table 3.2 - Evaluation of Remedial Action Plan.

Remedial Action Plan	Comments
Remedial Goals	<ul style="list-style-type: none"> ■ Complete remediation and validation works such that the land is rendered suitable for the proposed residential and open space (conservation) land uses. ■ Verify that there are no unacceptable off-site impacts at the site during or following remediation. ■ Ensure that the remediation works are conducted safely so as to protect on-site workers, and the public. <p>In the Auditor's opinion, these goals are considered appropriate.</p>
Discussion of the extent of remediation required.	Remediation required for each area was discussed within the RAP (See Section 3.2 above)
Remedial Options	<p>AOC 1: Collection and off-site disposal</p> <p>Stockpiles: Excavation and off-site disposal Use as backfill</p> <p>AOC 2/3, blackberry infestations: Zero tolerance – 100% removal Visual clearance</p> <p>AOC 4/5: Re-engineer and construct sealing layer Excavation and off-site disposal</p> <p>AOC 6: On-site treatment Excavation and off-site disposal</p> <p>AOC 7: Cap and cover in situ Excavation and relocation to engineered capped area Excavation and off-site disposal</p>
Selected Preferred Option	The preferred options were discussed within the RAP (refer Section 3.2 above)
Rationale	The decision-making rationale was based on technical feasibility, environmental impact, relative cost benefit and ongoing maintenance requirements.

Remedial Action Plan	Comments
Proposed Validation Testing	<p>AOC 1: None proposed.</p> <p>AOC 2 and 2a: 10% repeat check for UXO/ SAA in 100% clearance areas</p> <p>AOC 3: None proposed.</p> <p>AOC 4/5: Validation of "effectiveness" of capping is proposed but the methodology is not clear. The required chemical quality of the capping layer is not clear. More information regarding the required quality, proposed analytes and frequency is required.</p> <p>AOC 6, 7, Waste Disposal West, SP6: Validation of soil remaining on site from excavation area. Analytes and sample density are not specified.</p> <p>Groundwater: Sampling of groundwater before and after remediation. Analytes as per the detailed site investigation.</p>
Interim Site Management Plan (before remediation)	No measures discussed in the RAP. Site is currently fenced and unoccupied.
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and OH&S	<p>The need for health and safety and environmental controls during the remediation works is identified. Golder states that the implementation of these will be the responsibility of the Site Contractor and Project Manager.</p> <p>The RAP states that the following plans will need to be prepared:</p> <ul style="list-style-type: none"> ■ Soil and Erosion Management Plan (SEMP) ■ Site Management Plan (SMP) ■ Construction Management Plan (CMP) ■ Contractor Site Specific Health and Safety Plans (SSHSP)
Contingency Plan if Selected Remedial Strategy Fails	None specifically discussed, not likely to fail since proven methodologies.
Contingency Plans to Respond to site Incidents. Site Management Plan for the Operation Phase.	Emergency response measures are to be detailed in Site Specific Health and Safety Plans.
Remediation Schedule	Indicative project duration was given as eight months commencing November 2005.
Hours of Operation	Hours of Operation are not provided.
Licence and Approvals	Discussed in the RAP, refer Section 6 of Interim Advice
Contacts/Community Relations	No measures discussed in the RAP.
Staged Progress Reporting	No measures discussed in the RAP.

Remedial Action Plan	Comments
Long term site management plan	<p>A Site Management Plan (SMP) will be required for AOC 2a, 3, 4 and 5. Golder states that the implementation of this will be the responsibility of the future landowners (private landowners for AOC 2a; DEC for AOC 3, 4 and 5).</p> <p>An outline of the required contents of the SMP is provided in the RAP. It is stated that input in preparing the SMP will be required from a suitably qualified environmental consultant.</p> <p>For AOC 2a/ 3, the RAP notes that the SMP should include contingency measures for the instance where UXO/ SAA are encountered.</p> <p>Specific management requirements identified for AOC 4/ 5 include:</p> <ul style="list-style-type: none"> Maintain integrity of sealing layer Erection of notices No planting of deep rooting plants No installation of site services Avoid erection of structures Notation via planning instrument

