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Integrated Practical Solutions

Non Statutory Site Audit Report

Lot 1 DP 620265
Sark Grove and Pembroke Road
Minto NSW

Prepared for
Endeavour Energy
(formerly Integral Energy)

Project 36339.01
Audit DPNS/7
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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GLOSSARY OF TERMS - LIST OF ABBREVIATIONS

General

ACM	asbestos containing materials
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AGST	above-ground storage tank
CLM Act	Contaminated Land Management Act
COCD	Chain of Custody Documentation
CRA	Colebee Release Area
DA	development application
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DLWC	Department of Land and Water Conservation
DIPNR	Department of Planning and Natural Resources
DNR	Department of Natural Resources
DP	deposited plan
DQI	data quality indicators
DQO	data quality objectives
DWE	Department of Energy and Water
EMP	environmental management plan
ENM	Excavated Natural Material
EPA	Environment Protection Authority
ESA	environmental site assessment
HDPE	high-density polyethylene
HIL	human health investigation level
HMTV	hardness modified trigger value
MSDS	Material Safety Data Sheet
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measure
NPER	National Professional Engineers Register
NS SAR	Non statutory Site Audit Report
NS SAS	Non statutory Site Audit Statement
NSW	New South Wales
PESA	preliminary environmental site assessment
PID	photo-ionisation detector
PPIL	provisional phyto-toxicity investigation level
PQL	practical quantitation limit
PSH	phase-separated hydrocarbons
QA	quality assurance
QC	quality control
RAP	remediation (remedial) action plan
RL	relative level
RPD	relative percentage difference
SAC	site assessment criteria
SAQP	sampling and analysis quality plan
SAS	site audit statement

SAR	site audit report
SIL	site investigation level
S(E)MP	site (environmental) management plan
SOP	standard operating procedure
SRN	sample receipt notification
SSC	sensitive site criteria
TCLP	Toxicity Characteristic Leaching Procedure
TBT	tri-butyl tin
UCL	upper confidence limit
UST	underground storage tank
VENM	Virgin Excavated Natural Material

Analytes – Inorganic

As	arsenic
Be	beryllium
B	boron
Cd	cadmium
Co	cobalt
Cr	chromium
Cu	copper
Fe	iron
Hg	mercury
Mn	manganese
Mo	molybdenum
Ni	nickel
Pb	lead
Sb	Antimony
Se	Selenium
Sn	Tin
V	Vanadium
Zn	zinc
CN	Cyanide

Analytes – Organic

BaP	benzo(a)pyrene
BTEX	benzene, toluene, ethylbenzene, xylene
OCP	organochlorine pesticides
OPP	organophosphorus pesticides
DDT	dichloro-diphenyl-trichloroethane
DDE	dichloro- diphenyl-dichloroethylene
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
SVOC	semivolatile organic compounds
TPH	total petroleum hydrocarbons
VHC	volatile halogenated compounds
VOC	volatile organic compounds

Measures

μg/L	micrograms per litre
km	kilometer
L	litre
m	metre
m^2	square metre
m^3	cubic metres
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mm	millimeter

Note: All acronyms listed above may not have been used in the report

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1. Introduction

1.1 Background

The subject of this Site Audit Report (SAR) is a 5.9 hectare parcel of land located at Sark Grove and Pembroke Road, Minto, NSW which comprises Lot 1 DP 620265. The site is located in the Parish of St Peter, County of Cumberland and forms part of the Campbelltown City Council (**Figure 1, Appendix A**[1]). The site is zoned special uses 5(a).

The site was operational from the 1960s up until early 2004 as Integral Energy's main depot for the Campbelltown and Macarthur Region for maintenance of electrical distribution network. Site operations involved motor vehicle workshop, timber and concrete pole storage, general goods storage and fuel, oil and creosote storage.

The land is surplus to the requirements of Endeavour Energy (formerly Integral Energy) and is intended to be divested for sale.

As this site audit is not a requirement of Campbelltown City Council as part of an application for development consent the audit is not deemed to be statutory in nature as defined under the provisions of Part 4 of the Contaminated Land Management Act, 1997. It is understood that a DA (Reference I17/2002) was obtained for demolition works and remediation works, but as yet no development application has been lodged for the site and as such the proposed end use is not known.

The commission for the site audit was originally received from Integral Energy on 8 September 2003. The audit was notified to the NSW Department of Environment and Conservation (now Office of Environment and Heritage) on 8 September 2003, however, a further notification was provided on 11 May 2004 to inform EPA of the conversion of the audit to non-statutory following the decision by Integral Energy that the site was not to be rezoned for residential purposes (Ref CH8376). The audit was therefore converted to a non statutory site audit.

The purpose of this NS SAR is to determine, following investigation, remediation and validation, whether the land (comprising Lot 1 in DP 620265) is suitable for any specified use or range of uses as defined in S1.3 (b) (iii) of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006.

The site audit is based largely on the results of contamination investigations, and the implementation and validation of a remedial strategy and related reports prepared by Sinclair Knight Mertz (SKM), IT

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[1] Figure 1 and other associated figures are abstracted from the reports referenced in Section 1.5. Figure numbers may have been changed for convenience.

Environmental (ITE), Coffey, Environmental Resource Management Australia (ERM), URS, Parsons Brinkerhoff (PB), Earth2Water (E2W) and Environmental Risk Sciences Pty Ltd (EnRiskS).

The findings of the various investigations are outlined in their reports on the subject site which are listed in Section 1.5.

This NS SAR has been prepared generally in accordance with the provisions of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006. It has been prepared by Michael Nash who is accredited as an auditor with the NSW EPA (Auditor No. 9822) under the Contaminated Land Management Act, 1997 and who is also a NPER registered engineer (No. 1168905) in both the Civil and Environmental Divisions of the Engineers Australia.

1.2 Involvement of Consultants and Auditor

A number of consultants including SKM, ITE/Coffey, URS, ERM, PB, E2W and EnRiskS were engaged by the proponent to conduct contamination investigations, remediation works, groundwater studies, risk assessments and validation works on the subject site.

Prior to the involvement of the auditor, an Environmental Assessment was undertaken by SKM and a Remediation Action Plan (RAP) produced (January 2000). Remediation works were undertaken between 2003 and 2006 by Ronnies Environmental (Ronnies) and ITE/Coffey. The remediation works included removal of several USTs including a creosote tank and an underground oil tank and validation of remediation excavations. Installation and sampling of four groundwater wells was also undertaken as part of this work.

A number of consultants worked on the site over the next few years. URS conducted an independent review and screening level risk assessment in 2005 to address community concerns regarding the potential for contamination along the eastern site boundary. In 2006 ERM conducted an additional investigation and conceptual model of risk associated with the residual contamination in the area of the former creosote tank on the site.

From 2006 – 2010, PB undertook additional assessment works and prepared a number of excavation and backfill reports. Further remediation works were undertaken between 2006 and 2007 and subsequent soil validation works were undertaken by PB with validation reports for various areas (6 areas in total) prepared in 2010.

Groundwater investigation and remediation works were undertaken between 2005 and 2011 by a number of consultants including ITE, URS, ERM, PB and E2W. ITE installed 4 groundwater monitoring wells in 2005. URS installed 3 wells in 2006. ERM installed 3 wells in 2006. PB installed 3 more wells in 2006 as well as sampling from the 9 existing wells. In 2006, PB installed another 4 wells. URS conducted a peer review of the groundwater strategy by PB in 2006. In July 2006 a multi phase extraction (MPE) trial was undertaken under the supervision of PB. Gauging was undertaken over the next months until 11 new wells were installed by PB in 2007 (2 replacements and 9 new wells). A four-day multi phase extraction and air treatment (MPEAT) event was undertaken in April 2008, with pre and post event monitoring of 18 wells by PB. Quarterly groundwater monitoring was then undertaken between May 2009 and March 2010 by PB. E2W undertook additional groundwater gauging, installation and sampling of soil vapour for the human health risk assessment prepared by EnRiskS in

2010-2011. Additional groundwater sampling was undertaken in 2011 by E2W and results were included in various documents by E2W and EnRiskS including a Remedial Technology Review, Monitored Natural Attenuation Report, Identification of 'Impacted Zone' Requiring Management Report, Environmental Management Plan (EMP) and a Groundwater and Remediation Validation Report.

The results of these investigations and remediation works by consultants are discussed in more detail later in the audit report.

The auditor has undertaken a number of site inspections during the course of works which were recorded in a series of date stamped photographs. Photographs 1 - 6 in **Appendix B**, taken by the auditor during these site visits, show selected views of the site during the investigations.

A more comprehensive photographic record of the site is retained on file by the auditor.

1.3 Scope of the Site Audit Report

This site audit was carried out principally using the criteria established by the NSW EPA (formerly EPA, DEC and DECC,DECCW and OEH) in their publication, 'Guidelines for the NSW Site Auditor Scheme (2nd Edition)', NSW DEC, 2006, and in Guidelines for Assessing Service Station Sites, NSW EPA, 1994.

In addition, the auditor has referenced, where appropriate, other guidance documents made or approved by the NSW EPA (or it's forerunners) under Section 105 of the Contaminated Land Management Act, 1997, including, inter alia:

- NSW EPA (1995). Sampling Design Guidelines (September 1995);
- NSW EPA (1997). Guidelines for Consultants Reporting on Contaminated Sites (November 1997);
- NSW EPA (1999). Environmental Guidelines: Assessment, Classification, & Management of Liquid & Non-Liquid Wastes (May 1999);
- NSW DEC (2007). Guidelines for the Assessment and Management of Groundwater Contamination (March 2007);
- NSW DECC (2008). Waste Classification Guidelines Part 1 Classifying Waste and Part 2 Immobilisation of Waste, NSW DECC (April 2008);
- NSW DECC (2009). Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (June 2009).

In completing the audit process the auditor has reviewed the consultants' reports and supplementary information against checklists of requirements for reporting which have been adapted from Section 3.1 of the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997) and from the Appendix IV and V of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006. Other information referred to by the Auditor is listed in Section 1.5 and the Bibliography at Section 10.

1.4 Limitations

The auditor has prepared this NS SAR and accompanying NS SAS for the purposes specified in the above sections and as defined by Regulation and by the NSW EPA. The project scope of works undertaken by the auditor was developed specifically for the purpose of meeting the objectives outlined above. The objectives and scope of works adopted by the contamination assessment consultants are understood to have been developed based on similar objectives.

The auditing work and reporting undertaken has been carried out to a standard of care and diligence normally expected of professional engineers and scientists practicing in the areas of contaminated land assessment and management in New South Wales.

The degree of confidence in the findings and conclusions of the NS SAR and related NS SAS is governed by the typical limitations and constraints inherent to such audits. The audit is based entirely on the investigations undertaken by the contamination assessment consultant as well as on the reported relevance and quality of the information and data obtained during remedial planning and the subsequent remediation and validation program.

Where there are shortcomings or limitations in regard to the data obtained from the site or uncertainties in respect to the conclusions drawn from these data, such issues are identified in the SAR.

The audit undertaken reflects the condition of the site at the time of audit based on the investigations under audit. No liability can therefore be accepted for failure to identify site conditions or related environmental issues which may arise in the future from ongoing site uses, or which could not have reasonably been determined or envisioned based on the scope of investigation works undertaken and the data obtained during the assessment and/or site validation. In this regard it is noted that site conditions are determined by the consultants during the assessment, remediation and validation phase of investigations by means of both interpretative and statistical methods using data obtained during sampling, and it is noted that conditions between sampling locations may not be reflective of those actually sampled or analysed.

Accordingly, no liability is accepted by the auditor for unidentified contamination or subsurface features or structures subsequently found to be present on the site where the investigations have been undertaken in substantial compliance with the guidelines endorsed by NSW EPA.

The data used to support the conclusions reached in this SAR have been obtained by other consultants and have been audited with a reasonable level of scrutiny, care and diligence by the auditor. No liability can be accepted for unreported omissions, alterations or errors in the data collected and presented by the other consultants. Accordingly, the data and information presented by others are taken and interpreted in good faith by the auditor.

This NS SAR should not be used for purposes other than those indicated in the previous sections of this report. The report and attached NS SAS (DPNS/7) should not be reproduced without the permission of Douglas Partners Pty Ltd.

If additional copies of the report are required for any reason then the NS SAR should be reproduced in its entirety including the NS SAS to which this report is attached.

This site audit does not address the geotechnical or engineering suitability of the site, or any materials thereon, and accordingly it is recommended that suitable specialist advice in this regard is obtained. Similarly the audit does not address the suitability of any materials for re-use in land which falls beyond the boundary of the site.

1.5 Associated Reports and Other Materials Referenced

The reports reviewed for this audit were as follows:

- SKM (2000). Environmental Assessment of Potentially Contaminated Sites Minto Field Services Centre, dated January 2000;
- SKM (2000). Minto Field Services Centre Remediation Action Plan, dated March 2000;
- ITE[2] (2003). Draft Soil Sampling Summary Report August – November 2003, Integral Energy Depot Cnr Pembroke & Sark Grove Minto NSW, Ref J109965A-R01a, dated 2003;
- ITE (2004). Draft Soil Sampling Summary Report November 2003 – May 2004, Integral Energy Depot Cnr Pembroke & Sark Grove Minto NSW, Ref J109965B-R01a dated 2004;
- ITE (2005). Addendum to Stockpile Sampling Summary Report North Eastern Corner, Integral Energy Depot Cnr Pembroke & Sark Grove Minto NSW, Ref J109965B-L05 dated 2005;
- Coffey (2005). Geotechnical Report
- ITE (2005). Re: Integral Energy Depot Cnr Pembroke & Sark Grove Minto Stockpiles SP31 and 35, Cnr Pembroke & Sark Grove Minto NSW, dated 3 November 2005;
- URS (2005). Sampling, Analytical and Quality Plan Environmental Site Assessment Integral Energy Minto Sark Grove and Pembroke Road Minto Ref: 43217292 dated November 2005;
- URS (2005). Screening Level Human Health Risk Assessment Minto Field Service Centre Ref: 43217283 dated December 2005;
- ERS (2006). Integral Energy, Field Services Centre, Sark Grove, Minto NSW dated February 2006;
- ERM (2006). Integral Energy, Field Services Centre, Sark Grove, Minto NSW Conceptual Model dated February 2006;
- PB (2006). Sampling and Analysis Quality Plan for the Integral Energy Depot, Minto, NSW , draft, Ref PR_3324_Rev_C, dated March 2006;
- PB (2006). Hazardous Materials Survey The Former Integral Energy Worksites Depot, Townson Rd, Minto NSW 2566 Ref: PR_3348, dated March 2006
- URS (2006). Independent Review Integral Energy Minto Sark Grove and Pembroke Road Minto Ref: 43217292 dated April 2006;

[2] In 2006/2007 Coffey Environments acquired IT Environment. Subsequent reports authored by Coffey.

- ERM (2006). Additional Site Investigation Data Summary and Risk Assessment Report, Integral Energy, Field Services Centre, Sark Grove, Minto, NSW Australia Ref: 0046268-FINAL, dated April 2006;
- PB (2006). Combined Phase 1 & 2 Environmental Site Assessment and Remediation Action Plan for Integral Energy Depot, Minto, NSW Ref: PR_2655, dated May 2006;
- ITE (2006). Soil Sampling Summary Report August 2003 – February 2006, Former Integral Energy Depot, Sark Grove, Minto, NSW, dated June 2006;
- PB (2006). Updated Groundwater Remediation Strategy for Minto Services Depot and Costings Ref. 2115098A/FX_4458 dated September 2006;
- PB (2006). Proposed groundwater remediation strategy and costings for Minto Service Depot, Ref: 2115098A/FX_4916. dated December 2006;
- PB (2007). Excavation and Backfill Plan Former South Car Park Integral Energy Minto Depot Minto, NSW, draft, Ref PR_5349_RevC dated March 2007;
- PB (2007). Review of possible options for the vegetated land corridor along the site southern boundary Ref: LT_5600_RevA dated March 2007;
- PB (2007). Excavation and Validation Plan Primary Backfilled ("Ronnies") Tankpit Area Integral Energy Minto Depot Sark Grove, Minto, NSW Ref PR_5534_RevB dated March 2007;
- PB (2007). Former Integral Energy Depot, Sark Gr, Minto, NSW - Investigations in the vegetated land corridor along the site western and southern boundaries Ref: LT_5701_RevD dated May 2007;
- PB (2007). Proposed groundwater remediation strategy for the area south of Buildings E, F & G - Former Integral Energy Depot, Sark Grove, Minto, NSW Ref: 2115098A/LT_5665_RevD dated June 2007;
- PB (2007). Excavation and Backfill Plan Vegetated corridor Integral Energy former Depot, Sark Grove, Minto, NSW Ref PR_6048 Rev B, dated June 2007;
- PB (2007). Excavation and Backfill Plan Corner of Pembroke Road and Sark Grove – Integral Energy former Depot, Sark Grove, Minto, NSW Ref PR_6024_Rev C, dated June 2007;
- Coffey (2007). Addendum to Soil Sampling Summary Report (J109965B) Integral Energy Depot Cnr Pembroke Road and Sark Grove Minto NSW 2566 dated August 2007;
- PB (2007). Groundwater Monitoring Round & Proposed Remediation Plan, Area South of Buildings E, F and G, Integral Energy Former Depot, Sark Grove, Minto, NSW Ref. 2115098A/PR_6157_RevA dated November 2007;
- PB (2008). Groundwater Monitoring Round and MPEAT event, Former Integral Energy Depot, Sark Grove, Minto, NSW Ref. 2115229F/PR_8512 RevA, dated December 2008;
- JFTA Environmental Solutions (2008). Multi Phase Extraction and Air Treatment Event (21st – 24th April, 2008). Former Integral Energy Site, Sark Grove, Minto, NSW. JFTA Ref: 700281, dated May 2008;
- PB (2010). Validation Report, Former Building A and B Area, Former Integral Energy Depot, Sark Grove, Minto, NSW (PR_6918RevA), dated July 2010;
- PB (2010). Validation Report, Former Building C and North West Corner, Former Integral Energy Depot, Sark Grove, Minto, NSW (PR_6921RevA), dated July 2010;

- PB (2010). Validation Report, Former Southern Car Park and Vegetated Corridor, Former Integral Energy Depot, Sark Grove, Minto, NSW (PR_6992RevA), dated July 2010;
- PB (2010). Validation Report, Former Hardstand Areas and Buildings E, G and G, Former Integral Energy Depot, Sark Grove, Minto, NSW (PR_7763RevA), dated July 2010;
- PB (2010). Validation Report, Former Building H Area, Former Integral Energy Depot, Sark Grove, Minto, NSW (PR_6855RevA), dated July 2010;
- PB (2010). Validation Report, Former Creosote Pit and Pole Storage Area, Former Integral Energy Depot, Sark Grove, Minto, NSW (PR_6624RevA), dated July 2010;
- PB (2010). Factual Report – Groundwater Monitoring Events (May 2009 to March 2010) Former Integral Energy Depot, Sark Grove, Minto, NSW Ref: PR_2418 RevA, dated July 2010;
- E2W (2010). Groundwater Assessment and Vapour Well Installation, Sark Grove, Minto, NSW prepared for Environmental Risk Sciences Pty Ltd, dated 14 December 2010;
- EnRiskS (2011). Human Health and Environmental Risk Assessment – Sark Grove, Minto Prepared for Endeavour Energy Ref: IE/10/R001-C-Revised Final, dated August 2011;
- E2W (2011). Minto Sampling Analysis and Quality Plan, Ref: Ref: E2W-0153 L001, dated June 2011;
- EnRiskS (2011). Addendum Human Health and Environmental Risk Assessment – Sark Grove, Minto Prepared for Endeavour Energy Ref: IE/10/R001-C-Revised Final, dated 17 October 2011;
- E2W (2011). Remedial Technology Review for Residual Groundwater Contamination at Minto, NSW dated 1 September 2011;
- E2W (2011) Monitoring of Natural Attenuation and Groundwater Modelling, Sark Grove, Minto, NSW, dated 27 September 2011;
- EnRiskS (2011). Identification of 'Impacted Zone' Requiring Management Report, dated 24 October 2011;
- EnRiskS (2011). Re: Addendum to HHERA – Methane in Soil Gas – Sark Grove, Minto Prepared for Endeavour Energy Ref: EE\11\LR002-C, dated 12 December 2011;
- EnRiskS (2012). Environmental Management Plan (EMP) for 'Impacted Zone' – Sark Grove, Minto Environmental Management Plan (EMP) dated 10 January 2012; and
- EnRiskS (2012). Groundwater and Remediation Validation Report for 'Impacted Zone' – Sark Grove, Minto dated 11 January 2012.

Other relevant information including correspondence between the auditor and consultants and/or proponent is included at **Appendix C**.

2. Site Details

2.1 Site Description

The site is located at Sark Grove and Pembroke Road, Minto NSW, southwest of Sydney and covers 5.9 hectares. It is known as Lot 1 in Deposited Plan 620265 and forms part of the Campbelltown City Council local government area in the Parish of St Peter, County of Cumberland and is zoned special use 5(a). The site location is shown on **Figure 1, Appendix A.**

The site was previously occupied by a number of buildings including offices, amenities, storage areas, workshops, wash bays, loading docks, as well as underground storage tanks, bowsers, a radio tower, parking areas, a gantry crane area, sheds, etc (see **Figure 2, Appendix A**).

Adjacent land uses to the site include mainly residential with a council depot to the north and McBarron Creek to the south.

Survey drawings provided by Proust and Gardner Consulting Surveyors and Planners and JSM Surveying Consulting Surveyors and Project Managers are provided in **Appendix D** which show the site layout. A summary of site details is provided in Table 1 below.

Table 1 – Summary of Site Information

Site Name:	Minto Depot
Site Owner:	Endeavour Energy
Site Location:	Sark Grove and Pembroke Road, Minto
Total Site Area:	5.9 hectares (as shown in **Figures 1 and 2)**
Title Identification:	Lot 1 in Deposited Plan 620265
Geographical co-ordinates:	34° 2' 0" South, 150° 51' 0" East
Zoning:	Campbelltown City Council local government area in the Parish of St Peter, County of Cumberland and is zoned special use 5(a).
Recent Land Use:	The site was previously used as a Depot with operations including motor vehicle workshop, transformer maintenance, timber and concrete pole storage, fuel, oil and creosote storage in underground and above ground tanks and general goods storage.
Proposed End Land Use:	The proposed end land use is not known at this stage, and no development application is known to have been lodged.

Auditor's Opinion

The auditor concurs with the site description and locational information provided by the consultant (and by the proponent) which appears to coincide with the actual site under audit.

2.2 Topography, Drainage and Meteorology

The highest point of the site is in the north-eastern corner at the intersection of Sark Grove and Townson Road at an elevation of 90 m AHD. From this point the ground slopes to the southwest towards Pembroke Road boundary at 70 m AHD.

Stormwater is collected via stormwater sumps which drain to a local collection area that distributes flow towards Pembroke Road and McBarron Creek (piped Creek) to the west and southwest of the site. McBarron Creek runs along the southern boundary towards Bow Bowing Creek (1.3 km west of the site) and is a concrete lined channel.

Meteorological details were provided by some of the consultants. The auditor notes that based on Australian Bureau of Meteorology records, average temperatures range from 3.2°C and 28.4°C with a maximum recorded temperature of 45.8 °C and a minimum recorded temperature of -5.6°C showing a substantial potential variation in temperatures for the area. The average yearly rainfall was 829.1 mm in 2011 (Table 2).

Table 2 – Average Rainfall for the Campbelltown Swimming Centre (BOM Station 068081)

Month	Average Rainfall
January	90.6
February	78.6
March	100.7
April	62.6
May	60.2
June	81.6
July	33.7
August	50.4
September	40.7
October	74.3
November	84.3
December	70.5
Total	829.1

Detailed services diagrams of the site were not provided by the consultants.

Auditor's Opinion

The consultants' description of the topography and drainage is satisfactory.

2.3 Geology and Hydrogeology

The Wollongong-Port Hacking 1:100,000 Geological Series Sheet 9029-9129 (Department of Mineral Resources, 1985) indicates that the area of the site is underlain by Ashfield Shale. Ashfield Shale is described as laminite and dark-grey siltstone. Hawkesbury Sandstone is also locally present at surface in the area of the site. The Hawkesbury Sandstone is described as medium to coarse-grained quartz sandstone with minor shale and laminite layers. The geology is shown in **Figure 3, Appendix A.**

Two soil profiles were identified at the site. Shallow soil consisting of hard red friable dry clays overlying shale bedrock were present along the top ridgeline near Townson Avenue in the north-eastern corner of the site. The remainder of the site was underlain by sandstone, where soils consist of red to orange sands, sandy clays and stiff clays.

SKM provided the following summary of the stratigraphy at the site based on their investigations:

- TOPSOIL – generally sandy loam, dark red brown from surface to 0.1 m depth;
- FILL – silty clay red mottled stiff medium plasticity to 0.6 m depth;
- CLAY – red mottled stiff, medium plasticity from surface to 1.8 m depth;
- CLAY – silty/sandy clay – red orange mottled from 0.6 to 3.0 m depth;
- Silty SAND – mid brown from surface to 2.8 m depth; and
- SANDSTONE – light grey and medium brown, weathered at the top from 1.1 to end of investigations (3 m).

Groundwater flow is thought to occur mostly within the fractured and weathered sandstone, with the shale/siltstone deposits acting as barriers to vertical flow causing groundwater to flow along bedding planes. Groundwater flow is also likely to occur in the intergranular pore space in the un-fractured sandstone, but this flow is likely to be quite limited.

The receiving water body is McBarron Creek, which is located in the south western corner of the site. Gauging results support that groundwater flow was to the west and south west towards McBarron Creek. The inferred groundwater flow is shown in **Figure 4, Appendix A**.

PB provided the following review of hydrology:

'A search of the Department of Natural Resources (DNR) licensed borehole register (http://www.waterinfo.nsw.gov.au/gw/index.html) indicated that there were five registered bores within a 1 km radius of the site. Four bores were located 700 m to 1 km east of the site and one bore was located approximately 800 m to the North West of the site. No information was available for any of the bores.'

PB provided the following information regarding potential uses down-gradient of the site:

- *groundwater discharge to water bodies sustaining aquatic ecosystems, such as McBarron Creek (freshwater) which is the most likely receptor of groundwater at the site. McBarron Creek discharges into Bow Bowing Canal approximately 1 km west of the site, which itself discharges into Georges River (approximately 10 km further) and ultimately into Botany Bay;*
- *groundwater discharge to the same water bodies used for recreational purposes such as swimming and boating, whose aesthetic appeal should be considered. Regarding surface films, these guidelines state that "Oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odour".*
- *It is considered unlikely that groundwater downgradient of the site would be used for industrial purposes, drinking, stock watering or irrigation based* [primarily] *on the low* [bore] *yield and absence of any industrial or rural properties downgradient of the site.'*

It is noted that groundwater in the impacted area of the site is generally located at a depth of 4 to 8.5 mBGL within competent sandstone bedrock and the area of impacted groundwater is located greater than 75 m from McBarron Creek, traversing the south western corner of the site. Based on this, it is considered that any off-site discharge is unlikely to occur.

Further details of 'aquifer' characteristics, groundwater flow and groundwater quality are provided in **Section 4.**

Auditor's Opinion

The consultants' description of the nature of substrate materials is considered to be adequate and the information is considered to be consistent with published information and with auditor observations during prior investigations by ITE and PB which were attended by the auditor.

The consultants' desktop assessment of local hydrogeological conditions is considered to be adequate.

2.4 Site History

The site history review included review of the following sources:

- Historical titles;
- Historical site plans;
- Aerial Photographs
- Integral Energy Records including internal Memos, questionnaires, interviews, reports etc.
- Site inspections by various consultants.

The desktop assessment contains the standard site history search according to the Guidelines for Consultants Reporting on Contaminated Sites, NSW EPA (1997).

SKM provided the following summary of site history:

The site has had a history of industrial use. The site was granted by the Crown to Nepean River County Council in 1976. The title of the land was transferred to Prospect County Council in 1982. Since this date the site has been used as a field services centre. The title is held by The Prospect County Council, now Integral Energy. The site forms a part of the Campbelltown Local Government Area in the parish [sic] *of St Peter County of Cumberland.*

Aerial photographs were also reviewed by SKM with the following summary provided:

- *'1947 Photograph – the aerial photograph indicates that the site was comprised completely of farming land. The area has been cleared of bushland, but is not yet developed.*
- *1961 Photograph – by 1961 there were a number of small farmhouses/buildings/shed on the site. However the remainder of the site is still rural/farming land.*

- *1978 Photograph – by 1978 the site had been established. The site consisted of approximately six buildings, four large ones and two smaller sheds. There was a large unsealed pole storage are on the north east corner of the site. The current car park to the south east of the site was a vegetated area. The north west corner of the site had been cleared and covered with asphalt. There was a type of turning bay to the south east of the site with an open storage area.*
- *1984 Photograph – there are a number of buildings on the site. There is a new large building on the north east of the site still appears to be in use. A sealed carpark has been constructed adjacent to the eastern site boundary. The site is mostly cleared of all vegetation. The area to the north of the site is industrial. The remaining areas surrounding the site are residential.*
- *1990 and 1994 Photographs – The 1990 and 1994 photographs show little change from 1984 with the exception of a few more small buildings and shed on the site.*

A site questionnaire was filled out by Integral Energy outlining the history of the Minto Field Services Centre.

Historical evidence that was collected in the questionnaire included the following:

- *A distillate spill occurred on the site in 1991. The spill occurred whilst pumping out from a tank that had been identified as leaking. During the pump-out a substantial amount of distillate escaped into the stormwater drains on site and flowed into the Creek in Pembroke Reserve.*
- *There are a number of fuel, oil and creosote tanks located at the site as well as drum storage of fuel lubricants. There are refuelling facilities on the site as well as vehicle washing bay.*
- *Works carried out at the site include maintenance and repair, machining and fabrication. Transformers are stored on the site.*
- *Pesticides have been used and stored on site together with wood poles.*
- *A number of chemicals have been/are stored on the site. These include solvents, cleaning fluids, coal tar emulsion, creosote, degreasers, LPG, paints, pesticides, and timber treatments chemicals.*
- *Historically, liquid waste from the site has been discharges to the local creek. The SPCC (now the EPA) put a stop to this practice and modifications to the liquid waste system were made.*
- *A quote from an Agricultural Chemical Supplier details plans for the use of the herbicide Round-up*[3] *to treat weeks* [sic] *on the site, particularly along the southern boundary line of the site fronting the local creek. An internal memorandum provides further details of the plans to use Round-up on the site.*
- *It is believed that contamination of the soil at the site has taken place as a result of fuel spillage's and leaking chemical storage tanks. Contamination surrounding the creosote tanks has also been noted. Surface water contamination has also been identified as an issue on the site.*
- *Imported fill is present on the site, particularly in the parking area to the south of the site.*

[3] Round-up is a glyphosate based weed-killer / herbicide.

An extract of a report completed by land economists and planners, Burrell, George and Co. has been provided by Integral Energy. Information obtained from the reports includes:

- *The Minto Depot was previously the headquarters of Nepean County Council prior to its amalgamation with Prospect County Council. Although a "green-fields" site at the time of its development, the site is now surrounded by residential developments.*
- *A distillate spill occurred in 1991. A tank on site was leaking and whilst pumping the tank out during replacement, substantial contamination of the creek in Pembroke Rd reserve occurred.'*

ITE provided the following summary of the site history:

'The site was initially used for agriculture, with a 1947 aerial photograph indicating that the area had been cleared but not yet developed. It has been used for industrial purposes since at least the 1970's. In 1976 the land was granted by the Crown to Nepean River County Council and subsequently transferred to Prospect County Council (now Integral Energy) in 1982. The site was used as a field services centre since at least this time. Five underground storage tanks were installed on-site. Anecdotal evidence (SKM 2000) indicates that contamination of the site occurred as a result of fuel spillages and leaking tanks.

Until the SPCC (now the EPA) stopped the practice, liquid waste from the site was discharged into a local creek. In 1991 a distillate spill occurred while pumping out a leaking tank, resulting in substantial contamination of McBarron Creek in nearby Pembroke Park. A variety of chemicals have been stored on-site in the past, including solvents, cleaning fluid, coal tar emulsion, creosote, degreasers, LPG, paints and timber treatment chemicals. Pesticides have also been used and stored on-site, and evidence suggests that the herbicide Round-up may have been used to treat weeds.'

In addition, URS added the following information:

'The Site formerly contained three workshops (one with an oil water interceptor), a loading dock and wash bay with associated oil water interceptor, a gantry, a metering inspection area, three substations, an amenities building and office buildings. The site also had five USTs, four of which stored petroleum products (petrol and diesel) and one UST stored creosote emulsion. Bowsers associated with the petroleum USTs were also noted on the Site. In addition, two above ground storage tanks (ASTs), reportedly holding motor oil, were located on the Site as were several soil bins holding bitumen coated crushed rock. Two small empty creosote tanks (ASTs) were temporarily stored on the Site. Pesticides have also been used and stored on the Site.'

A review was undertaken by URS to address the alleged dumping of 'toxic waste along the eastern boundary of the site with Townson Avenue. During the interviews with Integral Energy employees the following information was obtained by URS regarding historical activities on the site:

- *'Reports of dumping of liquid comprising dieldrin and creosote mix at a depth of 2 to 3m in several locations along the Townson Avenue boundary, north of the creosote tank (date not given);*
- *Heavy weed spraying in the substation area, which was located on the Corner of Sark Grove and Pembroke Road, i.e. in the north-west corner of the Site. The type of chemical used was not reported, and*
- *Accidental discharge into McBarron Creek of diesel during pumping out of diesel tank. It is understood that this occurred in 1991.'*

Adjacent land uses identified by PB include:

- *North – Sark Grove and council depot*
- *South – Piped creek (McBarron Creek) and residential development beyond*
- *East – Townson Avenue and residential beyond*
- *West – Pembroke Road with Pembroke Park beyond.*

Areas of environmental concern (AEC) identified in the previous reports (SKM, ITE) included:

- Pesticides:
  - Especially around pole storage areas (north-east of the site),
  - Possible use of Round-up for weed control
- Total petroleum hydrocarbons including oil, grease and fuel, from a variety of sources including:
  - Underground fuel tanks and bowsers;
  - Above ground fuel tanks,
  - Creosote tank and filling area,
  - Distillate spill,
  - Vehicle maintenance and repair areas,
  - Washing down of maintenance area,
  - General storage or spills,
  - Historical substation in North West corner.
- Heavy metals:
  - On-site fill/ash
  - Industrial-related activities,
  - Building materials,
  - In pesticides.
- Polycyclic Aromatic Hydrocarbons (PAH):
  - Fill material,
  - Coal tar emulsion storage,
  - Creosote storage and spills,
  - Industrial activities.
- PCBs:
  - Electricity transformers,
  - Fluorescent light capacitors.
- Phenol/creosols:
  - Creosote.
- Asbestos:
  - Building materials.

Auditor's Opinion

The search of the site history by SKM, PB, ITE, URS etc is quite comprehensive and is believed to have identified, as far as possible, the most likely types and areas of potential contamination. Inevitably these are identified by a range of methods, mostly at the macro scale. No comprehensive aerial photograph review was undertaken and this is considered a data gap in the site history review by the consultants, but is not expected to affect the overall integrity of the site history search as the history is largely known from other sources.

2.5 Contaminants of Concern

Based in the AECs outlined in Section 2.4 the following chemicals of concern were identified by the consultants.

Areas of environmental concern (AEC) identified in the previous reports (SKM, ITE) included:

- Pesticides,
- Total petroleum hydrocarbons,
- BTEX,
- Heavy metals,
- Polycyclic Aromatic Hydrocarbons (PAH),
- PCBs,
- Phenol/creosols, and
- Asbestos.

With respect to groundwater the following COCs were identified by the consultants (PB):

- TPH;
- MAHs (including BTEX compounds);
- VOCs; and
- MTBE.

Auditor's Opinion

Overall the range of potential contaminants identified and subsequently tested by the various consultants was considered broadly suitable to cater for the range of contamination likely to have been derived from the previous land uses and the corresponding areas of environmental concern (AEC) identified by the consultant(s).

2.6 Site Redevelopment

The purpose of the soil validation works was to remediate the site for an anticipated residential housing development with accessible soil. As the site is yet to be divested to a future developer, no proposed development plans are, however, available for the site at this stage.

Auditor's Opinion

As the end-use of the site under any future DA is unknown, the selection of guidelines associated with the proposed land-use is not possible. The auditor notes that in the reports, the consultants have classified the site as 'residential with gardens and access to soils including town houses and villas' as defined under Column 1 in the Guidelines for the NSW Site Auditor Scheme – 2nd Edition (NSW DEC

2006) (HILA). In this regard it is noted that the 'Decision Process for Assessing Urban Redevelopment Sites' in the above Guideline requires that both the Column 1 – human health investigation levels (HILA) and Column 5 provisional phyto-toxicity investigations levels (PPILs) be taken into account when assessing the optimum land use for the site.

The auditor also notes that where wastes are to be disposed off-site they are required to be classified for disposal purposes under the Waste Classification Guidelines Part 1 Classifying Waste and Part 2 Immobilisation of Waste, NSW DECC (2008) (previously the Environmental Guidelines: Assessment, Classification, & Management of Liquid & Non-Liquid Wastes (NSW EPA, 1999)). For waste removed from the site during the initial works by RES and ITE from 2003 – 2006, waste guidelines adopted were NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes which were the appropriate guideline at that time.

3. Site Assessment and Remediation Criteria

The soil investigation levels and site validation criteria adopted by the consultants during the course of the investigation program and for the remediation and validation were based largely on the following guidelines:

- National Environment Protection Council (1999). National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM);
- NSW EPA (1994). Guidelines for Assessing Service Station Sites; and
- NSW EPA (2006). Guidelines for the NSW Site Auditor Scheme.

The soil investigation levels (SILs) selected for TPH by the consultants for comparison purposes were largely based on the threshold concentrations for hydrocarbons (NSW EPA, 1994) in sensitive land-uses, or sensitive site criteria (SSC).

Generally, the consultants adopted SILs based on the lower of the Column 1 (residential with accessible soils) (HILA) and Column 5 (PPIL) criteria. However, it is noted that in the original investigation SKM also adopted NEHF F (industrial/commercial) for the (then) operational depot with some buildings still being used for storage etc. The auditor also notes that earlier reports by ITE/Coffey adopted HILA without consideration for the provisional phyto-toxicity based investigation levels (i.e. the Column 5 PPILs in the Guidelines for the NSW Site Auditor Scheme, NSW EPA, 1998 and 2006) and EILs in the NEPM. Following auditor correspondence to address this issue, revised reports by ITE/Coffey (Addendum) as well as later works by URS and PB included PPILs in the selections of SILs and RAC for the site.

Despite the indication in the site history that Round-up is suspected to have been used on the site, the consultants did not specifically cite the Guidelines for Assessing Former Orchards and Market Gardens NSW DEC, 2005. In this regard it is noted that the Guidelines for Assessing Former Orchards and Market Gardens NSW DEC, 2005, as well as including OC and OP pesticides, also refer to synthetic pyrethroids and carbamates. However, it is further noted that the literature indicates that synthetic pyrethroids whilst chemically more stable than natural pyrethroids (sensitive to light, heat and moisture) will still degrade in direct sunlight fairly rapidly with the half lives being as little as a few hours (Gosselin, 1984)[4]. Similarly, carbamates are readily degraded by microorganisms in soil and by UV light, heat etc (Gray, 1971)[56].

The remediation acceptance criteria (RAC) adopted by PB were based on the lower of the Column 1 (residential with accessible soils) (HILA) and Column 5 (PPIL) criteria, and are listed in tables extracted from their report(s), included in summary tables provided in **Appendix F**. These criteria are considered appropriate.

For asbestos in soils there were no published or endorsed guidelines in NSW at the time of assessment and reporting. Guidelines published in May 2009 by Western Australian Department of Health provide an asbestos fibre criterion of <0.001% w/w for all site uses, however given that the validation works for soil were undertaken prior to 2009, these were not in place at the time of the works.

The groundwater investigation levels (GILs) adopted by PB were:

- Table 3.4.1 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (2000), hereinafter, ANZECC 2000 for the protection of 95% species (freshwater);
- Section 5 of the ANZECC 2000, Guidelines for recreational water quality and aesthetics;
- NSW DEC (2007) Guidelines for the Assessment and Remediation of Groundwater Contamination with regard to the presence of PSH (phase separated hydrocarbons); and
- USEPA Guideline for Drinking Water based on Taste for MBTE.

ERM (2006) adopted ANZECC 2000 and the Dutch Guideline for TPH and URS (2006) adopted ANZECC with no TPH guideline actually proposed.

The *Guidelines for the Assessment and Remediation of Groundwater Contamination* NSW DEC (2007) discusses the management objectives that should be implemented in areas of identified groundwater contamination. Section 3.5.1 of the guidelines discusses nonaqueous phase liquids and indicates that where PSH is present in the subsurface it must be removed or treated to the extent practicable.

Acid sulphate soils are not expected to be an issue on the site on the basis of the observed substrate conditions, geology, elevation and the location.

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[4] Gosselin, R.E. (1984). Chemical Toxicology of Commercial Products, Williams & Wilkins.
[5] WHO (1986). Carbamate pesticides: a general introduction (EHC 64, 1986).
[6] Gray, R.A. (1971). Behaviour, persistence, and degradation of carbamate and thiocarbamate herbicides in the environment. In: Proceedings of the California Weed Control Conference, 18-20 January 1971, Mountain View, California, Stauffer Western Research Centre, pp. 128-143.
Research Centre, pp. 128-143.

Auditor's Opinion

Ultimately for the purposes of site characterisation, remediation and validation of the SILs/RAC adopted by the consultants are generally in accordance with lowest value from Column 1 HILs and Column 5 PPILs from the Guidelines for the NSW Site Auditor Scheme. For TPH and BTEX, sensitive land use criteria from the Guidelines for Assessing Service Station Sites, NSW EPA, 1994 (NSW EPA, 1994) were adopted. These are considered appropriate for the site.

Groundwater criteria adopted are also considered appropriate for the site.

The auditor considers that acid sulphate soils are not likely to be an issue on this site.

4. Site Investigation

4.1 Overview of Testing

Investigations were undertaken in 2000 by SKM and an RAP was produced which formed the basis of the subsequent remediation works by ITE/Coffey in 2003-2006. The investigation by SKM included sampling of 61 boreholes (BH1-BH62) across the site to depths of 3 – 4 m. As groundwater was not intercepted, no groundwater wells were installed as part of the SKM investigation. Sample locations are shown in **Figure 5, Appendix A**. Soil samples were tested for heavy metals, OCP, BTEX, TPH, PAH and PCBs. An assessment of hazardous material was also undertaken by SKM with 5 samples analysed.

The first round of remediation works was undertaken by ITE/Coffey Environments which included removal of 10 tanks, bowsers and a separator, and validation sampling from 10 tank pits. Fifty-six (56) stockpiles of soil were landfarmed or disposed off-site. More information relating to the remediation works can be found in Section 5.2 – Site Remediation Works. During the IT/Coffey work, four groundwater wells (MW1-4) were installed and sampled. Sampling included 281 validation samples taken from ten (10) tank pits (plus an additional 56 QA/QC samples), 384 stockpile samples from fifty-six (56) stockpiles, 49 landfarm samples, 7 soil samples (plus 1 QA/QC sample) taken from three (3) boreholes, 17 imported fill samples and water samples were collected from two (2) test pits. Tank pit, groundwater well and stockpile locations are shown **Figures 6 - 8, Appendix A**. Samples were tested for a range of analytes, including TPH, BTEX, PAH, OCP, PCB and phenols.

In 2005-6 URS were employed to undertake a qualitative risk assessment of the remediation activities and also to undertake an independent review in relation to claims of dumping of "alleged toxic waste" along the eastern boundary of the site[7] and the potential for off-site impacts. As part of the work, URS excavated 18 test pits (TP01-TP18) and installed (3 groundwater wells MW101-103) along the southern site boundary and collection of 3 surface water samples SW01-SW03 from McBarron Creek. Sample locations are shown in **Figure 9, Appendix A**. Soil samples were tested for TPH, BTEX, PAH, phenols, PCBs and OCPs. Groundwater samples were tested for TPH/BTEX, PAH, phenols and

[7] The URS Report refers to the alleged toxic waste as the purpose for their Independent Review (April 2006). The report does not specify who is suspected to have dumped this waste, and there was no evidence of it found during the URS investigation.

dissolved heavy metals and volatile halogenated hydrocarbons (VHCs). Surface water samples were tested for TPH, BTEX, PAH, phenols, OCPs and PCBs.

In 2006, ERM were employed to undertake a risk assessment of the former creosote tank location (pit) to determine whether further remediation of the creosote pit was required and to evaluate whether contaminant migration was apparent downgradient of the excavation. ERM fieldwork included installation of three boreholes (MW201, MW202 and MW203) to depths of 13.8, 14.25 and 15.45 metres below ground level (m bgl) and installation and monitoring of 3 groundwater wells. Monitoring of MW4 was also undertaken as well as performing slug tests in groundwater wells to determine formation permeability. Fate and transport modelling to determine risk to groundwater receptors also formed part of the ERM works. The location of groundwater wells is shown on **Figure 10, Appendix A**. Samples were tested for TPH, BTEX, PAH and phenols.

In 2006 PB conducted a Phase 1 and 2 Investigation. Three (3) groundwater wells (MW05, MW06 and MW07) were installed up and down hydraulic gradient of MW01 in the vicinity of the former oil UST. Groundwater sampling was undertaken of the 9 onsite wells (MW1-3, MW5-7, MW101-103). Groundwater sampling of wells from the ERM study were not included in the PB sampling event (i.e. MW201-203 and MW4 not sampled). Ten soil bore locations were sampled as part of the investigation (BH62-BH68 and BH105-107. Sample locations are shown on **Figure 11, Appendix A**. Soil samples were analysed for TPH, BTEX, PAH, OCP, PCB and metals. Groundwater samples were tested for TPH, BTEX, metals, PAH, phenols and VHCs.

A pre-demolition hazardous building material survey was also undertaken by PB (March 2006) with samples taken of various materials and analysed for asbestos, lead based paint and synthetic mineral fibre (SMF).

In September 2006, PB carried out further groundwater investigation works to address the issue of phase separated hydrocarbons detected in some of the wells (MW01, MW05 and MW06) with apparent PSH thicknesses of 9 mm, 0.25 m and 0.8 m respectively, in the vicinity of the former underground waste oil storage tank and fuel tanks. Dissolved TPH also detected in MW07. PB installed 4 additional groundwater wells, MW08 to MW11, and conducted a Multi Phase Extraction (MPE) trial. The purpose of this work was to further delineate the PSH plume identified in June 2006 and to collect data during the MPE trial works. Gauging of groundwater wells was undertaken between April and December 2006.

More information relating to the MPE trials can be found in Section 5.2 – Site Remediation Works. The MPE trial was undertaken in July 2006 and MPE removal in September and December 2006.

In May 2007 eleven (11) new wells were installed by PB, including MW05A and MW09A to replace the monitoring wells that were demolished during the soil remediation works, and installation of new wells (MW12 to MW20) in the central tank pit area at the site. Well locations are shown on **Figure 12, Appendix A**.

From 21 to 24 April 2008, a four-day multi phase extraction and air treatment (MPEAT) event was conducted at the site by JFTA, under the supervision of PB. The event utilised a specialised vacuum truck and wellhead fittings to extract PSH, dissolved groundwater and soil vapour from 9 selected monitoring wells at the site (MW01, MW05A, MW06, MW10, MW11, MW15, MW16, MW18 and MW19). In addition, PB undertook both pre and post groundwater gauging and sampling rounds of all 18 existing monitoring wells on 16 April and 5 May 2008 respectively.

Between May 2009 and March 2010 PB undertook four quarterly groundwater monitoring rounds of the 18 existing wells on the site (MW01-MW03, MW05A, MW06, MW07, MW09A, MW10-MW20). Samples were analysed for TPH, MAHs, volatile organic compounds (VOCs) and methyl tertiary butyl ether (MTBE). Well locations are shown on **Figure 12, Appendix A**.

Details of further testing undertaken as part of the soil remediation works which were undertaken in the six defined areas of the site are discussed in **Section 5.2**.

Inspection and gauging of 18 (active) wells was undertaken by E2W in October 2010. Wells were inspected using an interface probe to determine the presence or absence of PSH and samples were taken for observation of PSH using bailers. Where located, a sample of PSH was collected (MW06) and sent to a NATA laboratory for analysis. Product recovery testing was performed at MW-06 on 5 October after detection of PSH. Approximately 20 L (water) was purged from the well using a bailer which included approximately 1 L of PSH. After 30 minutes the thickness of PSH was remeasured. Inspection of McBarron Creek was also undertaken by E2W.

Soil vapour wells were installed by E2W in October 2010 at 3 locations (SV1-SV3) with sets of nested wells (1.8 and 3.2 m depth) at each location. The location of soil vapour wells is shown on **Figure 13, Appendix A.** Soil vapour was sampled using 1 litre Summa canisters for petroleum hydrocarbons and field measurements of landfill gases were undertaken using a landfill gas meter. Soil vapour monitoring was undertaken by EnRiskS in November 2010. Soil vapour samples were collected into Summa canisters using mass controllers and sent to Air Toxics P/L for analysis. Leak tests were undertaken prior to sampling to determine the likelihood of ambient air entering the sampling line during sampling. EnRiskS concluded that helium leak rates for soil vapour locations met the relevant guidelines, which allow for a maximum helium concentration of 10% measured above the soil vapour location. The auditor notes the exceedances of the criteria in SV-3S (which was reportedly repaired). Wells were purged removing 3 volumes of air from the sampling line prior to sampling. Sampling conditions were recorded including Bureau of Meteorology data for the sampling date.

Additional monitoring of the 18 wells was undertaken by E2W in July 2011 as outlined in their SAQP dated June 2011, with the overall objectives being to collect additional data from the site to assess the groundwater plume characteristics, and to assess the potential for natural attenuation and associated remedial strategies for managing the residual contamination at the site. Works included inspection of the 18 wells for PSH, field chemistry and water sampling for TPH TPH/BTEX, total dissolved solids, major ions (chloride, sulphate, bicarbonate, magnesium, calcium, sodium, potassium) dissolved gases (H2S, CH4, CO2), nutrients (nitrate, nitrite, nitrogen, phosphorus, dissolved organic carbon) and heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, iron, ferrous iron). A product recovery test was performed on well MW-06 on (7 July 2011) due to the detection of the PSH (6.5 cm) (8 L) and short term pumping test and water level recovery monitoring (and purging) was undertaken of the 18 wells on 7 and 8 July 2011.

The bore logs and sample records provided by PB, URS, ERM and E2W provided sufficient information to broadly characterise the substrate conditions and were generally consistent with the anticipated geological conditions. Bore logs and monitoring well logs from the consultants reports are provided in **Appendix E.**

4.2 Adopted Sampling Pattern

SKM, ITE/Coffey, URS and PB combined judgmental and systematic sampling at the 5.9 hectare site. In total 61 boreholes (SKM), 10 tank pit locations (ITE), 4 bores converted to piezometers (ITE), 3 boreholes converted to piezometers (ERM), 18 test pits (URS) and 10 soil bores (PB) were sampled over the duration of the investigations (2003 – 2011). In total, this represents a total of 106 sample locations, which equates to a ratio of 18.4 points per hectare. The sample frequency specified in the *Sampling Design Guidelines* (NSW EPA, September 1995) for a site measuring 5 hectares is 55 locations, with a density of 11 points/hectare (63 sample locations for 5.7 hectare site). The total number of sample locations (106) is considered acceptable by the auditor for site characterisation purposes.

The sampling depths are recorded on the test pit and test bore logs included at **Appendix E.**

Eighteen groundwater and four soil vapour wells were installed during the various investigations between 2005 and 2011. This number of wells is considered appropriate for a site of this size and nature. Sampling undertaken by PB, E2W and EnRiskS is considered adequate to characterise the groundwater and plume characteristics and soil vapour in the vicinity of the plume.

Test locations are shown on **Figures 3 - 13, Appendix A**.