Of the items excluded, the ones considered significant and warranting addressing at this stage are:

- More detailed specification of validation sample methodologies, analytes and frequencies.
- The RAP does not consistently refer to remedial action related to UXO/ SAA. Some sections discuss SAA only, however, it is understood that remedial works proposed for both UXO and SAA are the same.
- Figures included with the RAP do not appear to be the most up-to-date and do not show the most recent proposed land uses (RZNWC).

3.4 Conclusion

Overall, it is considered that the remediation approach recommended by Golder is appropriate. Section 3.2 and 3.3 include recommendations for changes to the RAP. Contamination issues raised within the previous Interim Advice letters have been addressed by the RAP. Of critical importance will be the successful implementation of SMPs for ongoing site management in certain areas of the site.

4 CONTAMINATION MIGRATION POTENTIAL

In the long term, remedial works would further reduce the low potential for offsite migration discussed in the previous Interim Advice (#3). In the short-term, however, there would be a higher potential for off-site migration due to high activity levels and disturbance of the site during remediation works. As such, an EMP is required to control environment impacts during the remediation works. This is already identified as a requirement in the RAP.

5 ASSESSMENT OF RISK

Based on assessment of results against relevant guidelines and consideration of the overall investigation and proposed remediation, the Auditor provides the following assessment of risk.

5.1 Munitions

The following are identified as the risks associated with the site in its current state:

- The risk of live UXO being encountered on site is very low. None has been found to date during the course of extensive investigations.
- The risk of live ball ammunition being encountered on site is very low. There has been no known usage at the site and none has been found to date during the course of extensive investigations. According to Golder (RAP, Section 9.7.3), it is possible that former land owners, community members or off duty soldiers with access to the site may have used live rounds over the sites history.
- There is a moderate risk of additional 'unexpected' inert grenade or mortar impacts to be present in general areas of the site. These items are difficult to locate due to the lack of fragmentation 'signature'. While these practice items do not present an explosive hazard, their discovery on site could be alarming to any future workers or occupants. There is a higher risk of such 'unexpected' impacts to be present in areas of the site that have not previously been accessed.
- Blank expended ammunition is present on site at an estimated 700 items/ha in high intensity usage training areas and 250 items/ha in remaining areas of the site. While presenting no explosive hazard, the discovery of expended blank SAA could be alarming to site workers or occupants.
- The proportional occurrence of live blank SAA has been estimated at between 2 and 10% however a lesser proportion than this has actually been found on site. Live blank ammunition can cause injury, particularly eye damage, if detonated through tampering.

The proposed 100% UXO/ SAA search in the proposed residential areas and grassed areas of the proposed 1G residential lands (AOC 2 and 2a) will reduce the likelihood of encountering the above items to minimal levels, and will reduce the associated risks to minimal levels.

The proposed visual clearance for UXO/ SAA in the protected vegetation areas of the proposed 1G residential lands and the proposed conservation zone (AOC 2a and 3) will reduce the likelihood of encountering the above items to low levels, and will reduce the associated risks to low levels. Implementation of site management controls via a SMP is required for these areas to reduce the associated risks to minimal levels.

5.2 Soil and Groundwater

- Remediation action is proposed to address the identified low levels of soil contamination and physical waste materials including asbestos in a number of

areas of the site where contamination detections were largely expected. The proposed remediation works will reduce the associated risks to human health and the environment under the proposed residential or conservation land use to minimal levels.

- There is considered to be a very low risk of undetected soil contamination being present in general areas of the site outside of the known areas of contamination.
- Groundwater investigations have identified possible minor contamination by heavy metals in the vicinity of the small arms firing range. The majority of heavy metals exceedances detected at the site are considered to be representative of background conditions within the shale bedrock. The Auditor considers the risk to human health or the surrounding environment due to groundwater contamination is currently very low and would be reduced further by the proposed remediation measures.