4.3 Results of Site Investigations

4.3.1 Soil Results

PID screening results were presented by PB, URS and ERM on test bore logs provided in **Appendix E**. SKM provided a table of results with the following exceedances of 100 ppm:

- TP24C – 245ppm
- TP52C – 160ppm
- TP53C – 160ppm

PID results from ITE/Coffey investigations ranged from 0 - 1354 ppm. The highest PID reading during the URS Investigation was 70 ppm with all other readings below 50 ppm. The highest PID reading recorded by ERM was 32.8 ppmV at borehole MW202 at 3.15 m bgl. PID results were below 50 ppm for all samples except MW6 at 2 m depth (553 ppm) and 2.5 m depth (1042 ppm). PID results are shown on the borelogs provided in **Appendix E**.

Summary tables showing analytical results of investigation are provided in **Appendix F**.

SKM (2000):

- SKM reported TPH, BTEX and PAH exceedances of the industrial commercial guidelines. Although these guidelines were relevant for the continued site use as a depot at the time, these were changed in later investigations to more sensitive criteria reflecting the likely future land-use of the site.

- Exceedances included:

  Creosote UST Area

  - BH9 (surface) PAH 616.5 mg/kg [20mg/kg], B(a)P 18 mg/kg [1 mg/kg]
  - BH10 (surface) B(a)P 2.1 mg/kg [1 mg/kg], TPH (C10-C36) 2315 mg/kg [1000 mg/kg]

  UST Fuel Storage Area

  - BH22 (1 – 2 m) TPH (C10-C36) 7060 mg/kg [1000 mg/kg]
  - BH24 (2 m) TPH (C10-C36) 1030 mg/kg [1000 mg/kg], toluene 1.5 mg/kg [1.4 mg/kg]
  - BH53 (2 m) benzene 35 mg/kg [1 mg/kg], toluene 213 mg/kg [1.4 mg/kg], ethylbenzene 68 mg/kg [3.1 mg/kg], xylenes 401 mg/kg [14 mg/kg], TPH (C6-C9) 722 mg/kg [65 mg/kg],
- Contamination was located in areas surrounding former underground storage facilities and the creosote UST.
- Aesthetic issues were noted by SKM and evidence of surface contamination was reported around the creosote tank and some staining of the concrete in the motor workshop.
- Asbestos was identified in fibro sheeting and amenity areas as well as training room and kitchen of Building D and lead paint on the exterior of Building D.

ITE/Coffey (2003-2007):

A summary of the exceedances of defined RAC for the site during the tank pit excavations and remediation works included:

- Tank pit 1 – PAH (maximum 42 mg/kg);
- Tank pit 2 – TPH (maximum C_{10}-C_{36} 9,300 mg/kg) and PAH (maximum 4,700 mg/kg);
- Tank pit 3 – TPH (maximum C_{10}-C_{36} 3,200 mg/kg) and PAH (maximum 27 mg/kg);
- Tank pit 4 – TPH (maximum C_6-C_9 390 mg/kg);
- Tank pit 5 - TPH (maximum C_6-C_9 1,000 mg/kg), benzene (maximum 3.8 mg/kg), toluene (maximum 44 mg/kg), ethyl benzene (maximum 66 mg/kg), total xylenes (maximum 289 mg/kg) and arsenic (maximum 23 mg/kg);
- Tank pit 6 – TPH (maximum C_{10}-C_{36} 5,400 mg/kg);
- Tank pit 7 – TPH (maximum C_6-C_9 4,600 mg/kg, C_{10}-C_{36} 2,170 mg/kg), benzene (maximum 67 mg/kg), toluene (maximum 680 mg/kg), ethyl benzene (maximum 190 mg/kg), total xylenes (maximum 1,230 mg/kg), PAH (maximum 40 mg/kg) – chased out, TPH (maximum C_6-C_9 1,400 mg/kg, benzene (maximum 12 mg/kg), toluene (maximum 170 mg/kg), ethyl benzene (maximum 56 mg/kg) and total xylenes (maximum 399 mg/kg);
- Tank pit 8 – PAH (maximum 93 mg/kg) and OCP (dieldrin 19 mg/kg);
- Tank pit 9 – TPH (maximum C_6-C_9 830 mg/kg), benzene (maximum 6.6 mg/kg), toluene (maximum 96 mg/kg), ethyl benzene (maximum 27 mg/kg) and total xylenes (maximum 138 mg/kg); and Tank pit 10 – TPH (maximum C_6-C_9 190 mg/kg, C_{10}-C_{36} 30,420 mg/kg), benzene (maximum 6.2 mg/kg), toluene (maximum 44 mg/kg), ethyl benzene (maximum 24 mg/kg), total

xylenes (maximum 118 mg/kg), PAH (maximum 14,000 mg/kg), B(a)P (maximum 68 mg/kg) and cadmium (maximum 16 mg/kg).

Summary tables of the tank pit validation and related results are provided in **Appendix F.** The summary table provided by Coffey contains the results compared to the correct SILs (i.e. the lower of HILA and PPIL whereas the original tables by ITE contained SILs (HILA only).

Results of stockpile and landfarm sampling as part of the ITE/Coffey works are provided in **Appendix F**. These were reviewed in detail at the time of the remediation works and were the subject of various correspondence provided in **Appendix C**. In summary, the following stockpiles were reportedly categorised according to the (then relevant) *NSW EPA Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes (NSW EPA, 1999)*:

- Hazardous Waste – part of SP17, SP26, SP2, SP33;
- Industrial Waste – part of SP17, SP26 , SP29, SP1, SP21, SP32, SP34, SP41, SP51;
- Solid Waste – SP17, SP26, SP3, SP12, SP13, SP28, SP30, SP36-40, SP43-47, SP50, SP52, SP55 and SP56; and
- Inert Waste – SP17, SP26, SP29, SP22, SP28, SP35, SP53.

The following stockpiles were validated for reuse on the site and were used to backfill excavations:

- SP4-11, 13-20, 23-25, DP27, SP31, SP42, SP48, SP49 and SP54.

URS (2006):

A total of 20 primary soil samples were analysed for PCB, OCP, Phenols, PAH, TPH and BTEX and were all below the limit of reporting (LOR) and SILs, the only exceedances were for:

- Asbestos in samples from MW103 located in the southern car park (0.2 - 0.4 m chrysotile asbestos cement and amosite fibres).

ERM (2006):

- Concentrations of TPH (C_6-C_{36}), BTEX, and phenols were reported as not detected above the laboratory EQL in the seven samples analysed;
- PAH constituent, Phenanthrene, was reported at a concentration of 0.5 mg/kg in sample S201 at 5.85 m bgl. Phenanthrene was reported at a concentration of 0.6 mg/kg in the duplicate sample collected at S202 (3.15 m bgl). Both concentrations were reported below the SIL [20 mg/kg];
- Total Organic Carbon (TOC) was reported as <0.1% in sample S203-13.2 m bgl (which was chosen to characterise TOC under ambient soil conditions).

PB (2006):

The soil samples taken from the 10 soil bores (shown on **Figure 14 in Appendix A**) were below the SILs for all analytes except:

- TPH C10-C36 in Sample SS01 (2940 mg/kg) [1000 mg/kg];
- Toluene in sample MW6/2.5 m) (2 mg/kg) [1.4 mg/kg];
- Cu in Sample SS01 (150 mg/kg) [100 mg/kg]; and
- Ni in Sample SS02 (61 mg/kg) [60 mg/kg].

Further investigation and remediation of soil at the site was undertaken as part of the 'Excavation and Backfill' remediation works at the site and is detailed in Section 5 of this SAR.

4.3.2 Groundwater & Soil Vapour Results

ITE/Coffey (2003-2007):

Groundwater results from the ITE/Coffey Investigation are provided in Table 3:

Table 3 – ITE Groundwater Results

Well	Diameter (mm)	Depth to water (m)	Total Depth (m)
MW1	50	8.560	17.090
MW2	50	4.237	9.959
MW3	50	3.700	16.405
MW4	50	12.600	17.015

Slug tests were conducted on these wells with results for hydraulic conductivity values of the sandstone aquifer in the range of 1.3×10^{-2} m/day to 1.978×10^{-4} m/day.

Results of groundwater sampling revealed the following exceedances (ITE 2005):

- MW1: High concentrations of TPH (C6-C9 (29,000 µg/L) and TPH C10-C36 (15,070 µg/L); Toluene (7,100 µg/L) and total xylenes (13,300 µg/L) exceeded GIL; Naphthalene (450 µg/L) and total PAH (460 µg/L), Cu 3µg/L exceeded GILs;
- MW2: Heavy metals – Cu (47 µg/L) Ni (45 µg/L) and Zn (293 µg/L);
- MW3: Total PAH (8 µg/L) Cu (5 µg/L) Ni (27 µg/L) and Zn (129 µg/L)exceeded GILs;
- MW4: Heavy metals – Ni (23 µg/L) and Zn (155 µg/L); and
- During the groundwater gauging and sampling, no measureable phase separated hydrocarbons (PSHs) or hydrocarbon sheen was detected by ITE.

URS (2006):

Groundwater results from the 3 wells tested were below the GILs except:

- MW01 – Cd (0.3 µg/L), Ni (49 µg/L) and Zn (39 µg/L);
- MW02 – Zn (29 µg/L);
- MW03 – Cd (0.2 µg/L), Cu (2 µg/L), Ni (45 µg/L) and Zn (44 µg/L);
- Low concentrations of TPH (C_{15}-C_{36} fraction) in groundwater were detected in MW101 and MW103 with a maximum concentration of 420 µg/L in MW101 and 310 µg/L in MW103;
- All surface water results were below LOR; and
- Phase separated hydrocarbons (PSH) was not detected during monitoring or sampling by URS.

ERM (2006):

ERM inferred groundwater flow was to the southwest (**Figure 10, Appendix A**). Groundwater results from the investigation were as follows:

- pH was found to range from 6.45 (MW201) to 6.80 (MW202);
- conductivity measurements ranged from 5360 µS/cm (MW202) to 8890 µS/cm (MW04);
- the temperature of the groundwater ranged between 21.2°C (MW203) and 22.2°C (MW04);
- dissolved oxygen concentrations ranged between 1.14 mg/L (MW203) and 2.47 mg/L (MW202); the Redox Potential of the groundwater ranged between 87 mV (MW202) and 125 mV (MW201).
- TPH (C15-C28) was reported in MW201 at a concentration of 280 µg/L and TPH (C29-C36) was reported at concentrations of 170 µg/L and 70 µg/L at MW201 and MW203, respectively. All other TPH sample results were reported as not detected above the laboratory EQL;
- toluene was reported in primary sample MW202 and its duplicate D-080306-1 at 11 µg/L and 11 µg/L, respectively. All other BTEX sample results were reported as not detected above the laboratory EQL;
- concentrations of PAHs and phenols were reported as Not Detected above the laboratory EQL in the five samples analysed;
- TOC was reported at concentrations between <0.1 mg/L and 5 mg/L in four wells; and
- No information is provided regarding the PSH noted during sampling. The use of low flow techniques would have affected the ability of ERM to sample PSH.

PB (2006):

PB groundwater contour plans are provided in **Figures 15 - 16, Appendix A**.

Groundwater results from the 10 groundwater wells sampled as part of the 2006 investigation by PB were below GILs except:

- MW01 - Cu (9 µg/L), Zn (40 µg/L) Pb (14 µg/L), TPH (C_{10}-C_{36}) (2500 µg/L), toluene (530 µg/L), ethylbenzene (570 µg/L), xylenes (2400 µg/L), PAH (85 µg/L);
- MW02 – Cd (0.3 µg/L), Cu (3 µg/L), Zn (50 µg/L), TPH (C_{10}-C_{36}) (1200 µg/L);
- MW03 – Cr (6 µg/L), Ni (30 µg/L), Zn (26 µg/L);
- MW05 – Ni (19 µg/L), Zn (23 µg/L), TPH (C_{10}-C_{36}) (34,070 µg/L), benzene (17,000 µg/L), toluene (30,000 µg/L), ethylbenzene (4,000 µg/L), xylenes (24,000 µg/L), naphthalene (950 µg/L), PAH (950 µg/L);
- MW06 – Zn (31 µg/L), Pb (5 µg/L), TPH (C_{10}-C_{36}) (100,521 µg/L), benzene (4,200 µg/L), toluene (23,000 µg/L), ethylbenzene (3,800 µg/L), xylenes (21,200 µg/L), PAH (2200 µg/L);
- MW07 – Ni (28 µg/L), Zn (27 µg/L);
- MW101– Ni (17 µg/L), Zn (33 µg/L);
- MW102 – Zn (20 µg/L); and
- MW103 – Ni (21 µg/L), Zn (31 µg/L).

Results are shown in **Figure 17, Appendix A**. PSH were identified in MW1, MW5 and MW6 with apparent thicknesses of 0.009m, 0.25m and0.8 m. The PSH was identified as petrol. Groundwater contaminants identified in wells containing PSH include elevated levels of TPH, BTEX, PAHs (speciated and totals), heavy metal Pb and total phenols.

Results for the next monitoring of piezometers MW8-MW11 undertaken in July 2006 included the following exceedances:

- MW09 – TPH(C_6-C_9) (2,300µg/L), toluene (1000 µg/L)
- MW10 - TPH(C_6-C_9) (18000 µg/L), TPH (C_{10}-C_{36}) (1937 µg/L), benzene (4800 µg/L), toluene (9,100 µg/L), ethylbenzene (610 µg/L), total xylenes (3,800 µg/L);
- MW11 - TPH (C_6-C_9) (35,000 µg/L), TPH (C_{10}-C_{36}) (9,051 µg/L), benzene (4,800 µg/L), toluene (15,000 µg/L), ethyl benzene (2,000 µg/L), total xylenes (12,700 µg/L), naphthalene (350 µg/L); and
- PSH was not encountered in these 4 wells during this sampling event.

An MPE trial event was undertaken in mid July 2006 following installation of the new groundwater monitoring wells (MW08 to MW11). The outcome of the trial was the removal of the following estimated volumes of contaminants from the site:

- 0.8 kg of hydrocarbon (as vapour); and
- 1,200 L Liquid (PSH and dissolved phase TPH in groundwater).

Groundwater gauging data from April to November 2006 is provided in **Appendix F**. The consultants suggested that PSH was most notable during the summer months (in groundwater wells MW1, MW5 and MW6) and less notable in winter. Periodically approximately 20 L of PSH was removed during groundwater gauging events from April to August 2006. The groundwater wells showed an instantaneous decline in product thickness following initial removal and in most cases did not support more than one PSH removal event per gauging event.

Sampling of the wells (including replacement wells MW05A and MW09A, and new wells MW12 – MW20) was undertaken in June 2007 by PB. As in previous rounds of well gauging, PSH were measured from MW01, MW05 and MW06. Nine of the eighteen (18) wells showed impacts from dissolved petroleum hydrocarbons as follows:

- MW01 - TPH (C_6-C_9) (15,100 µg/L), toluene (706 µg/L), ethylbenzene (421 µg/L), xylenes (2,052 g/L), naphthalene (63.9 µg/L);
- MW03 – Pb (9 µg/L), TPH (C_{10}-C_{36}) (800 µg/L);
- MW05A – TPH (C_6-C_9) (17,200 µg/L), TPH (C_{10}-C_{36}) (950 µg/L), benzene (3,010 µg/L), toluene (988 µg/L), ethylbenzene (285 µg/L), phenols (2.4 µg/L);
- MW06 – TPH (C_6-C_9) (29,200 µg/L), TPH (C_{10}-C_{36}) (97,570 µg/L), benzene (3,270 µg/L), toluene (10,700 µg/L), ethylbenzene (2,360 µg/L), xylenes (8,200 µg/L), naphthalene (983 µg/L), PAH (1000 µg/L);
- MW09A – TPH C_6-C_9) (4,080 µg/L), TPH (C_{10}-C_{36}) (610 µg/L), benzene (1,400 µg/L), toluene (1,930 µg/L), ethylbenzene (89 µg/L);
- MW10 - TPH(C_6-C_9) (56,000µg/L), TPH (C_{10}-C_{36}) (29,540 µg/L), benzene (9,860 µg/L), toluene (22,300 µg/L), ethylbenzene (3,270 µg/L), total xylenes (16,570 µg/L), naphthalene (544 µg/L), PAH (547 µg/L);
- MW11- TPH(C_6-C_9) (5,550 µg/L), TPH (C_{10}-C_{36}) (2,040 µg/L), benzene (2,340 µg/L), toluene (517 µg/L), ethylbenzene (149 µg/L), total xylenes (795 µg/L), naphthalene (21.6 µg/L), phenols (16.3 µg/L);
- MW14 – Pb (8 µg/L);
- MW15 – Pb (12 µg/L), TPH(C_6-C_9) (11,700 µg/L), TPH (C_{10}-C_{36}) (4,890 µg/L), benzene (994 µg/L), toluene (4,770 µg/L), ethylbenzene (514 µg/L), xylenes (3,028 µg/L), naphthalene (68.1 µg/L);
- MW16 – Pb (10 µg/L);
- MW17 – Pb (35 µg/L);
- MW18 - TPH(C_6-C_9) (18,600 µg/L), TPH (C_{10}-C_{36}) (4,280 µg/L), benzene (3,410 µg/L), toluene (3,810 µg/L), ethylbenzene (518 µg/L), xylenes (1,809 µg/L), naphthalene (86.1 µg/L), phenols (10.8 µg/L); and
- MW19– Pb (6 µg/L), TPH(C_6-C_9) (14,700 µg/L), TPH (C_{10}-C_{36}) (760 µg/L), benzene (2,480 µg/L), toluene (3,480 µg/L), ethylbenzene (137 µg/L); phenols (46.6 µg/L).

[Tables containing adopted GILs are provided in **Appendix E].**

Results from November 2007 and December 2008 are shown in **Figure 18, Appendix A** and provided in **Appendix H**. Nine monitoring wells (MW01, MW05A, MW06, MW10, MW11, MW15, MW16, MW18 and MW19) were selected for PSH, dissolved groundwater and soil vapour extraction. A summary of the MPEAT event is provided in Table 4.

	Duration of MPVE Day 1 (21/04/2008)	Duration of MPVE Day 2 (22/04/2008)	Duration of MPVE Day 3 (23/04/2008)	Duration of MPVE Day 4 (24/04/2008)
MW01	100 minutes	-	490 minutes	440 minutes
MW05A	-	60 minutes	-	-
MW06	70 minutes	-	125 minutes	440 minutes
MW10	-	380 minutes	-	-
MW11	90 minutes	-	-	-
MW15	100 minutes	-	365 minutes	-
MW16	-	-	-	-
MW18	-	80 minutes	-	-
MW19	-	100 minutes	-	-

Table 4 – MPEAT Extraction Details

Summary tables were provided of the pre-MPEAT and post-MPEAT event and are shown as Tables 5 and 6 herein, respectively.

Table 5 – Sample Results Pre MPEAT Event

No. of primary samples	Analyte	Min. Conc. (µg/L)	Max. Conc. (µg/L)	Sample locations exceeding investigation levels
Total petroleum hydrocarbons				
18	TPH C_6–C_9	nd	72,000	-
18	TPH C_{10}-C_{36}	nd	13,340	-
Monocyclic aromatic hydrocarbons				
18	Benzene	nd	17,000	MW01, MW05A, MW06, MW10, MW11, MW15, MW18
18	Toluene	nd	43,000	MW01, MW06, MW10, MW11, MW14, MW15, MW18
18	Ethyl benzene	nd	4,100	MW01, MW05A, MW06, MW10, MW11, MW15, MW18
18	m&p-xylene	nd	15,000	MW01, MW06, MW10, MW11, MW14, MW15, MW18
18	o-xylene	nd	5,900	MW06, MW10, MW11, MW15

nd – not detected

Table 6 – Sample Results Post MPEAT Event

No. of primary samples	Analyte	Min. Conc. (µg/L)	Max. Conc. (µg/L)	Sample locations exceeding investigation levels
Total petroleum hydrocarbons				
18	TPH C_6–C_9	nd	62,000#	-
18	TPH C_{10}-C_{36}	nd	17,720*	-
Monocyclic aromatic hydrocarbons				
18	Benzene	nd	15,000#	MW05A, MW06, MW10, MW11, MW15, MW18
18	Toluene	nd	40,000#	MW05A, MW06, MW09A, MW10, MW11, MW14, MW15, MW18, MW19
18	Ethyl benzene	nd	5,900*	MW05A, MW06, MW10, MW11, MW14, MW15, MW18
18	m&p-xylene	nd	14,000#	MW05A, MW06, MW10, MW11, MW14, MW15, MW18, MW19
18	o-xylene	nd	8,800*	MW06, MW10, MW11, MW15, MW18

nd – not detected

* indicates increase in maximum concentration of contaminant since previous sampling and gauging round.

\# indicates decrease in maximum concentration of contaminant since previous sampling and gauging round.

The results of PSH measurements undertaken between April and May 2008 indicated that PSH was present in MW06 and MW15, with no PSH being detected in MW01 or MW05A. Following the MPEAT event, no PSH was observed in any of the wells although this could be due to slow PSH movement (and hence recovery in wells) through the sandstone bedrock. PB provided the following summary of the results from this event:

‘Based on the conclusions of this investigation, PB recommends the following:

- *The MPEAT event appears to have been successful at reducing PSH thicknesses in groundwater beneath the site, however it is considered that the non detect levels of PSH in the post MPEAT gauging event may be due to slow movement of PSH through the sandstone bedrock at the site. Further monitoring of PSH is recommended to determine if PSH levels recover or remain at zero.*
- *The MPEAT event appears to have had little influence on dissolved phase hydrocarbon concentrations in the groundwater. Further MPEAT events are recommended, however, it may be necessary to install dedicated extraction wells in areas ideally located to target contamination. Dedicated extraction wells would feature larger diameters, larger slots and screening well above the saturated level to allow for more efficient removal of impacted groundwater and vapour.’*

Quarterly monitoring of the eighteen groundwater wells was undertaken by PB during the period from May 2009 to March 2010 with the following summary of results as shown in Table 7 (see also **Figures 19 - 24, Appendix A**).

Table 7 – PB Groundwater Results - May 2009 to March 2010

Analyte	Month/Year	Number of samples analysed	Min. Conc. (µg/L)	Max. Conc. (µg/L)	Sample locations exceeding investigation levels
Total petroleum hydrocarbons (TPH)					
TPH C_6-C_9	May 2009	18	nd	330,000	-
	August 2009	18	nd	55,000	-
	December 2009	18	nd	66,000	-
	March 2010	18	nd	46,000	-
TPH C_{10}-C_{36}	May 2009	18	nd	7,210	-
	August 2009	18	nd	9,340	-
	December 2009	18	nd	12,600	-
	March 2010	18	nd	10,330	-
Monocyclic petroleum hydrocarbons (MAHs)					
Benzene	May 2009	18	nd	72,000	MW01, MW05A, MW06, MW09A, MW10, MW11, MW14, MW15, MW18, MW19
	August 2009	18	nd	18,000	MW01, MW05A, MW06, MW10, MW11, MW14, MW15, MW18, MW19
	December 2009	18	nd	20,000	MW01, MW05A, MW06, MW10, MW11, MW14, MW15, MW18, MW19
	March 2010	18	nd	18,000	MW01, MW05A, MW06, MW09A, MW10, MW11, MW14, MW15, MW18
Toluene	May 2009	18	nd	130,000	MW01, MW05A, MW06, MW10, MW11, MW15, MW18
	August 2009	18	nd	21,000	MW05A, MW06, MW10, MW11, MW15
	December 2009	18	nd	22,000	MW05A, MW06, MW10, MW11, MW15, MW18
	March 2010	18	nd	18,000	MW01, MW05A, MW06, MW10, MW11, MW15, MW18
Ethyl benzene	May 2009	18	nd	28,000	MW01, MW05A, MW06, MW10, MW11, MW14, MW15
	August 2009	18	nd	2,500	MW01, MW05A, MW06, MW10, MW11, MW14, MW15, MW18
	December 2009	18	nd	2,600	MW01, MW05A, MW06, MW10, MW11, MW15, MW19
	March 2010	18	nd	2,700	MW01, MW05A, MW06, MW10, MW11, MW14, MW15, MW18

Analyte	Month/Year	Number of samples analysed	Min. Conc. (µg/L)	Max. Conc. (µg/L)	Sample locations exceeding investigation levels
m&p-xylene	May 2009	18	nd	78,000	MW01, MW05A, MW06, MW10, MW11, MW14, MW15
	August 2009	18	nd	8,800	MW01, MW05A, MW06, MW10, MW11, MW14, MW15
	December 2009	18	nd	7,800	MW05A, MW06, MW10, MW11, MW14, MW15
	March 2010	18	nd	9,200	MW01, MW05A, MW06, MW10, MW11, MW14, MW15, MW18
o-xylene	May 2009	18	nd	42,000	MW05A, MW06, MW10, MW11, MW15
	August 2009	18	nd	3,400	MW05A, MW06, MW10, MW11, MW15
	December 2009	18	nd	6,900	MW05A, MW06, MW10, MW11, MW15
	March 2010	18	nd	4,300	MW05A, MW06, MW10, MW11, MW15

nd – not detected

PB provided the following summary of the results:

- *'Groundwater elevations have generally remained steady over the four rounds with levels generally ranging from a minimum of 67.75 to 68.08 mAHD in MW06 to a maximum of 73.29 to 73.44 mAHD in MW12. The exception to this was the fourth round, undertaken in March 2010, where the lowest level was reported in monitoring well location MW03, at 67.11 mAHD. Groundwater flow was inferred to be to the west and south west towards McBarron Creek, confirming results of previous investigations.*
- *No PSH was detected in any of the wells during any of the four quarterly monitoring rounds using the interface probe, however PSH was observed during the fourth round (March 2010) in bailers collected from MW06 and MW15 following the gauging. PSH in bailers indicated thicknesses of*

0.010 m and 0.004 m in MW06 and MW15 respectively. No PSH had been observed at the site previously since April 2008, when PSH was also detected in MW06 and MW15.

- *A review of laboratory results for TPH and MAHs over time indicated that the highest impacted areas have generally remained consistent over the course of the quarterly monitoring rounds, and over the course of several years, with a degree of fluctuations in the levels of the contaminants detected.'*

E2W (2010 and 2011):

E2W PID results ranged from 0 to 875 ppm with highest readings in MW06, MW11 and MW15 in the central part of the site. Groundwater gauging results revealed PSH in MW06. A sample of PSH was taken from MW06 and analysed by gas chromatography. PSH removal was undertaken by E2W following identification of 0.175m thickness of PSH in MW6. Laboratory analysis of this product revealed the presence of petrol. Approximately 20 L of liquid containing 1L of PSH was removed (purged) and the residual thickness of 0.006 m was reported 3 days later. E2W concluded that PSH removal at MW06 by E2W indicated low recoverability within the shale/sandstone bedrock. Rebound of PSH is expected to occur over time due to the sorption of hydrocarbons onto the bedrock matrix and water level fluctuations. The PSH collected from MW06 in October 2010 was identified as petrol by ALS (qualitative assessment of the chromatogram).

E2W inspected McBarron Creek on 5 October 2010 and indicated the following:

- *Upgradient of Site: McBarron Creek was dry at intersection with Townson Avenue.*
- *Downgradient of Site: McBarron Creek was flowing (~1 L/sec) at the intersection with Pembroke Road. Based on creek flow, depth to groundwater and elevations of the creek invert (~5m lower than the site) E2W interpret that the creek is likely to receive groundwater (as baseflow) from the site. A detailed survey of the creek and water levels (including MW-02) is required to support this preliminary interpretation by E2W. It is noted that McBarron Creek is likely to represent a losing (upgradient) and gaining creek (downgradient). The creek is likely to minimise migration of polluted water and vapour to the residential area south of the creek (i.e. creek is interpreted to receive the polluted groundwater and divert/dilute with the surface water system)*

Soil vapour analysis was undertaken on the six (6) samples for COC including benzene, naphthalene, hexane, heptane, cyclohexane, 2,2,4-trimethypentane, MTBE and TPH. Soil vapour results were presented in the report for use in the HHRA. No criteria are presented in the report by E2W for comparison purposes. Results in the vapour wells are provided in **Appendix F**. The ranges for the analytes are summarised below:

- Benzene <LOR to 10,000 µg/m^3;
- Hexane <LOR to 63,000 µg/m^3;
- Heptane <LOR to 6800 µg/m^3;
- Cyclohehane <LOR to 16,000 µg/m^3;
- 2,2,8-trimethylpentane <LOR to 120,000 µg/m^3;
- Acetone <LOR to 110 µg/m^3;
- Carbon disulphide <LOR to 67 µg/m^3;
- Methylene chloride <LOR to 87 µg/m^3;
- Chloroform <LOR to 6.8 µg/m^3;
- 2-butanone (MEK) <LOR to 5.8 µg/m^3;
- MTBE <LOR to 16,000 µg/m^3;

- Ethanol <LOR to 76 µg/m^3;
- TPH C2-C4 21 to 354260 µg/m^3;
- TPH C5 83 to 1829570 µg/m^3;
- TPH C6 <LOR to 599,140 µg/m^3;
- TPH C7 <LOR to 696,690 µg/m^3;
- TPH C8 <LOR to 70,070 µg/m^3;
- TPH C10 <LOR to 700 µg/m^3;
- TPH C11 <LOR to 830 µg/m^3; and.
- TPH C12+ <LOR to 1180 µg/m^3

Results for groundwater sampling and monitoring undertaken in November 2011 by E2W are provided in **Appendix F**. The following summary was provided by E2W in the MNA report:

Nutrients

- Ammonia concentrations in all groundwater samples were below LOR (level of reporting, <0.1 mg/L) except for MW-11 (0.01 mg/L) which is below ANZECC (2000) guidelines (0.9 mg/L);
- Nitrate concentrations were below the LOR and ANZECC (0.7 mg/l) at all locations except for MW-13 (0.02 mg/L) MW-19 (0.06 mg/L) ;

Total phosphorus levels were below LOR and ANZECC guidelines (ANZECC 2000, 0.05 mg/L) at all sample locations, except for two TPH impacted wells [MW10 (0.22 mg/L) and MW-11 (0.14 mg/L)] ;

Heavy Metals:

- Arsenic concentrations were reported below ANZECC 2000 guidelines (0.013 mg/L) at all locations, except at MW-16 (0.048 mg/L) ;
- Cadmium concentrations were reported below the LOR at all sample locations, except at MW-02 (0.0006 mg/L), MW-07 (0.0004 mg/L), and MW-13 (0.0003 mg/L) where the ANZECC 2000 guidelines (0.0002 mg/L) are also exceeded;
- Chromium concentrations were reported below the LOR (<0.001 to <0.005 mg/L variable LOR) and below ANZECC 2000 guidelines (0.01 mg/L) at all locations;
- Copper concentrations ranged from <0.001 to 0.016 mg/L (MW-16 and MW-14, respectively). Concentrations exceeded ANZECC 2000 guidelines (0.0014 mg/L) at thirteen locations (MW-01, MW-02, MW-5A, MW-06, MW-07, MW-9A, MW-10, MW-12, MW-13, MW-14, MW-18, MW-19, MW-20) indicating naturally elevated background concentrations across the whole site in the bedrock;
- Manganese concentrations were reported above ANZECC 2000 guidelines (1.9 mg/L) at 8 sample locations, with concentrations ranging from 0.14 to 3.6 mg/L (MW-12 and MW-02, respectively) ;
- Lead concentrations ranged from the LOR (<0.01) to 0.01 mg/L with the ANZECC 2000 guidelines (0.0034 mg/L) exceeded only at one well (MW-06) ;
- Nickel concentrations were below the LOR at all sample locations, except at MW-01 (0.001 mg/L), MW-06 (0.01 mg/L), and MW-15 (0.002 mg/L) which were below ANZECC 2000 guidelines (0.011 mg/L) ;
- Zinc concentrations exceeded ANZECC 2000 guidelines (0.008 mg/L) at eleven wells (MW- 01, MW-02, MW-03, MW-5A, MW-07, MW-9A, MW-12, MW-16, MW-17, MW-19 andMW-20). Zinc

concentrations ranged from 0.008 to 0.049 mg/L (MW-02/MW-12 and MW-20, respectively) indicating that the lithology (clay/sandstone) is a likely source of zinc in the groundwater;

- Iron concentrations ranged from the LOR (<0.05) to 12.7 mg/L (MW-07/MW-12/MW-13 and MW-01, respectively). Iron exceeded the ANZECC 2000 guidelines (0.3 mg/L) at fifteen locations (MW-01, MW-02, MW-03, MW-5A, MW-06, MW-9A, MW-10, MW-11, MW-14, MW-15, MW-16, MW-17, MW-18, MW-19, MW-20) indicating that the lithology (clay/sandstone) is a likely source of iron (& ferrous iron) in the groundwater;
- Ferrous iron concentrations ranged from the LOR (<0.05) to 13.7 mg/L (MW-07/MW- 12/MW-13 and MW-01, respectively). Concentrations exceeded the ANZECC 2000 guidelines (0.3 mg/L) at fifteen locations (MW-01, MW-02, MW-03, MW-5A, MW-06, MW- 9A, MW-10, MW-11, MW-14, MW-15, MW-16, MW-17, MW-18, MW-19, MW-20). ; and
- Mercury concentrations were below the LOR at all sample locations, except at (MW-01 , MW-10, MW-11, MW-15, MW-16) which ranged between 0.0001 and 0.0002 mg/L and were below ANZECC 2000 guidelines (0.0006 mg/L).

E2W provided a summary table of BTEX/TPH results as reproduced in Table 8.

Table 8 – Groundwater Results E2W (2011)

Analyte	Guidelines (ug/L)	Minimum (ug/L)	Maximum (ug/L)	Exceedances
BTEX				
Benzene	950/300	<1 (MW-2, MW-3, MW-12, MW-13, MW-17)	6670 (MW-18)	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-15, MW-18
Toluene	300	<5 (MW-2, MW-3, MW-07, MW-9A, MW-12, MW-13, MW-16, MW-17, MW-19, MW-20)	11200 (MW-15)	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-15
Ethylbenzene	140	<2 (MW-2, MW-3, MW-07, MW-9A, MW-12, MW-13, MW-16, MW-17, MW-19, MW-20)	1670 (MW-15)	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-15, MW-18
Meta & para-xylene	380	<2 (MW-2, MW-3, MW-9A, MW-12, MW-13, MW-16, MW-17, MW-19, MW-20)	6430 (MW-01)	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-15
Ortho-xylene		<2 (MW-2, MW-3, MW-07, MW-9A, MW-12, MW-13, MW-16, MW-17, MW-19, MW-20)	2270 (MW-01)	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-15

TPH (C6-C36)				
C_6-C_9	600	<20 (MW-2, MW-3, MW-12, MW-13, MW-17)	34800 (MW-15)	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-14, MW-15, MW-18, MW-20
C_{10}-C_{14}	-	<50 (MW-07, MW-12, MW-13, MW-16, MW-17, MW-19, MW-20)	25700 (MW-06)	-
C_{15}-C_{28}	-	<100 (MW-3, MW-07, MW-9A, MW-12, MW-13, MW-14, MW-16, MW-17, MW-19, MW-20)	830 (MW-06)	-
C_{29}-C_{36}	-	<50 (ALL except MW-02)	180 (MW-02)	-
C_{10}-$C_{36\ (sum)}$	600	<50 (MW-3, MW-07, MW-12, MW-13, MW-16, MW-17, MW-19, MW-20)	26500	MW-01, MW-5A, MW-06, MW-10, MW-11, MW-15, MW-18

Note: Guidelines sourced from ANZECC (2000) and NSW EPA Guidelines for Assessing Service Stations Sites (1994, respectively. E.g.[sic] *950/300 ug/L for Benzene). Dutch guidelines adopted for TPH (600 ug/L).*

The results provide useful information regarding the location of contaminants and inputs used in the model for MNA undertaken by E2W. More information is provided in **Appendix H** and **Section 4.3.3.**

4.3.3 Phase Separated Hydrocarbons

A summary of results of measurements of PSH was compiled by the auditor for the following data sets:

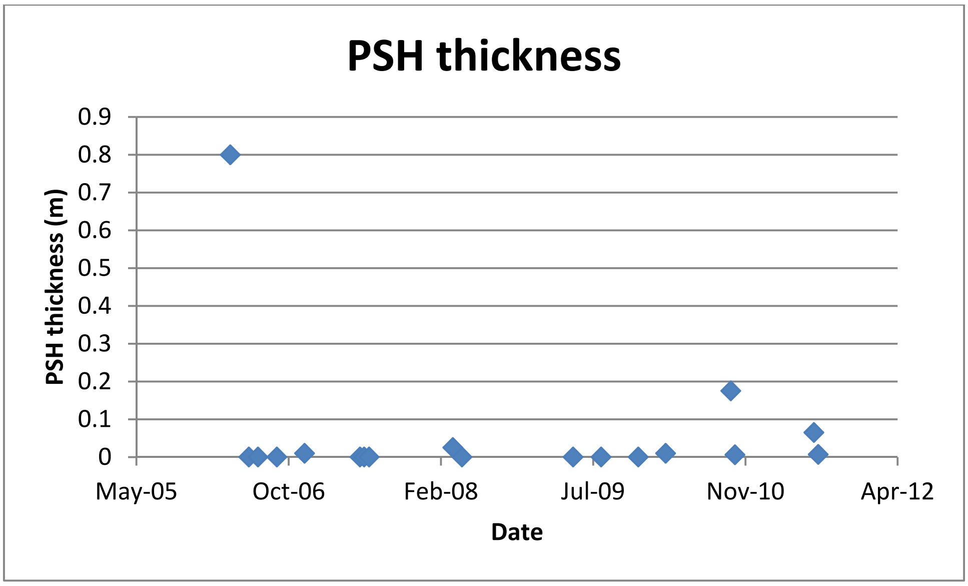
- PB - PSH monitoring (bailer)
  - April 2006 – 0.8 m;
  - June 2006 – 0.579 m;
  - July (product removal) residual PSH – 0.01 m;

- o Sept 2006 – none;
- o Dec 2006 – 0.01 m;
- o June 2007 – 0.19 m;
- o June 2007 (following product removal) residual PSH – 0.01 m;
- o July 2007 – 0.012 m;
- o April 2008 – PSH was identified PSH thicknesses of 0.001 m in interface probe and PSH thickness in bailer of 0.025 m;
- o May 2008 (following MPEAT event) – no PSH;
- o May 2009 – no PSH by interface probe or bailer;
- o August 2009 – no PSH by interface probe or bailer;
- o December 2009 – no PSH by interface probe or bailer; and
- o March 2010 – 0.01 m by bailer.

- E2W (2010) – interface probe no PSH, bailer 0.175 – removal, residual 0.006 m
- E2W (2011) – no interface probe – bailer only, bailer 0.065 m removal, residual 0.007 m

The results are shown in Chart 1 developed by the auditor.

Chart 1 – PSH thickness in sampling events from 2006 - 2011



The results are primarily based on the results of measurements taken of PSH thickness in the bailer. In the majority of the fieldwork the PSH was not detected using the interface probe but rather when the visual check was undertaken using the bailer and tape measure. For this reason the consultants have commented that the PSH is *'very thin/absent (actual) PSH layer'* as the visual PSH is likely to be an oily water mixed layer containing petrol rather that an actual PSH layer. The auditor considers this to be a reasonable observation based on the data provided.[8]

4.3.4 Monitoring of Natural Attenuation and Groundwater Modelling

The monitored natural attenuation assessment was undertaken on the groundwater results for TPH/BTEX and biological indicators to show the hydrocarbon plume and distribution of MNA parameters such as dissolved oxygen, sulphate/H2S and total CO2/methane. E2W concluded that:

- *'The groundwater plume is associated with depleted dissolved oxygen and sulphate concentrations. Elevated concentrations of H2S are associated with the groundwater plume core and likely to arise from sulphate reduction.*[sic]
- *Elevated concentrations of methane are associated with the groundwater plume and relate to methanogenic processes.'*

Results of the analyses are provided in **Appendix H**.

Plume stability was analysed using graphical interpretation of results. E2W provided the following summary of the results:

'In summary, the TPH plume is interpreted to be stable with shrinkage occurring in most areas. Some potential (but minor) plume variation may exist on the east/upgradient side (MW-01), however is likely to be minor given that it is against the hydraulic gradient. The variable TPH trends on the east/upgradient side (MW-01) may relate to dispersion in the bedrock aquifer or source contamination. It is noted that the status (expanding/contraction) of the plume on the upgradient/east side (e.g. MW-1, MW-14 and MW-15) has been assessed using data from the previous (now decommissioned) monitoring wells (i.e. MW201, MW202, M203) which were installed by ERM in 2006. These monitoring wells were installed as part of the creosote pit investigations and indicated either low (TPH <0.5 mg/L) or absent TPH in the east/hydraulically upgradient area (~50 to 100 m distance).'

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[8] The presence of PSH represents a trigger for notification of the site to EPA under Section 60 of the CLMA and as outlined in the Section 2.3.4 of the NSW EPA (then DECC) (June 2009) *Guidelines on the Duty to Report Contamination under the CLMA 1997* and under Section 3.1, DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination.* Endeavour Energy notified EPA of the groundwater contamination issue at the site and EPA are understood to have determined that formal regulation will not be required under the Contaminated Land Management Act 1997 (See correspondence from EPA dated 9 February 2012 in Appendix C), although formal notification to this effect has not been made at the time of writing. Personal communication between the auditor and EPA staff has also indicated that regulation under the Contamination Land Management Act is not likely.

Modelling was undertaken by E2W using Bioscreen to perform fate and transport modelling and demonstrate the MNA process. Model parameters and outputs of Bioscreen Model are provided in **Appendix F**. A number of scenarios were considered including:

- C1 – high flow rate with natural attenuation;
- C2 – average parameters;
- C3 – average parameters but with lower sulphate; and
- C4 – single plume and high flow.

E2W provided the following conclusions based on the Bioscreen modelling:

'Given the age of the former fuel infrastructure (1970s to 2003) and associated soil impact, the current plume shape is likely to reflect merging/overlapping of contamination plumes (under 4 USTs/bowsers, Appendix E). The scale of plume migration from under the former fuel infrastructure is considered small (< 20 m) due to the low permeability of the bedrock and demonstrated natural attenuation.

The groundwater contamination (petrol impact- dissolved phase BTEX) indicates that Bioscreen (2D analytical model) is a suitable fate and transport modelling tool for the Minto site. Based on the groundwater modelling utilising likely and conservative scenarios (C 1 to 4), the current plume extent is considered to have stabilised and undergoing shrinkage/contraction due to natural attenuation (sulphate reduction and source decay processes). The plume is predicted to shrink after approximately 15 to 25 years, and more substantially after 40 years (approximately > 5 years from date).

The modelling shows that various plume migration extents can be created from conservative parameters (mass of soluble product in aquifer, dispersion), however it is clear that the elevated sulphate in the aquifer provides a sound buffer to the slow plume migration and moderate changes in model parameters (soluble product mass in aquifer, Koc and aquifer properties). The risk for the plume to migrate to the offsite area (creek) is considered low. This interpretation (plume stability/shrinkage) is supported by the available long term monitoring data and time series trends for the site.

The available monitoring data (2005 to date) by previous consultants and E2W supports the model predictions and recommendation for adopting MNA as the preferred remedial approach for the site (not requiring enhancement due to the favourable hydrochemistry).'

The auditor conducted a review of the MNA report with reference to *Appendix 3 – MNA Checklist - Guidelines for the Assessment and Management of Groundwater Contamination* (NSW EPA, 2007). A summary is provided in Table 9.

Table 9 - MNA checklist

MNA Requirement	Comment Y/N
Has the site been adequately characterised in relation to stratigraphy, lithology, structure, water-bearing zones, groundwater flows, solute transport, lateral and vertical hydraulic gradients, hydraulic conductivities and porosities?	Y
Has the site been adequately characterised in relation to geochemical conditions, including salinity, temperature, pH, redox potential, organic carbon sources, nutrient availability, sorption capacity and the availability of electron donors and acceptors?	Y
Have all contaminants of potential concern been identified?	Y
Has the toxicity of the contaminants of concern been adequately assessed?	Y
Has the plume been fully delineated for all contaminants of concern?	Y
Have all potential receptors been identified?	Y
Have all potential beneficial uses and environmental values of the groundwater been identified?	Y
Are proposals to remove or control primary sources (e.g. leaking infrastructure) and secondary sources (e.g. residual NAPL, adsorbed phase) adequate and feasible?	Y
Is the proposed attenuation mechanism feasible for all the contaminants of concern under the conditions prevailing at the site?	Y
Do the natural attenuation processes include processes that reduce the dissolved mass of the contaminants of concern?	Y
Are there condition conflicts among multiple contaminants of concern?	Y
Have the toxicity and fate of all potential degradation products been considered?	Y
Will attenuation to acceptable concentrations be achieved well before potential human or ecological receptors could be impacted on?	Y
Have all feasible alternative remedial options been considered?	Y – see section 5.2.2 of this SAR
Will the remediation goals be reached within a timeframe that is reasonable compared with other remedial options, and community expectations?	Section 5.2.2 of this SAR
Is monitored natural attenuation sustainable, considering proposed source control measures and redevelopment of the site and surrounding area?	Y – see section 5.2.2 of this SAR
Are there financial mechanisms in place to ensure that monitoring can be continued for the required period?	Ongoing monitoring not recommended by consultants (see Section 5.2.2, 5.4.2 and 5.4.3) Previous monitoring was

MNA Requirement	Comment Y/N
	considered sufficient and satisfactory to demonstrate MNA had been achieved.
Have adequate contingency measures been proposed?	Y

Auditor's Opinion

Assessment of the site was undertaken by SKM in 2000 prior to remediation works between 2003 and 2005 by ITE/Coffey. Further assessment was undertaken by ITE/Coffey, URS, PB and ERM between 2006 and 2007. Groundwater investigation was undertaken in the subsequent years by PB and E2W. Risk assessments were undertaken by ERM in 2006 and EnRiskS in 2011. A number of testing programs of increasing focus and intensity were undertaken which examined identified areas of environmental concern (AEC) such as the former creosote tank pit, groundwater and soil vapour. Based on the site history which was reasonably well known, the sampling distribution and density is considered to have been adequate to characterize the site and to identify the nature, degree and extent of contamination of both soil and groundwater.

The overall investigation program and sampling approach on the site was considered satisfactory and is believed to have achieved a suitable characterization of all relevant phases of contamination both laterally and vertically within the soil profile and groundwater. The areas of concern were identified based on aesthetic criteria as well as comparison to the appropriate Human Health Investigation Levels and EILs/PPILs which is considered appropriate given the possible end use for the site i.e. residential land-use.

The overall program of groundwater investigation, sampling and the analytical approach is considered satisfactory and is believed to have achieved a suitable characterization of potential groundwater contamination within and downgradient of the site. Where relevant, soil vapour was also adequately characterised.

The monitoring and modelling (Bioscreen) of natural attenuation in groundwater is considered to adequately address the requirements of the relevant guidelines and provide a reasonable characterisation of the processes at the site and demonstrates plume stability within the central region of the site. The auditor considers that the MNA model has achieved the satisfied the requirements of the MNA checklist.

5. Site Remediation

5.1 Remediation Action Plan

A number of documents were produced by the consultants which addressed the remediation plans/strategies for the site. These included:

- RAP (SKM, 2000);
- RAP (PB, 2006) – part of the Combined Phase 1 and 2 ESA (including a groundwater remediation strategy);
- Revised groundwater remediation strategies – various documents (PB, 2006-2007) including 'Groundwater Remediation Strategy Discussion (PB, September 2006) and Proposed Groundwater Remediation Strategy and Costings for Minto Service Depot' (PB, December 2006) and 'Proposed Groundwater Remediation Strategy for the Area South of Buildings E, F & G - Former Integral Energy Depot, Sark Grove, Minto, NSW '(PB, May 2007) and 'Remedial Technology Review' (E2W, 2011); and
- PB 'Excavation and Backfill Plans' in 2007 outlining the specific remediation requirements for given areas of the site, including:
  - Vegetated corridor;
  - Corner of Pembroke Road and Sark Grove;
  - Former South Car Park; and
  - Primary backfilled ("Ronnies") tank pit area.

SKM (2000)

The SKM RAP in 2000 identified the following main areas of concern requiring remediation:

- *UST fuel storage area (BH22, BH24, BH52 and BH53) – three USTS are located in the central and western parts of the site. High levels of contamination were encountered for TPH and BTEX. The maximum levels of contamination in this area exceeded the industrial/commercial criteria by factors of 2 for TPH (C6-C9), 1.4 for TPH (C10-C36), 7 for benzene, 30 for toluene, 4 for ethylbenzenene, 6 for xylene, 120 for TPH and 188 for PAHs. The contamination was found under asphalt pavement in the form of organic vapours and through the soil column down to bedrock at 3 m depth.*
- *Creosote UST Area (BH9 and BH10) – high levels of PAH and TPH soil contamination were found in this area exceeding the industrial/commercial criteria by factors of 6 for total PAHs and 3.6 for benzo(a)pyrene. TPH contamination was found to be less than the industrial/commercial criteria but greater than the low-density residential criteria. Surface soil in the area of the creosote tank is heavily stained. Organic odours in the deeper soils were also noted in the area, suggesting the possibility of deeper soil contamination.*

Other areas of concern included:

- Two USTs in the area of BH17 and BH18;
- The Minto zone substation area situated in the fenced north west corner of the site that is now a parking area;

- Areas of oil staining around the motor workshop;
- Two above ground oil storage areas with staining located on the east side of the transport workshop;
- A petroleum UST in the north east corner of the car park;
- A metering inspection building with damp or leakage problems;
- Hazardous building materials observed on the site included fibro sheeting containing chrysolite asbestos in the kitchen area of the training building and lead in paint on the exterior door to Building D;
- Potential contamination within the fill across the site;
- Bitumen/asphalt containing PAHs; and
- Potential for groundwater contamination.

Much of the work outlined in the SKM 2000 RAP was undertaken by ITE/Coffey as detailed in the following section. The SKM RAP was superseded by the RAP by PB (2006),.

PB (2006):

The purpose of the PB RAP (2006) was outlined as follows:

- *To conduct a remedial options review for the site and develop a remediation strategy that would consider contaminants of concern identified during previous site investigations. The RAP provides a framework for the work practices and environmental management techniques to be implemented whilst undertaking the remedial works (following demolition); and*
- *The overall remediation objective is to remediate TPH, BTEX and PAHs (and potentially asbestos) impacted soils and TPH, BTEX, PAH and heavy metal impacted groundwater identified at the site to a level suitable for residential land use.*

The remediation goals provided by PB were as follows:

- *'Successfully removal* [sic] *all site infrastructure (demolition) and remove wastes to an approved facility;*
- *Remediate soil and fill to a level suitable for future residential land use that will pose no unacceptable risk to human health or the environment;*
- *Remove and dispose offsite any secondary sources of soil and groundwater contamination associated with petroleum products previously used and stored on site;*
- *Validate and remediate (if necessary) areas previously not sampled post demolition works such as building footprints or removed infrastructure;*
- *Validate and remediate (if necessary) areas where suspected or suspicious materials may be present in liaison with the Auditor;*
- *Remove PSH to levels practically manageable (preferably completely) and to allow potential for Monitored Natural Attenuation to occur;*
- *Ensure minimal disruption to surrounding residents during works;*

- *Validate the site in accordance with NSW EPA requirements;*
- *Obtain appropriate signoff on the conditions of the site from the NSW DEC Auditor and to allow IE to apply for residential re-zoning of the property.*

Remediation options were considered for both soil and groundwater works. For soil the following options were considered:

- Do nothing / ongoing management;
- Natural attenuation;
- Capping and containment;
- In-situ treatment;
- Excavation and on-site treatment; and
- Excavation and off-site disposal.

The preferred remedial strategy for the site by PB was '*excavation and disposal of soil to an appropriate facility. If an opportunity to treat soils on-site (bio-remediation) is feasible this will also be considered to allow re-instatement following appropriate clean up levels being reached.'*

For groundwater the following options were considered:

- Pump and treat;
- Bioslurping;
- PSH Removal and Monitored Natural Attenuation (MNA);
- Permeable Reactive Barriers (PRBs); and
- Addition of Oxygen Releasing Compound (ORC).