6 COMPLIANCE WITH REGULATORY GUIDELINES AND DIRECTIONS

The Auditor has used guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997*.

As discussed in Section 3, the RAP is generally in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*.

The regulatory approvals and licences relevant to the proposed remediation are as follows:

- Section 91 Licence from Department of Industry, Planning and Natural Resources (DIPNR) is required for vegetation clearance aspects of remediation.
- State Environmental Planning Policy 55 (SEPP 55). Remediation is assessed by Golder to be Category 2.
- Handling and disposal of any ACM in accordance with requirements of WorkCover NSW.
- Offsite disposal of soil/ waste in accordance with EPA (1999) *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non Liquid Waste*.
- An appropriately licensed landfill should be selected and the material tracked from the site to the landfill.
- Notation of SMP requirements will be required, for example, on the property title under Section 149(5) of the *Environmental Planning and Assessment Act 1979*.

7 CONCLUSIONS AND RECOMMENDATIONS

Golder has prepared a Remediation Action Plan outlining works required to make the site suitable for the proposed residential and conservation land uses. Seven primary Areas of Concern (AOC) requiring remediation are identified, as well as action relating to stockpiles on site and areas not previously assessed due to the presence of blackberry infestations. Prior to commencement of remediation, preparation of technical specifications and plans controlling the remedial works is required. Preparation of a Site Management Plan is also required for the ongoing management of certain areas of the site.

The Auditor has assessed the RAP by comparison with the checklist included in EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The RAP was found to address the required information for most items. The Auditor has also assessed the proposed remedial action for each issue for its suitability. Comments relating to the adequacy of the RAP and the proposed remedial action are provided in Sections 3.2 and 3.3 of this Interim Advice. Recommendations are made in those sections.

The Auditor is satisfied that the proposed remediation described in the RAP will be able to make the site suitable for the proposed residential and conservation land uses. Of critical importance will be the successful implementation of SMPs for ongoing site management in certain areas of the site.

* * *

Please do not hesitate to contact the undersigned or Rowena Salmon if you have any questions or comments regarding the above.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

DRAFT



APPENDIX D

Summary of Exceedances

Sample ID	Depth (m)	Sample Date	Sample Matrix	Zone	Metals			PAHs		Asbestos
					Copper	Lead	Zinc	Benzo[a] pyrene	Total PAHs	
Provisional Phytotoxicity Criteria					100	600	200	-	-	-
<i>Residential with Accessible Soils Criteria - NEHF A</i>					<i>1000</i>	<i>300</i>	<i>7000</i>	<i>1</i>	<i>20</i>	-
<i>Parks and Open Space Criteria - NEHF E</i>					<i>2000</i>	<i>600</i>	<i>14000</i>	<i>2</i>	<i>40</i>	-
TP642/2	0.1-0.3	21/02/2005	Fill	CZSRA	-	620	-	-	-	-
TP645/2	0.1-0.3	21/02/2005	Fill	CZSRA	-	380	-	-	-	-
TP646/1	0.0-0.1	21/02/2005	Fill	CZSRA	-	1578	-	-	-	-
TP691/4	2.5-2.7	22/02/2005	Fill	CZSRA	410	1187	-	-	-	-
TP692/1	0.0-0.2	22/02/2005	Fill	CZSRA	-	320	-	-	-	-
TP693/1	0.0-0.2	22/02/2005	Fill	CZSRA	-	1283	-	-	-	-
TP713/3	0.3-0.5	21/02/2005	Natural	CZSRA	-	760	-	-	-	-
TP723/1	0.0-0.1	22/02/2005	Fill	CZSRA	140	440	910	-	-	-
TP736/1	0.0-0.1	21/02/2005	Natural	CZSRA	-	580	-	-	-	-
TP599/1	0.0-0.1	22/02/2005	Fill	CZSRA	-	-	-	5.6	43	-
TP723/4	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA AS1/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile& Amosite Asbestos Detected
HA AS11/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA AS2/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile& Amosite Asbestos Detected
HA AS3/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile& Amosite Asbestos Detected
HA AS3/2	0.0-0.1	-	Fill	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA AS4/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA AS5/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA AS5/2	0.0-0.1	-	Fill	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA AS6/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile& Amosite Asbestos Detected
HA AS8/1	-	-	Board	CZSRA	-	-	-	-	-	Chrysotile Asbestos Detected
HA140/1	0.0-0.1	2/02/2005	Natural	RZNRA	-	-	470	-	-	-
TP469/1	0.0-0.15	23/02/2005	Natural	RZNRA	-	-	720	-	-	-
TP471/2	0.1-0.3	23/02/2005	Natural	RZNRA	-	-	810	-	-	-
TPSP6/1	0.0-0.2	-	Fill	RZNRA	-	-	-	-	-	Chrysotile Asbestos Detected