The preferred remediation strategy for groundwater by PB was as follows:
'It is anticipated that source removal of groundwater contamination will be the primary focus of groundwater remediation. In addition to PSH removal, a program of monitored natural attenuation (MNA) is also proposed to manage any residual groundwater contamination present in a way that minimises further impact to the surrounding environment (and future landuse). In addition to the proposed groundwater remediation techniques a comprehensive Human Risk Assessment (HRA) is also recommended.'

Ongoing monitoring / aftercare was also recommended in the form of a long-term program of monitored natural attenuation which is required to:

- *'Ensure that any residual hydrocarbon contamination present at the site and/or offsite are degrading and not migrating towards areas of environmental sensitivity.*
- *Assess whether contaminates are biodegrading to more toxic daughter products and,*
- *Monitor the rate of natural attenuation by assessing changes in plume geometry and the concentrations of natural attenuation indicator compounds.'*

A peer review of this remediation strategy undertaken by URS (July 2006) also recommended the *in-situ* remediation of groundwater using a variety of borehole extraction techniques including pump and treat, PSH skimmers and/or an MPE system.

The PB RAP recommended a method for sequence of events for remediation works such that demolition and hazardous materials removal as well as additional groundwater investigation including PSH measurement be undertaken prior to remediation works commencing. In addition the following preliminary excavation and disposal works:

- *'Prepare site by removing external surfaces such as bitumen and vegetation. Stockpile and segregate for separate disposal of material.*
- *Cut, seal and protect services and infrastructure.*
- *Excavate shallow fill material across the site and impacted soils from tank farm area*
- *Undertake dewatering/shoring (whichever is appropriate) to allow excavations to proceed to desirable depth or remove water from excavation (if required).*
- *Characterise stockpiled soil/fill material at a frequency consistent with the NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes.*
- *Load, haul and dispose soil/fill material classified as either solid or industrial waste to the appropriate licensed landfill facility, in accordance with the environmental controls.'*

Contingency management plans were provided by PB in the RAP for the following areas:

- *'General remediation management:*
    - *Previously unidentified areas of concern, USTs, structures or footings;*
    - *Dewatering/shoring to remove underground features and /or contaminated soil; and*
    - *Acid sulphate soils.*
- *Environmental/General management:*
    - *Excessive dust;*
    - *Excessive noise;*
    - *Odours/Vapours;*
    - *Excessive rainfall;*
    - *Water in excavations;*
    - *Leaking machinery or equipment;*
    - *Failure of erosion or sedimentation control measures;*
    - *Unearthing unexpected materials, fill or waste;*
    - *Previously unidentified heritage issues related to site building or structures found during excavation;*
    - *Equipment failures; and*
    - *Complaint management.*
- *Soil/Groundwater management:*
    - *Soil criteria exceeded;*

- o *Highly contaminated soils or different physical states of contaminants not identified during previous investigation are encountered;*
- o *Unanticipated asbestos wastes are encountered;*
- o *Changes in proposed future land uses at the site;*
- o *Greater volume of contamination encountered than estimated;*
- o *Heritage issues related to site building or structures found during excavation;*
- o *Contamination found in areas previously not identified or at site boundary; and*
- o *Additional groundwater monitoring reveals that significant impacts are occurring to sensitive down gradient receptors (McBarron Creek).'*

The broad outline for a health and safety plan was also included in the RAP which included the following:

- *'Regulatory Requirements*
- *Responsibilities*
- *Hazard Identification and Control*
- *Air Monitoring (including action levels) during excavation and construction (if necessary)*
- *Chemical Hazard Control*
- *Handling Procedures*
- *Personal Protective Equipment*
- *Work Zones*
- *Decontamination Procedures*
- *Emergency Response Plans*
- *Contingency Plans*
- *Incident Reporting'*

The consideration of approvals and licences were reviewed by PB with the following conclusion:

'The proposed remediation works at the site are considered to be SEPP 55 Category 2 (development consent not required) based on the following reasons:

- *The works do not constitute designated development*
- *The site is not considered to be critical habitat or contain threatened species*
- *No other SEPPs apply to the site*
- *The site is not zoned coastal protection, conservation or heritage protection, habitat area, habitat protection area, habitat or wildlife corridor, environment protection, escarpment, escarpment protection or escarpment preservation, floodway, littoral rainforest, nature reserve, scenic area or scenic protection, or wetland.*

Clause 16(2)a of SEPP55 requires that, for Category 2 remediation work, 30 days notice be given to Sydney Council before the commencement of work. Clause 17(3) require that notice be given to Council of completion of work within 30 days.'

The RAP did not describe Data Quality requirements or objectives for the remediation/validation work based on the 7 step process outlined in the NEPM (1999) or a proposed sampling plan for validation of the site. QA/QC requirements were also outlined in the RAP.

Site management issues were outlined including noise, odour and vapour, plant and machinery, dust and vehicle traffic, equipment and cleaning operations, disposal of contaminated soil material, water and sediment management, site security, working hours, contact information, community consultation and incident response.

Priority contaminants of concern identified by PB for validation sampling were petroleum hydrocarbons (TPH/BTEX), lead and PAHs. PB proposed site remediation acceptance criteria for soils based on the HILA (residential with accessible soils i.e. the lower of Column 1 HIL and Column 5 PPIL/EIL). Generally the adopted criteria were the same as the site investigation levels (SILs) and were therefore not determined on a site specific basis. For the most part, the RAC adopted by SKM and PB were based on the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006 or its forerunners, and are conservative. Where the NSW Auditor Scheme does not provide relevant guidelines (i.e. for TPH and BTEX), the sensitive land use criteria from the NSW EPA Guidelines for Assessing Service Station Sites (1994) were adopted.

The 2007 revised strategy for the area south of Buildings E, F and G included the installation of 11 small wells to monitor and sample groundwater since it was considered that the removal of the primary sources had been completed, and that only residual PSH and secondary sources remain, including hydrocarbon impact that could not be removed because it extended into sandstone. The groundwater remediation options outlined in this document included:

- *Large diameter extraction wells.*
- *Chemical oxidation.*
- *Soil Vapour Extraction.*
- *Bioventing.*
- *Air sparging.*
- *Monitored Natural Attenuation (MNA).*
- *Health Risk Assessment (HRA).*

PB proposed that it was likely that once the PSH has been removed, the management strategy would be MNA or a HRA. More information on groundwater issues and remediation is provided in Section 5.2.

The site was divided into validation areas for the purpose of validating the site as shown in **Figure 25, Appendix A**. The 'Excavation and Backfill Plans' for the Vegetated Corridor (2007), Corner of Pembroke Road and Sark Grove (2007), Former South Car Park (2007) and Primary Backfilled ("Ronnies") Tank pit Area (2007)contained the following objectives:

'The purpose of this Excavation and Validation Plan is to ensure:

- *any asbestos contaminated backfill material is excavated and disposed of to an approved waste facility*
- *personnel follow the requirements outlined in this document during supervision works to meet the requirements of Integral Energy*
- *excavation of asbestos contaminated fill material is undertaken with minimal impact on site personnel or the surrounding environment for the backfill material:*
- *any imported backfill material can be verified as VENM prior to importation on site in accordance with the VENM Checklist provided in the VENM Quality Control Plan a method of ensuring material being imported onto site is VENM if informative is not acceptable a template is available to track materials – VENM Vehicle Logging Track Sheet (VENM Quality Control Plan)*
- *loads are rejected (or materials exhumed and removed from site) if they do not meet VENM requirements (after testing) – by issuing Statements of Non-Conformance (VENM Quality Control Plan).'*

A summary of the areas of concern for each area was as follows:

Buildings A and B

- Buildings A and B – spills and overflows from possible storage in this area;
- Eastern half of the site – uncontrolled fill;
- Stormwater pit – transport of chemicals sourced from nearby areas;
- Eastern boundary – migration of contamination from the former creosote tank;
- Other boundaries – migration of contamination originating from offsite.

Building C and D

- Surficial soil in the vicinity of former location of Building C – uncontrolled fill and migration of contamination from Building D workshop and unsealed parking area;
- Remediation Area A in unsealed parking area – surface spills and runoff from processes on site;
- Surficial soil beneath former location of Building D – uncontrolled imported fill material, spills leaks and overflows from use of building as a workshop;
- Fill mounds in NW corner – uncontrolled imported fill material;
- Fill material beneath paved area in NW corner – uncontrolled fill material;

Southern Car Park

- Fill material in southern car park and vegetated corridor areas – uncontrolled fill material;
- Soil beneath base of stormwater drains – spills, leaks and overflows from runoff in stormwater drain;

Building H

- Building H – spills, leaks and overflows from the various storages in this area, uncontrolled fill;
- Stormwater Pit – transport of chemicals sourced from nearby areas;
- Eastern Boundary – migration of contamination originating from the former above ground oil tank in shed, migration of contamination originating from the former pole storage area;
- Other boundaries – migration of contamination originating from off-site;

Hardstand Areas and Buildings E, F and G

- Fill material beneath hard stand areas – uncontrolled imported fill, surface spills and runoff from processes on site;
- Surficial soil in the vicinity of former location of building E - uncontrolled imported fill, spills, leaks and overflows from use of building as a workshop and wash bay;
- Surficial soil in the vicinity of former location of building F- uncontrolled imported fill, spills, leaks and overflows from use of building as a workshop and garage;
- Surficial soil in the vicinity of former location of Building G - uncontrolled imported fill, spills, leaks and overflows from use of building as a motor workshop and oil storage. Remediation Area B – contamination associated with USTs previously removed to the south of the building;
- Soil beneath base of stormwater drains – spills, leaks and overflows from runoff in stormwater drain;

Creosote Pit

- Creosote tank and surroundings – leakage of creosote from former creosote tank and other chemicals;
- Pole Storage Area – spills, leaks and overflows from the storage of poles and other materials in this area, cross contamination during use of this area to stockpile soils originating from other parks of the former Integral Energy Site;
- Area of former above ground oil tank in shed;
- Stormwater pit – transport of chemicals sourced from nearby areas;
- Western boundary – migration of contamination originating from the adjacent building (H);and
- Other boundaries – migration of contamination originating from off-site.

Preliminary works such as removal of asbestos pipes (vegetated corridor), asbestos containing mounds (corner of Pembroke Road and Sark Grove), construction of perimeter fences, wheel washes etc. were outlined in the PB reports.

The reports include specification of:

- The extent and approximate dimensions of excavations;
- classification of waste to be removed from excavations (based on the (then relevant) NSW EPA (1999) Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes);

- approximations of volumes to be removed from the excavations;
- methodology for removal of material, stockpiling and sampling;
- validation methodology (analytes, frequency and number of samples, including QAQC); and
- backfilling with the requirements for VENM (origin, testing etc.).

The VENM Quality Control Plan (PB, 2007) was also prepared by PB with the following objectives:

'The purpose of this VENM Quality Control Plan is to ensure:

- *personnel follow the requirements outlined within this document during supervision works to meet the requirements of Integral Energy*
- *all imported backfill material can be verified as VENM prior to importation on site in accordance with the VENM Checklist*
- *a method of ensuring material being imported onto site is VENM if information is not acceptable Virgin Excavated Natural Material (VENM)*
- *a template is available to track materials – VENM Vehicle Logging Track Sheet*
- *loads are rejected (or materials exhumed and removed from site) if they do not meet VENM requirements (after testing) – by issuing Statements of Non-Conformance'*

The report specified the following criteria for the imported fill as provided in Table 10.

Table 10 – Imported Fill Criteria

Contaminant	Column 1 NEHF-A Criteria (mg/kg)	PPILs[4] (mg/kg)
TPH		
C_6-C_9	65[1]	
C_{10}-C_{36}	1000[1]	
C_{16}-C_{36} (aromatic)	90	
C_{16}-C_{35}	5,600	
>C_{36} (aliphatic)	56,000	
BTEX		
Benzene	1[1]	
Toluene	1.4[1]	
Ethyl Benzene	3.1[1]	
Total Xylene	14[1]	
Heavy Metals		
Arsenic	100[2]	20
Beryllium	20[5]	
Cadmium	20[2]	3
Chromium (III)	120,000[2]	400
Chromium (VI)	100	1
Cobalt	100[5]	
Copper	1,000[2]	100
Lead	300[2]	600
Manganese	1,500[5]	500
Methyl Mercury	10[5]	
Mercury (inorganic)	15[2]	1
Nickel	600[2]	60
Zinc	7000[2]	200
PAH		
Total PAH	20[2]	
Benzo(a)pyrene	1[2]	
Total Phenols	8,500[2]	
OC Pesticides		
Aldrin & Deildrin	10[2]	
Chlordane	50[2]	
DDT+DDD+DDE	200[2]	
Heptachlor	10[2]	
Total PCBs	10[2]	
Other		
Boron	3,000	
Cyanides (complex)	500	
Cyanides (free)	250	
Asbestos	*	

[1] NSW EPA (1994) Guidelines for Assessing Service Station Sites – Sensitive Land Use. Speciation analysis of TPH (Aromatics and Aliphatics) in accordance with NSW EPA (1998(Guidelines for the NSW Site Auditor Scheme (2nd Edition), shall be undertaken if fill source is suspected to have petroleum contamination

[2] NSW EPA (1998(Guidelines for the NSW Site Auditor Scheme (2nd Edition) – Residential with accessible soils (NEHF A)

[3] Laboratory Limits of Reporting

[4] NSW EPA (1998(Guidelines for the NSW Site Auditor Scheme – PPILs for sandy loams) – proposed used in decision making process for urban redevelopment sites

[5] Less frequent analysis as outlined in NSW EPA (1998(Guidelines for the NSW Site Auditor Scheme (2nd Edition)

* Asbestos assessment criteria will be determined based upon whether asbestos is present and its extent. Appropriate guidelines may refer to Australian Contaminated Land Consultants Association (ACLCA) code of practice or NSW WorkCover requirements.

Auditor's Opinion

The various RAPs and remediation strategy documents prepared by SKM (2000) and PB (2006-2007) in respect to hydrocarbon related contamination in soil and groundwater are considered to generally comply with the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997) and provide a satisfactory evaluation of the remedial requirements for the affected materials and the site in general.

The various remediation documents provided discussion of the available remedial options and the chosen remedial strategy. The specification of the requirements for validation works, including *inter alia* sample frequency, analyte suite, data quality objectives and QA/QC, laboratory methods as well as criteria to be adopted for classification of material were also appropriately discussed in the RAPs and in other related documents.

The RAPs and associated documents contained sufficient contingency measures to cater for unexpected and or previously unidentified occurrences of contamination. The RAP set out remediation criteria which were generally consistent with the intended land uses.

The criteria adopted for the assessment of VENM imported to the site as outlined in the VENM Quality Control Plan have been questioned by the auditor on a number of occasions as provided in **Appendix C** and posed a significant issue in respect to whether the imported material was suitable for use as fill on the site. In this regard the auditor notes that HILs and PPILs are not appropriate criteria for assessing fill material that has been, or will be, imported to a site. The Auditors Guideline specifies that auditors must check that HILs and PPILs have not been used for this purpose by consultants. Sections 4.1.1 and 4.1.2 of the Sampling Design Guidelines (EPA 1995) provide advice on the validation of imported fill. In this regard the auditor considers the adoption of HIL or PPIL for assessing fill being imported to the site is not appropriate based on the guidelines quoted above. The material accepted to the site as VENM is considered further in the following section. The material accepted to the site did however comprise VENM and the related analytical results indicated no elevated levels of (natural) contamination. Imported fill material (VENM) is considered further in the subsequent sections of this report.

5.2 Further Groundwater Remediation Documentation

5.2.1 PB Groundwater Remediation Strategy (2006 and 2007):

The remediation goal was stated as follows (similar to PB RAP):

'It is anticipated that source removal of groundwater contamination will be the primary focus of groundwater remediation. In addition to PSH removal a program of monitored natural attenuation (MNA) is also proposed to manage any residual groundwater contamination present in a way that minimises further impact to the surrounding environment (and future landuse)'

The updated remediation options provided by PB i.e. to remove PSH, were based on the most recent information gathered during soil remediation works (see also Table 11 below):

- *'Large scale excavation to remove impacted soil and create a groundwater collection sump area to remove PSH or* [sic]
- *Undertake in situ remediation by installing groundwater a series of groundwater remediation wells to simulate sump collection points for pumping, treating/disposing PSH and hydrocarbon contaminated water.*

The options were considered by PB and the following conclusions were drawn:

'In situ remediation is considered to be a suitable option following remediation works exposing the area around and underneath the Test Area (Dyno), Buildings E, F and G. These works have identified (and removed) sources thought to be major contributors to the PSH plume.

These sources are primary and secondary in nature and include concrete 40,000L oily water filled underground inspection pit area, one previously un-identified waste oil UST, and impacted soils underneath and surrounding the aforementioned structures. It is estimated that this combined remediation approach will be effective in removing PSH contamination at the site.

It is considered that a program of finding and chasing PSH within the environment present at the Minto site through installation of groundwater wells and extraction sumps will be better suited than installation of a permanent unit to remove PSH contamination.'

Table 11 – Groundwater Remediation Techniques

Groundwater extraction sumps and periodic removal	Long term on site unit to remove PSH
Advantages Remove PSH only when present. Passive and manual removal mechanisms such as bailers, pumps and skimmers can be used to more effect than on site removal. MPE unit can also be brought in to maximise effect on site More hands on approach in determining how contamination is reaching within fractures – removal strategy can be modified to best suit maximising PSH removal at a reduced cost **Disadvantages** May take some time to gauge most effective removal method once extraction wells have been installed If large amounts of PSH is present passive and manual systems may not be able to cope – however this has not been the case on site	**Advantages** Mobilise unit and leave on site within a Sea Container or similar compound **Disadvantages** Expensive set up costs – specialised system only suited to certain geological areas and conditions Effective only if large amount of PSH is present and wells have geologic respond and connect with one another Constant monitoring and maintenance required PSH may not recover quick enough for removal unit to be effective – may be sucking air for long periods Special Da or license may be required from council Visual impact to surrounding landuse may be of concern with vents/periodic vapour release (may require air monitoring for protection of public health)

A revised strategy and methodology was provided by PB for groundwater remediation and PSH removal as well as for the ongoing monitoring and sampling and risk assessment work required.

5.2.2 E2W (2011): Remedial Technology Review (RTR)

A remedial technology review for residual groundwater contamination (phase separated hydrocarbons [PSH] and dissolved phase) was undertaken by E2W in 2011. The objective of the assessment was to assess the available remedial technologies and practical feasibility against the net environmental gain and to '*facilitate "remediation to the extent practical" within the context of residual risk issues (as identified by EnRiskS, 2011) and the pending site divestment.'* E2W also noted that '*It is noted that effective or complete groundwater remediation of the site is not practical given the depth to water (~4m) and complex fractured bedrock geology (>3m).*'

The groundwater remediation technologies considered by E2W included:

- *Hotspot removal - excavate and removal impacted soil and groundwater* [sic]
- *Pump and treat – pump water / vapour via wells for aboveground treatment and disposal*
- *Pulsed or variable pump-and-treat – variable pump rate to allow contaminants to dissolve, desorb, and or diffuse from stagnant areas*
- *In situ well aspiration – injection of air into well allowing VOCs to transfer to vapour phase by air bubbles*
- *Air sparging – inject air below water table and captures it above the water table to extract VOCs and promote biodegradation*
- *Steam-enhanced extraction – injects steam above or below the water table to promote volatilization of contaminants*
- *In situ thermal – injects heat above water table to promote volatilisation*
- *Natural attenuation – allows contaminants to biodegrade naturally without intervention*
- *Physical containment – cutoff walls, caps, liners*
- *In situ reactive barriers – treat contaminated water as it passes through physical barrier containing reactive chemicals organisms or activated carbon*
- *Biological - In situ bioremediation – pump nutrients through subsurface to promote growth or microorganisms that biodegrade contaminants*
- *Chemical - soil flushing (surfactants and co-solvents below water table) and in situ chemical treatment (injects chemicals to transform contaminants in place).*

E2W considered the specific conditions at the site as follows:

- *'The site has been adequately characterised and is dominated by sandy clay sediments which overly relatively impervious fractured sandstone bedrock (>3m depth, a semi-confined aquitard).*
- *The RTR review follows previous remedial works including primary source removal (fuel tanks and contaminated soil), multiphase extraction events (2008), and groundwater monitoring and assessment (MNA, permeability tests).*
- *Residual hydrocarbon contamination (&PSH) is localised within fractured/weathered zones with the sandstone bedrock. High sorption (adsorption/absorption- rebound issues) and low effective porosity/interconnectivity/permeability prevents the mass removal of residual contamination.*

- *The existing well network comprises eighteen (18) deep monitoring wells (approximately 13m depth) which have low yield and provide limited capacity for either injection/extraction of water/vapour.'*

E2W undertook calculations to estimate the polluted area and mass of polluted groundwater as well as mass of recoverable polluted groundwater. Calculations were based on a total polluted area of 1,200 m^2 and the 3 m depth of groundwater (3,600 m^3). Based on an estimated effective porosity of 5% due to groundwater being restricted in impacted bedrock, recoverable groundwater was estimated by E2W to be 18 m^3. Estimated removal of PSH from groundwater using a (standard) bailer was 182 mL/month based on recent monitoring data by E2W.

The conclusions of the RTR were as follows:

'E2W preferred remedial approach for Minto is to rely on natural attenuation processes (i.e. anaerobic biodegradation via sulphate reduction processes) to demonstrate plume stability and remediate (long term) the residual groundwater plume. The site conditions (fractured rock aquifer) are not suitable for active remedial technologies such as excavation, pump/treat or installation of physical or reactive barriers. Previous MPEAT events at the site have limited success due to the lack of interconnected vapour/groundwater pathways.'

5.2.3 EnRiskS (2011): Identification of 'Impacted Zone' Requiring Management – Future Use of Minto Site

This letter report was prepared by EnRiskS to provide justification for the identification of the groundwater 'Impacted Zone' that remains on the subject site. The 'Impacted Zone' was taken to comprise the impacted groundwater wells (MW06, MW01, MW5A, MW11, MW14, MW15, MW07 and MW10 and MW18) and a 10 m wide buffer in all directions from these wells. The survey plan showing the 'Impacted Zone' is provided in **Appendix D**. The zone is defined based on a number of considerations provided in the EnRiskS letter report as follows:

'While the majority of the site is proposed to be rezoned for Residential (2(b)) purposes, the following is noted in relation to the area to be defined as the Impacted Zone:

- *The final use of the Impacted Zone, as to be defined by council during the rezoning of the whole site, is for roadway access, public car parking or public open space.*
- *No buildings are to be constructed above the PSH impacted zone; and*
- *No groundwater is to be extracted for any purpose on the site (note that this would be unlikely given the poor yield of the groundwater aquifer and the availability of reticulated water in the area).'*

Auditor's Opinion

The various documents provided by consultants relating to the remediation strategies for groundwater in respect to hydrocarbon related contamination in groundwater are considered to generally comply with the *Guidelines for the Assessment and Management of Groundwater Contamination* (*NSW EPA, March 2007)* and provide a satisfactory evaluation of the remediation options and strategy for groundwater at the site.

The delineation of the 'Impacted Zone' based on the results of groundwater investigation and modelling of the groundwater plume characteristics is considered reasonable. Further discussion relating to the 'Impacted Zone' is provided in **Section 5.4.2** and **Section 5.5** (EMP) of this NS SAR.

The auditor requested evidence to show that the final use of the 'Impacted Zone', has been defined and agreed by Council to show that Council has accepted the premise of future environmental management, and that there are provisions in place to ensure that ongoing management of the 'Impacted Zone' is 'reasonably legally enforceable'. Correspondence (**Appendix C**) provided by Endeavour (19 December 2011) includes a summary and minutes from a meeting with Council to support the auditor's queries.

5.3 Site Remediation Works

5.3.1 Remediation and Decommissioning of Tanks (ITE/Coffey, 2003-2007)

During August/September 2003, excavation and the removal of 10 tanks were undertaken by Ronnies Environmental Services P/L including:

- Creosote – 5,000 L UGST;
- Diesel – 25,000 L UGST;
- Diesel – 20,000 L UGST;
- ULP – 55,000 L UGST;
- ULP – 50,000 L UGST;
- ULP – 25,000 L UGST;
- Waste oil – 5,000 L UGST; and
- 3 x creosote – 500 L tanks.

Tank destruction certificates verifying that tanks were send to Knights Syndicate P/L or Gameco P/L for destruction were provided by the consultants and are replicated in **Appendix G**.

Validation sampling and analysis of the stockpile contents and tank pits continued until February 2006. ITE/Coffey (2007) reviewed the results of the tank pit validation sampling with respect to the relevant guidelines. The following conclusions were provided by ITE/Coffey:

- Tank pit 1 – validated and backfilled with 101.9 imported fill of crushed sandstone obtained from Kings Tunnel. Tank pit 1 subsequently became part of Tank pit 10;
- Tank pit 2 – not validated due to exceedances of PAHs and benzo(a)pyrene – subsequently became part of Tank pit 10;
- Tank pit 3 – exceedances of PAH and TPH, chased out and validated, backfilled with 192.52 tonnes of imported fill of crushed sandstone from Kings Tunnel;
- Tank pit 4 – exceedances of TPH – chased out and validated and backfilled with 563.84 tonnes of imported fill of crushed sandstone from Kings Tunnel;

- Tank pit 5 – exceedances of TPH, BTEX, chased out walls and base and bowser lines and validated. Backfilled with 377.74 tonnes imported fill of crushed sandstone from the Cross City Tunnel excavation works;
- Tank pit 6 – exceedances of TPH in wall samples chased out and validated with 35.46 tonnes of imported fill of crushed sandstone from the Cross City Tunnel excavation;
- Tank pit 7 – exceedances of TPH, BTEX in wall and based samples. Chased out and validated and backfilled with 563.84 tonnes of imported fill of crushed sandstone from the Cross City Tunnel;
- Tank pit 8 – exceedances of PAH and OCPs (dieldrin). Tank pit 8 subsequently became part of Tank pit 10;
- Tank pit 9 – exceedances of TPH and BTEX in wall and base samples. Impact remains in wall sample along the northern wall under the motor workshop building. Further sampling was recommended by ITE;
- Tank pit 9 was backfilled with 131.82 tonnes of imported ripped shale blend obtained from Brandown Quarry;
- Tank pit 10 (location of former creosote tanks and includes Tank pits 1, 2 and 8) – exceedances of TPH and toluene, PAH, B(a)P and OCP (dieldrin) in wall samples. Material was chased out from Tank pit 10 on 8 separate occasions, however, exceedances of the RAC were still evident in wall samples (north and west walls and northwest corner). Groundwater was removed from the tank pit (46.5 tonnes) from Tank pit 10 and reportedly disposed by Rethmann ARS P/L.

Liquid waste

- Water from the base of Tank pits 2, 8 and 10 was removed by Coopers Environmental Waste Recycling P/L or Rethmann Australia Environmental Services P/L and transported to Collex.

Stockpiles and Landfarming

The sampling and classification of the 56 stockpiles of material were undertaken in stages during 2003 – 2005. The overall results are summarised in Coffey's tables replicated in **Appendix F**. In summary the following volumes of soil were disposed off-site (note: a conversion factor of 1.8 t/m^3 can be assumed):

- Hazardous Waste sent to Collex Unanderra – 216 m^3;
- Industrial Waste sent to SITA Kemps Creek – 1249 m^3;
- Solid Waste sent to Collex Horsley Park – 3021.7 m^3;
- Inert Waste sent to Horsley Park – 3859.6 m^3;
- Material validated and resused for backfilling on-site - 3134.5m^3.

5.3.2 Asbestos remediation works (PB, 2006)

Asbestos containing material (ACM) was identified in a number of areas across the site. In particular the following areas of asbestos were remediated as part of the works:

- Former Area A and B Area - Asbestos cement fragments were encountered in the fill materials behind the concrete retaining wall. The trees were removed and retaining wall dismantled so that the asbestos containing material could be removed and disposed offsite. The remaining excavation was validated (see **Figures 26 and 27 Appendix A**);
- Former Area A and B Area – following demolition of the buildings chrysotile asbestos was identified in one soil sample. These validation samples were analysed for asbestos: asbestos was not detected in these samples, suggesting that material at this location was suitable to stay on-site;
- Former Building C location - Shallow fill material beneath the former location of Building C was found to contain asbestos. This material was excavated and disposed of off-site. No asbestos was detected in validation samples collected from the resulting excavation (see **Figures 28-30, Appendix A**);
- Fill mounds in north western corner - Fill material in the mounds at the north western corner of the site was found to contain asbestos pipe pieces. This material was excavated and disposed of off-site. No asbestos was detected in validation samples collected from the resulting excavation (see **Figures 28-30, Appendix A**);
- Primary backfilled ("Ronnies") tank pit area - backfill material in the primary backfilled tank pit area in the central area of the site was found to contain asbestos. This material was excavated and disposed of off-site. No asbestos was detected in validation samples collected from the resulting excavation;
- Asbestos cement fragments were found at the surface at two locations in the centre of the area formerly occupied by Building H. Impacted materials at these two locations was subsequently excavated and disposed of off-site. The resulting pits were validated by collecting soil samples from the base and walls of the excavations. These validation samples were analysed for asbestos. Asbestos was not detected in the samples analysed (see **Figure 40, Appendix A**);
- Former south car park - Fill material in the south car park was found to contain asbestos pipes and fragments. This material was excavated and disposed of off-site. No asbestos was detected in validation samples collected from the resulting excavation (see **Figures 31-35, Appendix A**);
- Former vegetated corridor - Fill material in the vegetated corridor was found to contain asbestos pipes. This material was excavated and disposed of off-site. The resulting excavation was visually inspected for any visible asbestos fragments following the removal works. No visible asbestos was observed (see **Figures 28-30, Appendix A**);

In total 32,169 tonnes of solid waste (with small quantities of asbestos) were removed from the site and disposed at Enviroguard P/L - Erskine Park, NSW. The waste dockets provided by PB (2011) are replicated in **Appendix I**.

5.3.3 Excavation and Backfill of Remainder of the site (PB, 2006-2007)

A summary of Remediation Works undertaken by PB is as follows:

1. Former Building A and B Area –
   a. Stormwater pits- The stormwater drains SWD 01, SWD 02, SWD 10, SWD 11 and SWD 12 were removed using an excavator between 5 and 7 December 2006. For validation purposes, samples were collected from the base of each pit. These samples were

analysed for heavy metals, TPH, BTEX and OCP. Results in validation samples were below the adopted assessment criteria for residential with accessible soil land use, suggesting that material at this location was suitable to remain on-site;

b. Retaining wall area - Asbestos cement fragments were encountered in the fill materials behind the concrete retaining wall during the investigations by test pitting at a number of locations. The trees that were present at this location were removed and the retaining wall behind which the fill was placed was dismantled, the fill material in the area of these test pits was excavated. The excavated material was disposed offsite as soil containing asbestos material. The resulting pit was validated by collecting soil samples from three locations in the eastern wall marking the maximum extent of the excavations. It was not considered necessary to collect soil validation samples from the base of this excavation as excavations of the fill were terminated on natural soil, forming the base of the excavation. Asbestos was not detected in the validation samples analysed. Subsequently, the wall marking the maximum extent of the excavation was re-sloped and stabilised;

c. Remainder of Former Buildings A & B Area - Following the demolition of Buildings A & B, fifteen surface samples were collected across the remainder of the area of Buildings A & B, and analysed for heavy metals, TPH, OCP and asbestos (a selection of these samples was also analysed for BTEX and PAH). Results indicated either non-detect concentrations or concentrations in the background range, suggesting that these locations had not been grossly contaminated by the previous activities undertaken in this area. The exception was sample V(A/B)15, in which chrysotile asbestos was found and removed (see Section 5.2.2). At the completion of these works, it was considered that this part of the site had been remediated and was now suitable for the anticipated (likely) future use; and

d. Sample locations are shown in **Figures 26 and 27 Appendix A**.

2. Former Building C and North West Corner –
    a. Former Building C location - Shallow fill material beneath the former location of Building C was found to contain asbestos (see Section 5.2.2);
    b. Unsealed parking area (‘Remediation Area A’) - One soil/sludge sample collected from a surface drain in the western area of the unsealed parking area by PB (2006) reported elevated levels of TPH C10-C36 above the adopted soil validation criteria. As the likely source of the contamination was surface spills and run-off from processes on site, the impacted surficial material in the vicinity of the sample was excavated and disposed off-site. Results for validation samples collected from the resulting excavation were below the adopted soil validation criteria for the site;
    c. Former Building D location - elevated levels of Aldrin and Dieldrin were reported for a validation sample collected beneath the former location of Building D. This material was excavated and disposed off-site. Results for validation samples collected from the resulting excavation were below the adopted soil validation criteria for the site;
    d. Fill mounds in north western corner - Fill material in the mounds at the north western corner of the site was removed (see Section 5.2.2); and
    e. Sample locations are shown in **Figures 28-30, Appendix A**.

3. Former Southern Car Park and Vegetated Corridor:
    a. Former stormwater drain locations - Four stormwater drains (SWD04, SWD06, SWD07 and SWD09) were removed from the site and representative soil validation samples collected from the base of each excavated pit were analysed for contaminants of concern including heavy metals, TPH and OCPs. All results were below the adopted soil assessment criteria for the site;

b. Former south car park - Fill material in the south car park was found to contain asbestos pipes and fragments (see Section 5.2.2);
c. Fill material in the vegetated corridor was found to contain asbestos pipes and fragments (see Section 5.2.2); and
d. Sample locations are shown in **Figures 31-35, Appendix A**.

4. Former Hardstand Areas and Buildings E, G and G:
   a. Area of former Buildings E, F and G - surficial soil validation samples were collected from the former locations of Building E and G and selected representative validation samples were analysed for contaminants of concern including 8 priority heavy metals (arsenic, cadmium, chromium, copper, lead, nickel and zinc), beryllium, cobalt, manganese, total petroleum hydrocarbons (TPH, including relevant fractions), BTEX compounds (benzene, toluene, ethylbenzene and xylenes), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), phenols, volatile organic compounds (VOCs) and asbestos. All results were below the adopted soil validation criteria fill material previously identified as impacted by hydrocarbons by IT Environmental (ITE, 2003) ("Remediation Area B") was excavated and disposed of off-site. Chase out of the contamination included removal of fuel lines and associated soil contamination in an area beneath the southern portions of Buildings E, F and G. Soil validation samples were collected and representative samples were analysed for contaminants of concern including 8 priority heavy metals, TPH, BTEX, PAHs, PCBs, OCPs and phenols. All results were below the adopted soil validation criteria. A petroleum underground storage tank (UST) was removed from the south western corner of the Remediation Area B excavation. Soil validation samples were collected from the tank pit and representative samples were analysed for contaminants of concern including 8 priority heavy metals, TPH, BTEX, PAHs, PCBs and phenols. An elevated level of PAHs was observed in a sample collected in sandstone bedrock at a depth greater than 3 metres below ground level (mBGL). All other validation results were below the adopted soil validation criteria. Soil validation samples were collected in the northern area of former Buildings E, F and G and analysed for contaminants of concern including 8 priority heavy metals, TPH, BTEX, PAHs, OCPs and organophosphate pesticides (OPPs). Elevated levels of PAHs were detected in one location. Impacted fill material was excavated and disposed of off-site. All other validation results were below the adopted soil validation criteria former stormwater drain locations;
   b. three stormwater drains (SWD15, SWD16 and SWD20) were removed from the site and representative soil validation samples collected from the base of each excavated pit were analysed for contaminants of concern including 8 priority heavy metals, TPH and OCPs. All results were below the adopted soil validation criteria;
   c. primary backfilled ("Ronnies") tank pit area - backfill material in the primary backfilled tank pit area in the central area of the site was found to contain asbestos (see Section 5.2.2). Excavation validation samples collected from the eastern area of the excavation reported some elevated levels of TPH C6-C9, BTEX, naphthalene and VOCs. Contaminated soil was chased out to shale bedrock to a maximum depth of approximately 4 mBGL. Elevated levels of toluene, TPH C6-C9 and total xylenes were detected in samples collected from the base of the excavation, exceeding the adopted soil validation criteria. Elevated levels of VOCs were also detected in some samples. All other results were below the adopted soil validation criteria;
   d. former hardstand area - soil validation samples were collected from test pits undertaken across the eastern and southern former hardstand areas at the site. Selected soil

validation samples were analysed for contaminants of concern including 8 priority heavy metals, TPH, BTEX, PAHs, OCPs, OPPs and asbestos. All results were below the adopted soil validation criteria; and

e. Sample locations are shown in **Figures 36-39, Appendix A**.

5. Former Building H Area:
   a. Area impacted by PAHs - Following the demolition of Building H, staining and hydrocarbon odours were observed in the surface soils in the south west corner of the former Building H. Test pitting in the area indicated that the soil was impacted by PAHs. These materials were excavated on 29 January 2007, with further chasing out on 7 February 2007. The materials were disposed off-site on 19 and 20 February 2007 to the Enviroguard landfill (176.24 tonnes, therefore equating to approximately 110 m3 in volume). Following the excavation of the contaminated material, samples were collected on the base and walls of the pit, in order to validate the excavation. Results were below the adopted soil validation criteria for residential land use with accessible soil, suggesting that material at this location was suitable to remain on-site. Backfilling of the pit was carried out in March 2007 using imported VENM from Brandown Quarry, located at Kemps Creek, NSW. At the same time similar backfilling also took place on the adjacent southern car park area of the depot;
   b. Stormwater pits - On 16 January 2007, the stormwater drains SWD 17, SWD 18 and SWD 19 were removed using an excavator. For validation purposes, one sample was collected from the base of each pit. One pit was found to be impacted by TPH and another was found to be impacted by lead: material was removed at these two locations and then further sampling was carried out following these excavations on the base and walls of the excavation. Results reported from validation samples were below the adopted soil validation criteria for residential land use with accessible soil, suggesting that material at this location was suitable to remain on-site;
   c. Areas with asbestos cement fragments (see Section 5.2.2);
   d. Remainder of Building H area: a number of test pits were excavated in 2006 across the remainder of the area formerly occupied by Building H. In summary, no samples exceeded the adopted soil validation criteria; and
   e. Sample locations are shown in **Figure 40, Appendix A**.

6. Former Creosote Pit and Pole Storage Area
   a. Creosote Pit - In May 2006, most of the accessible contaminated materials in and beneath the pit had been excavated. The pit was the subject of a Qualitative Health Risk Assessment undertaken by ERM in April 2006, which identified the following potential exposure pathways:
      i. Direct contact with affected soil by on-site construction workers. Inhalation of vapours from residual constituent concentrations in soil by future on-site residents;
      ii. Direct contact with affected groundwater by off-site users; and
      iii. Migration of affected groundwater to off-site surface water receptors (e.g. McBarron Creek).
   b. The qualitative health risk assessment by ERM concluded that it was unlikely there would be significant health risks to future residents and short-term exposure risks to construction workers, as modelled concentrations were below acceptable levels. Backfilling of the creosote pit was carried out in September 2006 using approximately 1,600 m^3 of material originating from the excavation of Tank pits 4, 5, 6, 7 and 9 that had been validated by IT and stockpiled in the former pole storage area, and approximately 5,500 m^3 of imported

VENM from Brandown Quarry, Kemps Creek, NSW. All results, with the exception of two anomalies, were below the adopted assessment criteria set out in the PB (2006) VENM Quality Control Plan (PB ref. 2115098A/PR_5377) prepared for the site. Subsequently the VENM was covered with validated topsoil that was later seeded with spray grass to limit erosion;

c. Above ground oil tank in building - The above ground oil tank and the building surrounding it were demolished around September 2006. Following demolition, the soils located underneath the above ground oil tank that were visibly impacted by hydrocarbons were excavated. Residual contamination was chased out until the material with concentrations exceeding the adopted soil validation criteria had been removed. The excavated material (approximately 70 m^3 of gravely sandy clay) was validated and assessed to be suitable for re-use on-site. The material was subsequently used to backfill the pit;
d. Stormwater pit: The stormwater Drain #13 was removed using an excavator and the pit validated;
e. Former pole storage area - To complement the investigations carried out by SKM and URS in this area, PB carried out a number of additional investigations, comprising seven test pits TP19 to TP25, and one borehole: all sampling results were either non detect or below the adopted soil validation criteria. Subsequently, as per the creosote pit and at the same time, topsoil was placed across this area and seeded to limit erosion; and
f. Sample locations are shown in **Figures 41-42, Appendix A**.

Material removed from the site between October 2006 and August 2007was reportedly classified for off-site disposal as per the NSW EPA (1999) *Environmental Guidelines: Assessment, Classification & Management of Liquid and Non-liquid Wastes*. The waste dockets provided by PB (2011) are replicated in **Appendix I**. The auditor considers the waste disposal locations concur with the disposal dockets provided.

Waste reconciliations were provided in the PB letter titled 'Summary of waste disposal information and imported VENM for works undertaken at the Former Integral Energy Depot located at Sark Grove, Minto, NSW dated July 2010. The letter addressed various queries raised by the auditor regarding waste classifications, excavation and disposal volumes. The materials excavated were disposed as follows:

- Soil waste including inert, solid and solid waste (with asbestos) – Enviroguard P/L – Erskine Park, NSW;
- Bitumen, Asphalt, roadbase and concrete/brick – Eco Cycle Materials P/L – Wetherill Park, NSW.

PB provided the following reconciliation of the volumes.

Table 12 – Reconciliation of Waste Volumes

Validation Report Area	Excavation Area	Volume (m3)
Former Creosote Pit and Pole Storage Area	Creosote pit excavation	5,030
Former Building H Area	Surficial materials removed around footings (stockpiles SP(H1) and SP(H2))	520
	Removal of materials within retaining wall east of Building H	600
	PAH impacted area excavation	240
	Stormwater drain excavations	19
	Asbestos impacted areas excavations	8
Former Building A & B Area	Removal of materials within retaining wall east of Buildings A and B	200
	Removal of impacted materials in Building A and B footprint	30
Former Hardstand Areas and Buildings E, F & G	'Remediation Area B'	1,585
	Primary Tankpit Excavation ("Ronnies")	1,153
Former Building C and North West Corner	North west corner excavation (incl. fill mounds)	798
	Removal of surficial impacted materials in footprint of Building C	154
	Removal of surficial impacted materials in footprint of Building D	50
	'Remediation Area A'	80
Former Southern Car Park & Vegetated Corridor	Southern car park excavation	9.565
	Vegetated corridor excavation (incl. chase-out of asbestos pipes identified in fill materials during southern car park investigation)	4,447
TOTAL		**24,479**

PB also noted that:

'By comparison, the waste dockets indicate that:

- *40,475 tonnes of soil and subsurface materials was disposed of to an off-site waste facility* ['sic]
- *8,322 tonnes of surfacing and building materials (including bitumen/asphalt, roadbase and concrete/brick) was removed from the site, generally to a recycling plant.*

It is considered that the volume of soil and subsurface materials removed to landfill and the total excavation area calculations are comparable, with a difference of only 1,309 tonnes between them. This difference is likely due to the following factors:

- *the density of the materials, which has been estimated to be 1.6 tonnes/m3 but may have been different for different materials excavated from the site*

- *excavation areas may have included roadbase, bitumen/asphalt and/or concrete within the excavation volumes which was removed separately to the soil waste.*

A total of 35,559 tonnes of imported VENM was used to backfill the excavations ..'

The auditor considers that the variation in actual versus calculated waste volumes/tonnages are within acceptable ranges and that the overall quantities are in line with the expected values based on the dimensions of excavations and bulk densities of materials delivered to landfill.

Auditor's Opinion

Remediation works at the site are considered by the auditor to have been undertaken in an organised and appropriate manner in accordance with the various remediation plans which were reviewed and agreed by the auditor prior to the commencement of remediation works (see **Appendix C**).

The validation reports provide an adequate level of detail of the remediation operations and reconciliation of the excavation dimensions, waste volumes, disposal dockets and waste classifications applicable to the material removed from the site and accepted onto the site as backfill.

This information provided in the validation reports regarding the remediation works were scrutinised by the auditor (**Appendix C**) and revisions and addenda were provided to address any issues identified.

5.4 Site Validation

5.4.1 Soil Validation

During the initial validation works by ITE/Ronnies Environmental, 281 validation samples were taken from 10 tank pits (plus an additional 56 QA/QC samples). Given that these samples were taken from walls and bases of tank pits only and many of these were subsequently filled during remediation works, these are not considered in the Table below.

During the PB validation works in the 6 site areas, validation results were compiled using the previous investigative sample locations and validation sample locations. The summary table provided includes the number of locations for the site as shown in Table 13.

Table 13: Summary of Validation Samples taken during PB Soil Validation Works

Area		Size (m^2)	Investigative sample locations	Validation sample locations
Former Building A and B Area	stormwater drains, retaining wall area	6900	1 former stormwater drain 4 samples from retaining wall material	4 stormwater drain 3 retaining wall
	building footprint below the former Building A and B		1 under former Building A	7 boreholes, 1 monitoring well, 19 surficial and 11 test pit locations
		6900	6	45
Former Building C and North West Corner	Northwest corner (including area of fill mounds and paved area)	1550	5 test pits	24 locations - fill mounds 6 locations -paved area
	Former Unsealed Carpark Area	850		5 locations
	Remainder of site (Building C and D)	4400	2 locations	13 locations - Building C 16 locations - Building D
		6800	7	64
Former Southern Car Park and Vegetated Corridor,	Former stormwater drain locations	9		4 soil validation
	Remainder of site	18,790	18 test pits	16 test pit, 73 validation samples
		18,800	18	93
Former Hardstand Areas and Buildings E, G and G,	Area of former Buildings E, F and G	3,840	6 surficial soil samples - Building E 4 surficial soil samples - Building G	14 surficial soil, 45 validation 'Remediation Area B', 20 tank pit, 32 test pit locations
	Former stormwater drain locations	7		3 soil validation samples
	Primary Backfilled ("Ronnies") Tank pit Area	1,153	10 surficial soil samples, 5 test pits, 40 excavation validation samples	
	Former hardstand areas	7,350		17 test pit locations
		12,350	25	171

Area		Size (m^2)	Investigative sample locations	Validation sample locations
Former Building H Area,	Area impacted by PAHs	210	5 test pits	19 soil validation
	Stormwater pits	25	2 soil validation	11 soil validation
	Areas with asbestos cement fragments	40		10 soil validation
	Remainder of Building H Area	3,345		4 boreholes, 9 test pits, surficial samples
		3,620	7	55
Former Creosote Pit and Pole Storage Area	Remediation Area C (Former location of shed)	85	1 borehole	6 surficial samples
	Former pole storage area	1,600		1 surficial, 7 test pits
	Creosote pit excavation area	1,250	3 boreholes	Refer to ITE/Coffey results
	Former stormwater drain location	3		1 soil validation
	Remainder of site	6,912		7 boreholes, 18 test pits, 3 boreholes (monitoring wells)
		9,850	4	43
Total		58,320	67	471

Based on the summary of validation samples in Table 13 the overall investigation and validation sampling density comprised 538 locations (including 67 investigative locations and 471 validation sample locations) for a site of 5.9 hectares. This equates to a validation sampling frequency of 91 samples per hectare and is considerably higher than the minimum sampling frequency provided in the NSW EPA (1995) Sampling Design Guidelines of 11 points per hectare for a site of 5 hectares. The auditor also considers that the number of validation samples was acceptable for the soil validation works at the site. Validation sample locations are shown in **Figures 26 - 42, Appendix A.**

Sampling densities from stockpiles of excavated materials was typically 1 per 50 m^3 which did not meet the Service Station Guidelines of 1 in 25 m^3 [9]. Samples of imported VENM material were reportedly collected at a rate of approximately 1 per 100 m^3.

The results of validation samples are provided in summary tables in **Appendix F**.

In summary, EnRiskS provided the following summary of the soil validation works by PB (2010):

Impacted soil on the site has been remediated with validation reported provided by PB (2010b to 2010h). Review of these reports indicates the following:

- *Soil has been remediated on site on the basis of future redevelopment for residential use;*
- *The work was conducted in accordance with a Remediation Action Plan (RAP, not available for this assessment).*[sic] *Review of the soil validation criteria, presented in the validation reports, are considered appropriate for the protection of human health and environmental (based on phytotoxicity) issues based on residential land use;*
- *Validation sampling conducted* [sic] *reported all concentrations below adopted validation criteria, relevant for residential use. Where exceptions were identified, additional excavation was conducted to remove materials that exceeded the adopted criteria. The exceptions identified include:*
    - o *The presence of some polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH) contamination which remained in the sandstone along the western wall of the creosote pit excavation. A risk assessment was conducted by ERM (2006) in relation to these residual impacts and did not identify any unacceptable risks to groundwater or future users of the site. On this basis no risk issues have been identified in relation to these residual impacts.*
- *Imported backfill was verified as VENM and is suitable for use on the site.'*

EnRiskS concluded that:

'*On the basis of the above, no soil impacts remain on-site that warrant further assessment in this report.'*

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[9] The Guideline variously states that sampling density of 1/25m^3 and 1/50m^3 are acceptable.

Auditor's Opinion

Soil validation works were reviewed in stages by the auditor and were the subject of a range of correspondence provided in **Appendix C**. The overall (final) validation reports are considered by the auditor to provide sufficient information regarding the nature and type of material remaining on the site and the suitability of the soils for a range of possible land-uses, including residential land-use.

Chemical validation sampling for remediation of the 6 areas of the site is considered to have been undertaken in a satisfactory manner and with a sufficient sampling density and analytical regime to suitably validate these areas.

In general, the auditor concurs with the adopted approach regarding leaving the material at depth in the former creosote pit, based on the results of the HHRA by ERM (Section 5.3.3) which determined that the material posed no significant risk to workers or future occupants on the site, and given the difficultly posed in removing the material.

The auditor considers the discussion and analysis conducted by PB with respect to the conditions at the site to be broadly acceptable and concurs with the overall conclusions presented by PB and EnRiskS in the various final Validation Reports regarding soil validation.

5.4.2 Groundwater Validation / Clean Up to the Extent Practicable

EnRiskS prepared a Groundwater Remediation and Validation Report in January 2011 in relation to the 'Impacted Zone' as defined in **Section 5.2.3** of this SAR. The report provides an overview of previous detailed investigations where the viability of a 'Clean-up to the Extent Practical (CUTEP) determination was assessed.