Notes:

All results are expressed as mg/kg (dry weight) unless otherwise specified

PAHs: Polycyclic aromatic hydrocarbons

CZSRA: Conservation Zone South of Rail Alignment

RZNRA: Proposed Residential Zone North of Rail Alignment

- denotes not applicable or no criteria available

Figures in **bold** exceed the Provisional Phytotoxicity Criteria

Figures in **bold italics** exceed the Residential with Accessible Soils Criteria - NEHF A

Figures in **bold italics and underlined** exceed the Parks and Open Space Criteria - NEHF E

* Result are for total chromium (III and VI), guidelines are for chromium VI only

^ The majority of the soil samples analysed in 2005 exceeded the Provisional Phytotoxicity Criteria for chromium (III and VI) of 1 mg/kg. These exceedences have not been presented as it is considered unlikely that concentrations of Cr III and CrVI at significant levels given historical land use.

Data sourced from: Golder (2005) *Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park NSW* (dated August 2005, Ref: 04623119/12)

TABLE 1
Summary of Exceedences - Soil

Landcom

107623047

DSI, Zouch Road, Edmondson Park

Sample ID	Sample Date	Sample Matrix	Zone	Arsenic	Chromium*	Copper	Lead	Nickel	Zinc
Threshold Concentrations for Groundwater				0.024	0.0033	0.0014	0.0034	0.011	0.008
BH558	24/02/2005	Water	CZSRA	-	0.007	-	-	0.016	-
BH608	24/02/2005	Water	CZSRA	-	0.012	0.004	0.005	-	0.021
BH675	24/02/2005	Water	CZSRA	-	0.008	-	0.012	0.022	-
Trench2	1/03/2005	Water	CZSRA	-	-	0.002	-	-	0.021
Trench3	1/03/2005	Water	CZSRA	-	-	0.003	-	-	0.041
BH521	24/02/2005	Water	RRZW	-	0.007	0.002	0.006	-	-
BH2	24/02/2005	Water	RZNRA	0.12	0.008	-	0.004	-	-
BH291	24/02/2005	Water	RZNRA	-	0.011	0.003	0.01	-	-
BH640	24/02/2005	Water	RZNRA	-	0.008	-	0.005	0.019	-

Notes:

All results are expressed as mg/L, unless otherwise specified

CZSRA: Conservation Zone South of Rail Alignment

RZNRA: Proposed Residential Zone North of Rail Alignment

RRZW: Proposed Rural/Residential Zone West

- denotes not analysed, not applicable or no criteria available

Figures in **bold** exceed the Threshold Concentrations for Groundwater

* Result are for total chromium (III and VI), guidelines are for Chromium VI only

Data sourced from: Golder (2005) *Detailed Contamination Site Investigation, Landcom Project No: 12619, Zouch Road, Edmondson Park NSW* (dated August 2005, Ref: 04623119/12)

TABLE 2

Summary of Exceedences - Groundwater

Lancom

107623047

DSI, Zouch Road, Edmondson Park