The report provides the following summary information for the site and in particular the impacted zone:

'While the majority of the site is proposed to be rezoned for Residential (2(b)) [sic] *purposes, the following is noted in relation to the area to be defined as the Impacted Zone:*

- *The final use of the Impacted Zone, as to be defined by council during the rezoning of the whole site, is for roadway access, public car parking or public open space.*
- *No buildings are to be constructed above the PSH impacted zone; and*
- *No groundwater is to be extracted for any purpose on the site (note that this would be unlikely given the poor yield of the groundwater aquifer and the availability of reticulated water in the area).'*

A conceptual site model is provided by EnRiskS for LNAPL (light non-aqueous phase liquids) or PSH found in the vicinity of the former fuel infrastructure. The PSH is described as *'confined to the fractured sandstone unit with in the central portions of the site*' and *'has exhibited limited mobility and as a result recoverability will be limited'*. The conceptual model presented is provided below:

- *'PSH distribution and migration at the site is highly anisotropic and controlled by a discrete fracture network. Based on pump tests conducted at the site this fracture network is discrete and limited with bulk permeabilities in the bedrock characterised as low;*

- *The recoverability of PSH within the fractured rock at the site is very low as PSH will remain trapped in fractures, voids and vesicles within the bedrock unit. Based on the limited recovery from both the MPE event and manual bailing conducted at the site, the volume of potentially recoverable PSH is low;*
- *The spatial distribution of PSH has changed little in the four to five years of groundwater monitoring (2005/2006 to 2011), with the observed changes in LNAPL thickness likely to be a function of fluctuations in groundwater levels; and*
- *The dissolved phase impact area is generally confined to the immediate vicinity of the LNAPL (also refer to Section 4.2 and 4.3 [of EnRiskS report] for further discussion on the overall plume stability).* [sic]'

EnRiskS provided a summary of the E2W MNA report:

'On the basis of the underlying site conditions, available data and the groundwater modelling, it was concluded by E2W (2011b) that natural attenuation processes are robust and sufficient for long term stability and ultimate restoration of the groundwater as:

1. *Bedrock aquifer has low permeability and groundwater velocity (<1 m/year);*
2. *The PSH is thin and localised to the central area of the site. The PSH is trapped as residuals within the fracture network, is not mobile and limited to no recoverable volumes of PSH exist at the site;*
3. *Long term monitoring data shows that the plume is generally stable with overall declining trend;*
4. *Groundwater is not and is unlikely to be used for any beneficial use, including as a potable supply, due to its low yield and salinity; and*
5. *Risks to offsite receptors are negligible as groundwater conditions are stable and the plume will not migrate off-site and/or discharge to surface water.'*

The remainder of the site outside the 'Impacted Zone' is addressed in the report with reference to the possible / intended development for low to medium density residential use. EnRiskS conclude that *'no unacceptable risks are associated with the development of the area outside of the 'Impacted Zone' and vapour migration from the 'Impacted Zone' to peripheral areas is not identified as a concern on the basis of the following:*

1. *The impacted groundwater plume is considered to be stable (refer to Section 4) and no further migration beneath adjacent areas on the site, or off-site, is expected to occur;*
2. *No significant geological zones have been identified in the unsaturated zone overlying the impacted groundwater that would result in the preferential lateral migration of vapours;*
3. *The migration of petroleum hydrocarbon vapours is attenuated by aerobic degradation (demonstrated to be occurring in the soil gas data collected and reported in the HHERA, enRisks 2011a and Appendix C), with conditions outside of the 'Impacted Zone' conducive to effective aerobic biodegradation;*
4. *The proposed use of the 'Impacted Zone' for roadway, car parking or public open space will not occlude the movement of oxygen into the subsurface sufficiently to prevent aerobic degradation from effectively attenuating vapour migration; and*

5. *No risk issues (that require any management measures for any receptor) have been identified for any of the proposed future use of the site at the edge of/adjacent to the proposed Impacted Zone.'*

A summary of the risk assessments which have been relied upon in the Groundwater Validation Report is provided in **Section 5.4.3.**

The groundwater remediation and investigation activities at the site were discussed by EnRiskS with reference to the demonstration of Clean-up to Extent Practicable (CUTEP) in their report. The consultant's conclusions were as follows:

'While the site has not been fully remediated and residual PSH and groundwater impacts remain in groundwater, the extent of these impacts are confined to the 'Impacted Zone' and the plume has been shown to be stable. The stability of groundwater impacts has been attributed to the low permeability of the bedrock units and the robustness of natural biodegradation processes. The plentiful supply of electron acceptors in both up-gradient and down-gradient groundwater will ensure the long term stability and continued reduction in the extent of groundwater impacts and ultimately restoration of groundwater.

While not fully remediated, further remediation of the 'Impacted Zone' is not considered practical and a CUTEP determination is recommended. CUTEP is considered a practical alternative for this site as extensive source remediation has been completed, the residual impacts in the bedrock are confined to the site, the groundwater plume is stable and poses no risks to the environment and through implementation of proposed land-use restrictions and an EMP, risk to human health are effectively managed. This CUTEP recommendation is consistent with the requirements outlined in the NSW Guidelines for the Assessment and Management of Groundwater Contamination (NSW DEC 2007).'

Auditor's Opinion

The auditor considers that the consultants' appraisal of the groundwater contamination and remediation works undertaken is reasonable. The auditor notes that vesicles are not commonly found in sandstone. The auditor is satisfied that the extensive investigation and modelling undertaken at the site has provided a sound and reliable database of information on which to base conclusions regarding the suitability of natural attenuation as a remediation strategy. Further (ongoing) monitoring has not been proposed by the consultant and the auditor considers that the monitoring results from previous investigations (2006-2011) can be relied upon to demonstrate that natural attenuation of hydrocarbons is occurring and is likely to continue over time.

An EMP for the 'Impacted Zone' is recommended in the report by EnRiskS to provide a framework for long-term management of the 'Impacted Zone' and to prevent the construction of buildings/structures and to preclude the abstraction of groundwater for any purpose within the Impacted Zone. The auditor considers the use of an EMP to be a suitable solution to the ongoing management of the site. In this regard the auditor notes the need for the EMP to be legally enforceable under Section 3.4.6 of the NSW DEC (April 2006) *Guidelines for the NSW Site Auditor Scheme* (2nd edition). As such the auditor requested that the approval of a regulatory body (such as local government) or the opinion or a suitably qualified legal professional be sought to determine that such a document (EMP) can be made legally enforceable. Further discussion of the EMP is provided in Section 5.5 of this NS SAR.

The auditor notes that the presence of PSH at one remaining location on the site (MW06) has triggered the notification of the site to the EPA, and while the auditor is satisfied with the findings of the consultants regarding the ongoing management of the site and implementation of the EMP (Section 5.5 of SAR), , and while EPA are understood to have determined that formal regulation will not be required under the Contaminated Land Management Act 1997 (See correspondence from EPa dated 9 February 2012 in Appendix C), formal notification to this effect has not been made at the time of writing. Notwithstanding it is the auditor's opinion that further monitoring is not required. In addition the auditor is of the view that the site does not require to be regulated under the Contaminated Land Management Act.

5.4.3 Risk Assessments

The first risk assessment was undertaken in 2005 by URS to address risk to offsite residents to site related particulate (dust) and volatile chemicals emissions caused by the planned remediation activities. Both short term (acute) and long term (chronic) exposures were evaluated in relation to both soil and groundwater contamination at the site. The following potential pathways were identified for groundwater contamination at the site:

- *Inhalation of volatile chemicals – BTEX, TPH*
- *Inhalation of Particulate (dust) – BTEX, TPH, PAH and B(a)P*
- *Direct Contact with impacted soil – BTEX, TPH, PAH and B(a)P – not applicable to off-site residents*

The following conclusion was provided by URS:

'In conclusion, the risk to human health for offsite residents associated with the remediation of contaminated soil and exposure to volatiles and particulates on the Minto field services centre is assessed as low and essentially negligible.

The risks to human health associated with groundwater for off-site residents (including visitors) and workers in the vicinity of the site have been quantified and are assessed as low. This does not include the assessment of potential future developments on the site that include subsurface basement levels, where further quantification of exposure would be required.'

A risk assessment was also undertaken by Environmental Risk Sciences (EnRiskS) in 2011. This risk assessment addressed the issues of risk associated with groundwater contamination on the site (in particular in the central portion of the site in the vicinity of the former USTs). Various exposure/risk scenarios were addressed in the human health and environmental risk assessment (HHERA) including:

- Risks During Construction and Intrusive Works;
- Risks Following Development – Residential Use;
    - o Construction of a new residential building (slab-on-grade) above the groundwater plume;
    - o Construction of a new residential building (slab-on-grade) above the groundwater plume with a ground level car-park;

- o No buildings are constructed directly above the groundwater plume, however a building is constructed adjacent to the plume and the area above the plume is used as an outdoor area (which may include a playground); and

- Environmental Risk – impacted groundwater derived from the site to migrate to and adversely affect the freshwater aquatic environment of McBarron Creek.

Soil, groundwater and soil vapour data were collected from primary and secondary sources at the site. Soil vapour data were obtained based on three nested soil vapour wells targeting shallow (approximately 1.8 m bgl) and deep (approximately 3.2 m) soil vapour horizons. One round of soil vapour sampling was undertaken on 1 November 2010.

Quantification of human health risk was modelled by EnRiskS according to enHealth (2004) based of the following:

- Source concentration term – based on the maximum soil vapour data from monitoring;
- Chemical-specific parameters – based on literature search;
- Soil properties and building parameters – based on literature defaults, standards and guidelines;
- Exposure dosimetry - based on Australian and international exposure guidelines; and
- Toxicity reference concentrations and unit risks - based on Australian and international exposure guidelines.

A qualitative assessment of environmental risk was undertaken on based freshwater aquatic environments.

The conclusions derived from the risk assessment by EnRiskS (2011) were as follows:

- *'Risks During Construction and Intrusive Works - Potential exposures by workers involved in construction of new buildings on-site and intrusive works to maintain services, in particular inhalation exposures within excavations, are considered to be low. No unacceptable risk issues have been identified for these workers. Hence no additional risk management measures are required, over and above those required by legislation and industry. In the event that deep excavations are placed above impacted groundwater, risks remain acceptable, however petrol type odours may be noticeable (depending on the proximity of works to the contamination).*
- *Risks Following Development*
  - o *Residential Use - Potential exposures by future residents who may reside/use the central portion of the site have been assessed for a number of potential scenarios, which include:*
    - > *Construction of a new residential building (slab-on-grade) above the groundwater plume: If a new building were constructed directly above the impacted groundwater, and residential homes were constructed on the ground floor, then there is the potential for exposures to volatile petroleum compounds within the home to be elevated and risks potentially unacceptable. If such a building were to be constructed vapour mitigation measures would need to be designed into the building to address vapour risks.*
    - > *Construction of a new residential building (slab-on-grade) above the groundwater plume with a ground level car-park: If the new building were constructed with a ground-level*

car-park, with residents living on the 1st floor, then exposures are low, and no unacceptable risks have been identified.

- o *No buildings are constructed directly above the groundwater plume, however a building is constructed adjacent to the plume and the area above the plume is used as an outdoor area (which may include a playground);*
  - > *If a new building were constructed that was adjacent to the groundwater plume, exposures, derived from lateral vapour migration would be low and no unacceptable risks have been identified. This conclusion is relevant for residential buildings adjacent to the groundwater plume regardless of the future use of the area above the plume;*
  - > *Exposures in outdoor areas located above the groundwater plume are low and no unacceptable risks have been identified.*

- *Environmental Risk - On the basis of the available data, including additional data/observations collected as part of this assessment, the potential for impacted groundwater derived from the site to migrate to and adversely affect the freshwater aquatic environment'.*

The auditor has conducted a review of the HRA with reference to the auditor's guidelines as provided in Table 14.

Table 14 - Human health risk assessment checklist (Appendix VII – Site Auditors Guideline 2006)

Hazard identification	Yes / No	Comments
Have all appropriate sources of information regarding chemicals of potential concern been identified and appraised?	Yes	
Has justification been given for the selection of the chemicals of potential concern?	Yes	Methane was detected in the soil vapour. Assessment of methane risk was undertaken qualitatively following auditor comments.
Has justification been given for the omission of chemicals from the analysis?	Yes	
Toxicological information		
Have all relevant toxicological facts been checked for accuracy and currency?	Yes	
Has the adequacy of the available toxicological database been commented on?	Yes	
Have the effects on each body system (for example renal, hepatic, cardiovascular and developmental) and the types of effects (for example genotoxic and carcinogenic) been summarised?	Yes	

Hazard identification	Yes / No	Comments
Have all relevant allergic/idiosyncratic toxicological effects been noted?	Yes	
Have the critical toxic effects been identified?	Yes	
Has the experimental basis of the toxicological reference dose or potency factor, where applicable, been discussed and the uncertainties noted?	Yes	
Have the NHMRC (now enHealth) (where applicable) or World Health Organisation (WHO) toxicological assessments been considered as the primary toxicological resource?	Yes	
Where relevant, have differences between, for example, WHO and US Environmental Protection Agency (USEPA) toxicological assessments been discussed?	Yes	
Has the dose-response relationship for chemicals of potential concern been discussed?	Yes	
Has the data been presented in a form amenable to efficient interpretation and review?	Yes	
Exposure assessment		
Has the potentially exposed population been identified?	Yes	Human exposure scenarios from future developments within the 'Impacted Zone' that include basements, swimming pools or other similar development that involves excavation such that human receptors are taken at or close to the source of contamination were deemed unlikely by EnRiskS citing that council rezoning of the site is intended to be for roadway access, public car parking or public open space. Furthermore, EnRiskS stated that no buildings are to be constructed above the phase separated hydrocarbons (PSH) impacted zone. An EMP has been prepared in this regard.
Have potentially exposed, unusually susceptible sub-populations been identified?	Yes	
Have the estimates of chemical exposure for each exposure route and	Yes	

Hazard identification	Yes / No	Comments
chemical of potential concern been quantified and tabulated?		
In cases of presumed insignificant risk, has the risk been demonstrated to be small?	Yes	Methane risk has been assessed to be insignificant following additional testing and flow measurements. (Ref: BS8485 and/or CIRIA 665)
Has the relative significance of each exposure pathway, based on the risk analysis, been discussed?	Yes	
Equations		
Have all equations used in the risk assessment been presented in the report?	Yes	
Are all equations consistent?	Yes	
Have all parameters in each equation been clearly defined?	Yes	
Have the correct units been allocated to each parameter?	Yes	
Are all equations dimensionally correct?	Yes	
Have all unit conversion factors, where applicable, been included in the equations?	Yes	
Has all pertinent information been provided to enable calculations to be checked through in a step-wise process?	Yes	
Data evaluation		
What were the data collection objectives and are they consistent with the requirements of the risk assessment?	Yes	
Have the laboratories that did the chemical analyses been noted, and do they have NATA accreditation (or equivalent) to perform each particular chemical analysis?	Yes	Soil vapour samples were analysed by Air Toxics Ltd (ATL) in the United States of America. ATL has certifications, validations and approval from local agencies in the USA including the National Environmental Laboratory Accreditation Conference (NELAC). NELAC is an association of the US EPA, State, and other Federal agencies formed to establish and promote mutually acceptable performance standards for the inspection and operation of environmental laboratories. NELAC standards include specifications contained in ISO/IEC 17025 by the

Hazard identification	Yes / No	Comments
		International Organization for Standardisation.
Has laboratory QA/QC been reported and analysed?	Yes	
Has field QA/QC been reported and analysed?	Yes	
Where appropriate, has the size of any 'hot spot' detected by the sampling pattern been stated?	Yes	E2W concluded that PSH was centred around MW06. The nearest soil vapour data is located approximately 10 and 20 metres from MW06. It is possible that the maximum soil vapour concentrations used in the HHERA may have been under estimated. However, doubling the maximum soil vapour concentrations will not alter the overall conclusion of the HHERA.
Have statements of the accuracy of the laboratory data for each contaminant been made?	Yes	
Assessment and report presentation		
Have all tables and figures been referred to correctly in the text of the report?	No	The text in Section 5.2 of the HHRA by EnRiskS has referred to Table 10 instead of Table 11. This typographical error does not alter the result of the HHERA.
Has information from other sites been excluded from the report?	Not applicable	
Has information from previous reports on the site been appropriately selected and incorporated into this report?	Yes	
Have all assumptions and default data been identified and justified?	Yes	
Has the analysis been based on an up-to-date literature appraisal?	Yes	
Have all conclusions been justified?	Yes	
If toxicological data and the exposure scenario lead to the conclusion that a high concentration of contaminant is permissible, does the result violate ecological, aesthetic, land-use or physical principles?	No	No adverse environmental risk has been identified in the HHERA.
Has a risk management decision been made during the course of the risk assessment and, if so, how might that have influenced the calculation of risk?	No	Risk management has not been included in the HHERA. It is noted that as a precautionary measures, a post-closure environmental management

Hazard identification	Yes / No	Comments
		plan (EMP) has been prepared to manage risk associated with the residual groundwater contamination.
Has a detailed uncertainty discussion been included in the report?	Yes	
Has information been presented coherently and in an appropriate sequence to enable efficient appraisal of the report?	Yes	

Auditor's Opinion

The auditor conducted reviews of the HHERA and earlier revisions were amended to incorporate auditor feedback and queries as noted in **Appendix C**. Whilst uncertainties exists on the spatial and temporal soil vapour and groundwater concentrations, the physico-chemical and toxicological properties of the identified chemicals of potential concern, and the exposure modelling as noted by EnRiskS, an environmental management plan (EMP) has been prepared to manage any residual risk posed by contaminated groundwater. In this regard, the overall conclusion of the HHRA is considered acceptable by the auditor.

5.5 Environmental Management Plan (EMP) for the 'Impacted Zone'

EnRiskS prepared an EMP for the 'Impacted Zone' in January 2012. The following objectives were listed in the EMP:

- *'To inform construction/development workers, and potential purchasers of the environmental condition of the site, including:*
    - *Groundwater contamination at the site;*
    - *Hydrocarbon vapour in soil; and*
    - *Any embargos regarding groundwater abstraction.*
- *To outline requirements for the management of exposure by construction workers and those involved in ongoing use and management of the site, to contamination.'*

The EMP provides an outline of the environmental management structure and responsibility including requirements for a Health and Safety Plan outlining key project personnel, scope of works, emergency contacts, emergency response procedures and job hazard analysis documents covering all works. Requirements for reporting including keeping records of site works, training records, incidents and complaints and monitoring and inductions are also included in the EMP.

The implementation of the EMP includes risk management. The following general stages of risk management were outlined by EnRiskS:

'1. Identify the hazards;
2. Assess the risks;
3. Decide on appropriate control measures to manage the risks (refer to Section 3.2);

4. Implement controls; and
5. Monitor and review the effectiveness of these measures.'

Management of risk during intrusive works, including the management of soil, groundwater and equipment at the site were outlined in the EMP. The following 'hierarchy of control' presents control measures was proposed by EnRisk :

1. Elimination;
2. Substitution;
3. Isolation / Engineering;
4. Administrative Controls; and
5. Personal Protective Equipment (PPE) and workplace monitoring.

Correspondence provided by Endeavour Energy dated 19 December 2011 (provided in **Appendix C**) addressed then queries from the auditor relating to the need for the EMP be 'reasonably legally enforceable'. In this regard, an extract from the minutes of a meeting held between Endeavour and Campbelltown Council to discuss the issues of management and enforceability of the EMP for the 'Impacted Zone' are shown below:

'The EMP will be implemented by the Council or by Endeavour, depending on the final agreement with Council. In the event that Council chose not to own and manage the area following receipt of the Site Audit Statement, Endeavour will fence and own the impacted land and implement the EMP. The mechanism by which the contamination would be notified would be through the planning tools available to the Council (e.g. Section 149). If the land is divided into separate Lots in the future, Council with refine the annotation on the Section 149 to accurately reflect and capture which Lots are above the impacted groundwater. The 'impacted zone' will be identified in the EMP and on the Section 149 using co-ordinates and a detailed survey plan.'

Auditor's Opinion

The auditor considers that the EMP provides a suitable framework for the ongoing management of the contamination remaining within the 'impacted zone'. Following clarification of some issues raised by the auditor with the consultant and client (Endeavour), EnRiskS consider the mechanisms to ensure that the EMP is reasonably legally enforceable have been suitably addressed with Council. Also, since the EMP is expected to be managed via planning arrangements (under the Section 149 Planning Certificate for the land), the auditor considers that measures to ensure appropriate notification of any restrictions to potential purchasers or interested parties will ultimately be in place. Also, based on the results from groundwater modelling EnRiskS and E2W have concluded that there is no off-site migration of contamination from the site which is the subject of the audit. As such, the EMP has been accepted by the auditor (noting that a revised EMP and HHRA may be required once details of the future redevelopment are known).

6. Completeness and Adequacy of Investigations

6.1 Sampling Strategy and Plan

The site history review provided in the earlier investigation by SKM (2000) revealed important information relating to the use and operations on the site whilst operational as Integral Energy's main depot for the Campbelltown and Macarthur Region for maintenance of electrical distribution network as well as the location of the various areas of environmental concern related to former land uses and activities.

The sampling density adopted for the investigation by SKM involved 61 boreholes in 2000. In addition, 18 test pits were excavated by URS and 10 additional boreholes drilled by PB. An additional 10 boreholes were drilled by ITE, ERM and URS and soil samples were also taken from these locations. In total, 99 soil locations were sampled during investigation works. This does not include the investigation samples taken by ITE during the first round of remediation works.

Given the site area of 5.9 hectares this represents 16.7 samples per hectare which satisfies the minimum sampling density proposed in the NSW EPA (1995) Sampling Design Guidelines of 11 points per hectare. The approach to investigation and site characterization is therefore considered to be satisfactory.

ITE, PB, ERM and URS installed a total of 20 groundwater monitoring wells on the site, which included two replacement wells for piezometers destroyed during remediation works (MW5 and MW9). This ratio is considered to provide adequate coverage of the site.

The sampling frequency for validation works of 538 samples for the 5.9 hectare site or 91 samples per hectare is also considered acceptable and meets the NSW EPA guideline requirement of 65 samples for a site of this size, noting that not all the site area required validation.

Sampling density of stockpiles during remediation works by ITE and PB were reportedly typically 1 per 50-100 m^3 of waste. Samples of imported VENM material were reportedly collected at a rate of approximately 1 per 100 m^3.

Auditor's Opinion

Following correspondence to clarify certain issues (**Appendix C**), the overall sampling strategy by the consultants was considered satisfactory.

6.2 Sampling Procedures

Soil sampling procedures adopted by SKM, ITE, PB, URS and ERM involved a range of testing and sampling methods, including drill rig, excavator, hand auger and hand tools. The majority of test locations were excavated using a drill rig to depths of up to 3 - 4 m bgl. Samples were taken from 0.5 m intervals by SKM. Validation surface samples taken by ITE/Coffey and PB were from the walls and base of the tank pits and excavations as well as from validation test pits. Surface samples were taken from 0 - 0.1 m with samples taken at 0.5 to 1.0 m intervals by PB.

PID readings were obtained using a pre-calibrated device to determine if VOCs were present in soils and filling, and from bores. The head space method was used in the majority of cases, by measuring VOCs emitted from bagged (replicate) soil samples. This was undertaken in the 2000-2006 sampling by all consultants. Calibration records were provided for the PID used in the investigation by ITE/Coffey, URS and ERM. Calibration certificates were requested by the Auditor for PB reports, however, these were not able to be found by PB and were therefore not provided in final PB validation reports (see **Appendix C**).

SKM noted that soil and validation samples were obtained from the solid stem and by hand auger. ITE/Coffey reported tank pit samples were obtained from freshly opened surfaces taken from within the excavator bucket, by use of a hand trowel or disposable nitrile glove. PB reported samples were collected by hand from split spoon. The decontamination of the hand auger or hand trowel was by high pressure cleaner or washing with phosphate free detergent and then potable water. Where relevant, new sterile gloves were used for each sampling event and following the decontamination of equipment. Samples were collected in laboratory prepared 250 gram glass jars and were immediately stored on ice in a chilled container and then couriered to the receiving NATA registered laboratories (AMDEL, MGT Environmental Consulting, ALS Laboratory, LabMark, Australian Safer Environmental and Technology P/L (ASET)). Sampling conducted for asbestos analysis was reportedly taken by PB and SKM using the same techniques provided above.

Groundwater monitoring well installation was undertaken by Terratest and Macquarie Drilling using a truck mounted rotary rig under the supervision of ITE, PB and URS. The drill rig was not specified in the ERM report. Wells were installed to depths of up to 18.0 m bgl and were constructed with UPVC machine slotted screen and blank riser, sand filter annulus, well base cap and gattic cover, and bentonite grout in the non screened section. Screen intervals were generally of 3.0 m lengths at the base of each well with the objective of spanning the interface between the sandy soils and clay (i.e. the zone of likely seepage). Sampling occurred followed purging and recovery and was subject to the monitoring of field parameters to demonstrate equilibrium conditions had been achieved. The driller, Terratest and Macquarie, were appropriately licensed. Despite a request from the auditor, no record of NSW Bore Licence Number was provided to the auditor to validate that the appropriate approval for the bores had been obtained.

Various rounds of groundwater purging and sampling have been carried out. PB reportedly used dedicated disposable bailers. Field parameters (pH, dissolved oxygen, electrical conductivity, redox potential and temperature) were measured during the purging process to ensure stable geochemical conditions were achieved prior to the collection of groundwater samples.

PB used a base-fed flow-cell TPS FLMV90 to measure all physiochemical parameters (electrical conductivity, pH, redox potential and temperature). Purging was apparently undertaken until these variables stabilised. Samples were decanted into supplied bottles (glass and plastic with preservatives) or vials (for BTEX analysis). No groundwater filtering was undertaken.

E2W inspected for PSH using disposable bailers. Groundwater was gauged with an acoustic water level probe and field chemistry (pH, EC, temperature, redox potential, DO) was measured during well purging using a calibrated (TPS 90FLMVF) multi-parameter meter. E2W purged wells using a bilge pump and water samples were collected with a dedicated (disposable) clear tube bailer (polyethylene) to allow inspection of the water sample.

The names of the field staff were supplied in the various reports, and as far as is known the personnel involved were well experienced and qualified field engineers and scientists.

Auditor's Opinion

The various sampling procedures were considered adequate for the ground conditions encountered and the range of contaminants present at the site. The use of either disposable bailer or interface probes for inspection of PSH and estimation of PSH thickness by different consultants may have resulted in some variation in results as noted elsewhere.

6.3 Quality Assurance and Quality Control (QA/AC)

6.3.1 Field QA/QC

Data quality objectives based on the seven step planning approach outlined in the NEPM, 1999 were not addressed in earlier reports by SKM (2000) in the format below. However the later reports by ITE/Coffey, URS, ERM, E2W and PB contained comprehensive information on DQOs. Copies of the DQOs have been provided in **Appendix J** for the validation reports.

Step 1 – State the Problem
Define the problem; identify the planning team; examine budget, schedule

↓

Step 2 – Identify the Decision
State decision; identify study question; define alternative actions

↓

Step 3 – Identify the Inputs to the Decision
Identify information needed for the decision (information sources, basis for Action Level, sampling/analysis method)

↓

Step 4 – Define the Boundaries of the Study
Specify sample characteristics; define spatial/temporal limits, units of decision making

↓

Step 5 – Develop a Decision Rule
Define statistical parameter (mean, median); specify Action Level; develop logic for action

↓

Step 6 – Specify tolerable Limits on Decision Error
Set acceptable limits for decision errors relative to consequences (health effects, costs)

↓

Step 7 – Optimise the Design for Obtaining Data
Select resource-effective sampling and analysis plan that meets the performance criteria

While earlier reports did not specifically address the 7-step DQOs, the consultants addressed the specific requirements for appropriate field team and site management during fieldwork, adoption of a suitable QA/QC system, recording of sampling (logs, field sheets etc.), equipment calibration, chain of custody documentation, sample preservation and integrity during handling, transport and delivery, collection of field duplicates and other field QA/QC samples and achievement of holding times.

Investigations

Earlier reports by SKM refer to the DQOs as to '*obtain sufficient data that would allow an Environmental Assessment to be made of the site and to determine the nature of contamination in the investigation area, and the risks posed to human* health'.

SKM reportedly collected 5 QA/QC duplicate samples from a total of 62 bores (58 samples) and sent to an alternative laboratory. Samples were analysed for a range of analytes including heavy metals, TPH/BTEX and PAH. Exceedances in RPD (<50%) were accredited to low concentrations, inhomogenous contaminant concentrations or difference in laboratory methodology. This ratio equates to 8.6% which and below the recommended DQO of 10%. The auditor notes shortcomings in the QAQC undertaken for the SKM 2000 report, however these results are largely superseded by works undertaken by other consultants.

During sampling by ITE/Coffey, 56 duplicate samples were taken from 281 validation samples, i.e. a rate of 1 duplicate per 10 samples for stockpile samples. Samples were analysed for a range of analytes including TPH/BTEX, metals, PAH, phenols, OCP and PCB. Exceedances in RPD (30-50%) were detailed in the QAQC sections of the ITE reports and were generally attributed to sampling methods (excavator bucket causing loss of volatiles), low concentrations (near LOR) causing larger RPDs for small variation, or the heterogeneous nature of the soil. Variation in the triplicate samples between the different labs (ALS and Amdel) was attributed to different analytical procedures, calibration setting, operation skill and judgement employed at each respective laboratory. Differences in RPD for triplicate samples were not considered to be significant by ITE. Equipment blanks were taken at the start of every day (16 samples in total) and analysed for a range of analytes.

In combination the reports by ITE (2003-2006) and the Addendum Report by Coffey (2007) provided sufficient information and discussion of DQOs and DQIs including identification of the QA/QC samples taken and analysed which equated to a frequency of 1 in 10 field duplicates and triplicates. Review of field samples and laboratory duplicates to evaluate whether RPDs for sample pairs were within acceptable ranges (less than 30-50% for field duplicates and 20-50% for laboratory duplicates), analyses of method blanks, matrix spikes, laboratory control and duplicate samples and recovery data, which should be in the range of 75-125%, confirming overall acceptability.

DQOs and DQIs were detailed in the URS report. Field duplicate (same lab) and triplicate (different lab) were taken at a rate of 1 per 20 samples. Rinsate blanks were also taken at a rate of 1 sample per investigation area. All results were reportedly within the acceptable range.

Duplicate sampling by ERM was undertaken at a rate of 1 duplicate per 10 samples (i.e. 2 duplicate water samples) and 1 trip blank water sample was taken as part of the investigation. Results were within the acceptable range for RPDs.

Validation

For the investigations PB outlined a site conceptual model in the investigation outlined contaminant sources, pathways and transport and potential receptors. On the basis of this model the sampling and analysis methodology was determined for each investigation. For the various soil validation reports, the QA/QC decision rule was specified as follows:

'Sampling to industry standard procedures – 1 in 10 blind duplicates (intra-laboratory) to the primary laboratory and 1 in 20 blind duplicates (inter-laboratory) to the secondary laboratory. Field duplicate acceptable limits are between 30-50% RPD as stated by AS 4482.1-2005 for non and semi volatile compounds. Non-compliance is to be documented in report and sample to be re-analysed or higher level to be conservatively adopted. 1 trip blank per sampling event. 1 trip spike per batch of volatiles'

Rinsate samples were taken for each of the remediation areas. In total 13 rinsate samples were taken from Buildings A and B, Building C and NW corner, Buildings E, F and G, former Building H area, former Creosote pit and pole storage area, southern car park and hardstand area. All results were below detection with the exception of low level lead in one rinsate sample. One trip blank was also taken with results below detection with the exception of low level chromium. Duplicate samples for validation, stockpiles and imported VENM were taken at a rate of 1 in 10 blind duplicates. In total 75 duplicate samples were taken across the 6 areas. Results were generally with acceptable RPD ranges, with the exception of some heavy metal, TPH, BTEX and PAH results. PB provided the following explanation of the exceedances:

'It is considered that the likely cause of these exceedances is concentrations being reported close to laboratory PQLs. It is considered that these RPD exceedances are marginal and likely to be due to some variability in the material sampled. It is considered that the RPD exceedances have not affected the overall conclusions of this report.'

Groundwater

The QA/QC programs employed for the groundwater investigation by URS, ERM, PB and E2W were reviewed by the auditor periodically as part of the audit review process as and when reports were submitted to the auditor. Similarly, SAQPs submitted prior to works were reviewed with reference to the QA/QC programs. Duplicates were generally taken at less than 1 in 10 blind duplicates. Where shortfalls were identified, these were discussed with the consultants as provided in correspondence in **Appendix C**.

In the PB investigation (May 2006), 2 rinsate samples, 1 duplicate and 1 triplicate samples were taken from 9 groundwater samples. Slightly elevated zinc in rinsates and some exceedances of RPD in duplicates and triplicates were noted. These were attributed to matrix interference as reported by the laboratory which was probably associated with the presence of PSH in the well (MW06).

During PB investigations in 2007, 2 trip blanks were analysed for TPH and BTEX and 2 trip spikes were analysed for TPH/BTEX. Results were within acceptable ranges, however, some volatile losses may have occurred between sampling and transport. Two intra-laboratory field duplicates were taken. Elevated RPDs for TPH and benzene were noted and attributed to variability in samples collected, inherent variability in analytical results and also possibly of some volatile loss during sampling.

During PB sampling undertaken in 2008 one trip blank was taken from each sampling round and analysed for BTEX. All results were non-detect. Two rinsate samples were taken as part of the investigation and analysed for TPH and BTEX/MAH. One trip spike from each sampling round was analysed for BTEX with volatile recovery results within acceptable ranges. Two intra-laboratory duplicates and 1 inter-laboratory triplicate sample were analysed for TPH and BTEX. Higher RPDs were attributed to variability in the samples, laboratory methods or equipment. These are not considered to impact the overall results of the investigation.

Between 2009 and 2010, PB undertook a QA/QC program which included collection of one trip blank from each sampling round, one trip blank per sampling round (BTEX), one rinsate for each day of sampling (9 rinsates in total), two intra-laboratory duplicates and one inter-laboratory triplicates for each of the four quarterly sampling events (12 in total). Where exceedances were noted, they were attributed to results being close to laboratory PQLs (LOR) and variability in the samples, laboratory methods or equipment.

Discussion of QA/QC in the E2W groundwater works undertaken in 2010 was limited. In 2011 the QA/QC sample suite included 1 blind field duplicate sample and one inter-laboratory duplicate. Exceedances of RPDs were attributed to TPH which is likely to cause some matrix interference and laboratory imprecision.

All exceedances of acceptable ranges in QA/QC samples were justified by the consultants and not considered to affect the overall reliability of the results.

A summary of the QA/QC sections of the various reports as well as QA/QC data is presented in **Appendix J.**

6.3.2 Laboratory Quality Assurance and Quality Control

The laboratory analytical reports prepared by the laboratories were presented by the consultants in site investigation reports (as referenced previously) as follows:

SKM (2000)

- MGT Laboratories Report 1365902 dated 25 November 1999 for 58 soil samples;
- ESP Laboratories Report 7842 dated 24 November 1999 for 2 material samples;
- Amdel Report 9E03206 dated 19 November 1999 for 5 soil samples;

ITE/Coffey (2003-2006):

- ALS Report ES0600717 dated 30 January 2006 for 23 soil samples;
- ALS Report ES43187 dated 6 November 2006 for 1 soil sample;
- ALS Report ES0508499 dated 18 October 2005 for 3 soil samples;
- ALS Report ES0508745 dated 26 October 2005 for 7 soil samples;
- ALS Report ES0508954 dated 4 November 2005 for 6 soil samples;

- ALS Report ES43187-0 dated 6 November 2005 for 1 soil sample;
- ALS Report ES43187-1 dated 6 November 2005 for 1 soil sample;
- ALS Report ES43187-1 dated 6 November 2005 for 1 soil sample;
- ALS Report ES43187-3 dated 6 November 2005 for 1 soil sample;
- ALS Report ES43187-4 dated 7 November 2005 for 1 soil sample;
- ALS Report ES3813 dated 28 November 2005 for 1 soil sample;
- ALS Report ES43392-0 dated 25 November 2005 for 3 soil samples;
- ALS Report ES43392-1 dated 25 November 2005 for 2 soil samples;
- ALS Report ES43392-2 dated 18 November 2005 for 2 soil samples;
- ALS Report ES43392-3 dated 19 November 2005 for 3 soil samples;
- ALS Report ES43392-4 dated 18 November 2005 for 3 soil samples;
- ALS Report ES508499 dated 18 October 2005 for 3 water samples;
- ALS Report ES45971 dated 17 March 2004 for 4 soil samples;
- ALS Report ES45971-0 dated 17 March 2004 for 4 soil samples;
- ALS Report ES45971-1 dated 17 March 2004 for 4 soil samples;
- ALS Report ES45971-2 dated 17 March 2004 for 7 soil samples;
- ALS Report ES46472-1 dated 2 April 2004 for 2 soil samples;
- ALS Report ES49875-0 dated 8 September 2004 for 1 soil sample;
- ALS Report ES49875 dated 9 September 2004 for 1 soil sample;
- ALS Report ES45971 dated 17 March 2004 for 4 soil samples;
- ALS Report ES43083 dated 31 October 2003 for 1 soil sample;
- ALS Report ES43187 dated 6 November 2003 for 1 soil sample;
- ALS Report ES43187 dated 10 November 2003 for 1 water sample;
- ALS Report ES43392 dated 25 November 2003 for 3 water samples;
- ALS Report ES43083 dated 31 October 2003 for 1 soil sample;
- ASET Report ASET6959/9909 dated 22 October 2005 for 2 material samples;
- Airsafe Report 07499 dated 24 October 2005 at 4 locations;
- Airsafe Report 07452 dated 6 October 2005 at 2 locations;
- Airsafe Report 07334 dated 26 August 2005 at 4 locations;
- A.D Envirotech Australia P/L report 1323/I – 43 dated 3 August 2005 – 17 October 2005;
- Labmark Report E024137 dated 2 November 2005 for 1 water sample;
- Labmark Report E025853 dated 20 March 2006 for 3 soil and 5 water samples;
- Labmark Report E025793 dated 21 March 2006 4 soil samples;

- Amdel Report 6E0244 dated 8 February 2006 for 13 soil samples;
- Amdel Report 6E0244A dated 21 February 2006 for 9 soil samples;
- Amdel Report 6E0077 dated 19 January 2006 for 33 soil samples
- Amdel Report 6E0077A dated 20 January 2006 for 2 soil samples;
- Amdel Report 6E4545 dated 5 January 2006 for 31 soil samples;
- Amdel Report 5E3620C dated 24 October 2005 for 30 soil samples;
- Amdel Report 5E3620D dated 24 October 2005 for 20 soil samples;
- Amdel Report 5E3620E dated 25 October 2005 for 31 soil samples;
- Amdel Report 5E3432B dated 19 October 2005 for 3 soil samples;
- Amdel Report 5E3620E dated 25 October 2005 for 31 soil samples;
- Amdel Report 5E3620F dated 17 October 2005 for 39 soil samples;
- Amdel Report 5E3620B dated 24 October 2005 for 30 soil samples;
- Amdel Report 5E3620C dated 24 October 2005 for 30 soil samples;
- Amdel Report 5E3688 dated 24 October 2005 for 1 soil sample;
- Amdel Report 5E3620A Revision 1 dated 25 October 2005 for 30 soil samples;
- Amdel Report 5E2915 dated 18 August 2005 for 18 soil samples;
- Amdel Report 5E3813 dated 28 October 2005 for 1 soil sample;
- Amdel Report 5E3515 dated 12 October 2005 for 8 water samples;
- Amdel Report 5E3620G dated 12 December 2005 for 14 soil samples;
- Amdel Report 5E4347 dated 12 December 2005 for 5 soil samples;
- Amdel Report 5E4285 dated 7 December 2005 for 15 soil samples;
- Amdel Report 5E4139 dated 28 November 2005 for 20 soil samples;
- Amdel Report 5E3807 dated 1 November 2005 for 10 soil samples;
- Amdel Report 5E3693 dated 26 October 2005 for 10 soil samples;
- Amdel Report 5E3380 dated 26 September 2005 for 8 soil samples;
- Amdel Report 5E3425 dated 27 September 2005 for 25 soil samples;
- Amdel Report 5E3368 dated 28 September 2005 for 20 soil samples;
- Amdel Report 5E3425A dated 30 September 2005 for 25 soil samples;
- Amdel Report 5E3177 dated 7 September 2005 for 30 soil samples;
- Amdel Report 5E2915A dated 9 September 2005 for 10 soil samples;
- Amdel Report 5E2566 dated 18 July 2005 for 15 soil samples;
- Amdel Report 5E2898 dated 10 August 2005 for 18 soil samples;
- Amdel Report 5E2915 dated 18 August 2005 for 18 soil samples;

- Amdel Report 5E2998 dated 23 August 2005 for 15 soil samples;
- Amdel Report 5E3016 dated 25 August 2005 for 10 soil samples;
- Amdel Report 4E0626 dated 19 April 2004 for 69 soil samples;
- Amdel Report 4E0626B dated 6 May 2004 for 2 soil samples;
- Amdel Report 4E0819 dated 13 May 2004 for 45 soil samples;
- Amdel Report 4E0819A Rev 1 dated 9 June 204 for 50 soil samples;
- Amdel Report 4E0819C dated 12 May 2004 for 1 soil sample;
- Amdel Report 4E0529A Rev 1 dated 7 April 2004 for 26 soil samples;
- Amdel Report 4N0529A Rev 1 dated 12 March 2004 for 23 soil samples;
- Amdel Report 4E0515 dated 25 March 2004 for 4 soil samples
- Amdel Report 4N0529 dated 19 March 2004 for 56 soil samples;
- Amdel Report 4E0515 dated 25 March 2004 for 4 soil samples;
- Amdel Report 3E3815B dated 17 November 2004 for 4 soil samples;
- Amdel Report 3N0995 dated 18 November 2003 for 74 soil samples;
- Amdel Report 3N0995A dated 25 November 2003 for 5 soil samples;
- Amdel Report 3N3815 dated 7 November 2003 for 12 soil samples;
- Amdel Report 3N3815A dated 7 November 2003 for 1 soil sample;
- Amdel Report 3E3814 dated 6 November 2003 for 4 soil samples;
- Amdel Report 3E3713 dated 30 October 2003 for 36 soil samples;
- Amdel Report 3E3757 dated 30 October 2003 for 13 soil samples;
- Amdel Report 3E3528A dated 15 October 2003 for 1 soil sample;
- Amdel Report 3E3568 dated 2 October 2003 for 58 soil samples;
- Amdel Report 3E3533 dated 29 September 2003 for 13 soil samples;
- Amdel Report 3E3528 dated 29 September 2003 for 42 soil samples;
- Amdel Report 3E3444 dated 11 September 2003 for 21 soil samples;
- Amdel Report 3E3348 dated 2 September 2003 for 57 soil samples;
- MGT Report 185714 dated 24 August 2005 for 1 soil sample
- MGT Report 185573 dated 25 August 2005 foot 1 soil sample
- MGT Report 185320 dated 25 August 2005 for 1 soil sample;
- MGT Report 1185573 dated 25 August 2005 for 1 soil sample;
- MGT Report 185714 dated 24 August 2005 for 1 soil sample;
- MGT Report 185832 dated 7 September 2005 for 1 soil sample;
- MGT Report 186128 dated 8 September 2005 for 1 soil sample;

- MGT Report 186727 dated 22 September 2005 for 2 soil sample;
- MGT Report 186940 dated 10 October 2005 for 1 soil sample;
- MGT Report 186956 dated 10 October 2005 for 1 soil sample;
- MGT Report 187078 dated 10 October 2005 for 1 soil sample;
- MGT Report 187078 dated 10 October 2005 for 1 water sample;
- MGT Report 187423 dated 20 October 2005 for 4 soil samples;
- MGT Report 187716 dated 28 October 2005 for 1 soil sample;
- MGT Report 187977 dated 2 November 2005 for 1 soil sample;
- MGT Report 188896 dated 2 December 2005 for 1 soil sample;
- MGT Report 189003 dated 1 December 2005 for 1 soil sample;
- MGT Report 189242 dated 9 December 2005 for 1 soil sample;
- MGT Report 189927 dated 4 January 2006 for 2 soil samples;
- MGT Report 190388 dated 20 January 2006 for 1 soil sample;
- MGT Report 190876 dated 16 February 2006 for 1 soil sample;

ERM (2006)

- Amdel Report 6E0077 dated 19 January 2006 for 10 soil samples;
- Amdel Report 6E0077A dated 20 January 2006 for 2 soil samples
- Labmark Report EO25853 dated 20 March 2006 for 3 soil and 7 water samples;
- Labmark Report EO25793 dated 21 March 2006 for 4 soil samples

URS (2006)

- ALS Report ES0508499 dated 18 October 2005 for 3 water samples;
- ALS Report ES0508756 dated 26 October 2005 for 7 soil samples;
- ALS Report ES0508954 dated 4 November 2005 for 6 water samples;
- ALS Report ES0600717 dated 20 January 2006 for 23 soil samples;
- ASET ES0508756 dated 22 October 2005 for 2 material testing;
- Labmark Report E024137 dated 2 November 2005 for 1soil sample.

PB (2006 – 2008)

- ALS Report EM0601942 dated 5 April 2006 for 1 soil sample;
- ALS Report ES0600717 dated 20 January 2006 for 23 soil samples;
- ALS Report ES0708054 dated 26 June 2007 for 25 water samples;

- ALS Report ES0708168 dated 28 June 2007 for 1 water sample;
- ALS Report ES0603996 dated 18 April 2006 for 1 water sample;
- ALS Report ES0603610 dated 30 March 2006 for 6 paint samples (lead);
- ALS Report ES0805475 dated 18 April 2008 for 1 water sample;
- ALS Report ES1004036 dated 11 March 2010 for 1 water sample;
- ALS Report ES0907607 dated 1 June 2009 for 1 water sample;
- ALS Report ES0913088 dated 4 September 2009 for 1 water sample;
- ALS Report ES0918586 dated 15 December 2009 for 1 water sample;
- ALS Report ES0805475 dated 29 April 2008 for 1 water sample;
- ALS Report ES0806450 dated 15 May 2008 for 1 water sample;
- ALS Report ES0708054 dated 19 June 2008 for 25 water samples;
- Amdel Report 163952 dated 28 March 2006 for 11 soil samples;
- Amdel Report 6E0866 dated 31 March 2006 for 15 soil and 1 water sample;
- Amdel Report 6E1070 dated 24 April 2006 for 10 water samples;
- Amdel Report 6E1154 dated 21 April 2006 for 5 water samples;
- PB Report 2118093A-2008 dated 8 March 2005 for 29 material testing (asbestos);
- Envirolab Report 18730 dated 18 April 2008 for 23 water samples;
- Envirolab Report 18730 dated 6 August 2006 for 23 water samples;
- Envirolab Report 19154 dated 14 May 2008 for 23 waters samples;
- Envirolab Report 29118 dated 1 June 2009 for 24 water samples;
- Envirolab Report 32696 dated 31 August 2009 for 25 water samples;
- Envirolab Report 35946 dated 11 December 2009 for 24 water samples;
- Envirolab Report 38549 dated 12 March 2010 for 24 water samples;

E2W (2010 - 2011)

- ALS Report ES1020087 dated 14 October 2010 for 1 product sample;
- ALS Report ES1114565 dated 18 July 2011 for 19 water samples;
- Air Toxics Report 1011154A dated 16 November 2010 for 6 gas samples;
- Air Toxics Report 1111242 dated 29 November 2011 for 5 gas samples.

In addition to providing these reports the consultants also supplied appropriate signed COCD and laboratory SRNs for each batch of samples.

The QA/QC assessments by various consultants are included herein at **Appendix J**.

All laboratories were NATA accredited (or equivalent) for the analyses undertaken, and analytical methods were undertaken using appropriate methods and detection limits. The analytical methods adopted by these laboratories are, however, in-house methods which may not be equivalent to US EPA endorsed methods, but are nevertheless NATA endorsed.

The laboratories provided details of the condition of the samples received, date of receipt, date of extraction (where applicable), extraction methods, laboratory methods adopted (including confirmation of the use of purge and trap method for volatiles), spiking method and the detection limits for each analyte and date of analysis. Also included were details of laboratory blanks, duplicates, spikes and spike recoveries.

The laboratory reports in respect to this project were appropriately endorsed with a NATA stamp/logo for each certificate/report issued. Method detection limits were generally appropriate for the analytes and for soil media tested, and were suitable in respect of the adopted soil investigation levels and remediation acceptance criteria for the site.

The laboratories undertook a range of internal QA/QC checks on analytical precision and repeatability including method blanks, laboratory duplicates of samples submitted, matrix spike recoveries and surrogate spike duplicates.

RPDs between laboratory duplicates were generally within tolerable limits for all analyses conducted by the laboratories employed. Laboratory (method) blank samples showed no evidence of cross contamination during preparation and analysis at any stage of the investigations or validation. Duplicates were generally not undertaken in respect to asbestos analysis (which is considered reasonable by the auditor – see earlier discussion).

The laboratories' analytical precision and accuracy are considered adequate for this type of investigation and these were assessed by each laboratory undertaking internal duplicates, (surrogate) spike recovery and method blank tests as well as other QC checks. No record of the use of certified reference materials was provided.

The range of analytes tested on behalf of the consultants, the laboratory methods adopted and the detection limits employed by each of the contract laboratories appears to be generally satisfactory when compared with the expected contaminants on the site and the levels of contamination acceptable to remain on the site dictated by the adopted SILs and RAC. Asbestos was analysed by polarized light microscopy in conjunction with the dispersion staining method. Asbestos analysis was NATA accredited.

The auditor considers that the samples obtained by the consultant and tested by the laboratories as part of the site investigations and validation works are, on the balance of probabilities, representative of both the observed and actual site conditions prior to and following removal of the bulk of contaminants during site formation/remediation. The overall accuracy, precision and repeatability of the results provided by the laboratory are also considered appropriate and are therefore sufficient to characterise the site.

It is understood that laboratories are no longer allowed by NATA to make a statement that they are in compliance with the requirements of NEPM in regard to the equivalence with referenced methods or non standard methods adopted.

The respective laboratories undertook internal QA/QC checks on soil, sediment and water analysis, but not on asbestos identification.

6.3.3 QA/QC Evaluation

- The auditor has reviewed the DQOs/DQIs and QA/QC information provided by the consultants and this is summarised below in Table 15.

Table 15: Summary of Data Quality Indicators

Part A

COMPLETENESS A measure of the amount of useable data (expressed as %) from a data collection activity					
Field considerations		Laboratory considerations		Comments	
• All critical locations sampled • All samples collected (from grid and at depth) • SOPs appropriate and complied with • Experienced sampler • Documentation correct	☑ ☑ ☑ ☑ ☑	• All critical samples analysed according to SAQP/RAP • All analytes analysed according to SAQP/RAP • Appropriate methods and PQLs • Sample documentation complete • Sample holding times complied with standards	☑ ☑ ☑ ☑ ☑ ☒	The required percentage completeness should be specified in the SAQP/RAP. All required data must be obtained for critical samples and chemicals of concern. Incompleteness is influenced by: field performance problems (access problems, difficulties on site, damage etc.) laboratory performance problems (matrix interference, invalid holding times etc.) matrix problems	☑ ☑ ☑ ☑☒ ☑☒
Comment: The clay, sandy clay and sandstone substrate of the site has the potential lead to difficulties in representative sampling, sample splitting (duplicates), some heterogeneity was evident as RPDs were on occasion over range. Holding times were exceeded in an early report. Some matrix interference was noted in groundwater sample analysis and has been attributed to the presence of PSH in some samples. Consultants specified that all samples were taken in accordance with protocols and measures of laboratory performance were within acceptable ranges resulting in 95% useability of the data obtained. The auditor concurs with this usability in terms of suitability for assessment purposes.					

Part B

COMPARABILITY The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event					
Field considerations		Laboratory considerations		Comments	
• Same SOPs used on each occasion • Experienced sampler • Climatic conditions (temperature, rainfall, wind, …) • Same types of samples collected (filtered, size fractions, …)	☑ ☑ ☑ ☑	• Sample analytical methods used (including clean-up) • Sample PQLs (justify/quantify if different) • Same laboratories (justify/quantify if different) • Same units (justify/quantify if different)	☑ ☑ ☑☒ ☑	• Same approach to sampling (SOPs, holding times etc.) • Quantify influence from climatic or physical conditions • Samples collected, preserved, handled in same manner (filtered, same containers)	☑ ☑ ☑☒
Comment: The main laboratories employed for the bulk of the analytical work included ALS, Labmark, Amdel, MGT, Envirolab but these are believed to operate using the same or very similar analytical methods. Different consultants were employed to undertake asbestos validation (ASET , Air Toxics, Airsafe and A.D Envirotech). Some minor loss of volatiles has been noted during groundwater sampling and transport. The variance in field methods is not considered likely to have impacted the comparability of the results or the overall outcome. As such, the confidence that data may be considered equivalent for each sampling and analytical event is described as high by the consultants and the auditor.					

Part C

REPRESENTATIVENESS The confidence (expressed qualitatively) that data are representative of each media present on the site					
Field considerations		Laboratory considerations		Comments	
• Appropriate media sampled according to SAQP • All media identified in SAQP sampled	☑ ☑	• All samples analysed according to SAQP	☑	Samples must be collected to reflect the characteristics of each media Sample analyses must reflect properties of field samples Homogeneity of the samples Appropriate collection, handling, storage and preservation Detection of laboratory artefacts, e.g. contamination blanks	☑ ☑ ☑☒ ☑ ☒
Comment: The clay and sandy clay substrate (matrix) of the site, including the filling matrix (where present) has the potential lead to difficulties in representative sampling, sample splitting (duplicates) and composite sampling (when undertaken), some sample heterogeneity was reported and evident as RPDs were occasionally over range.					

Part D

PRECISION A quantitative measure of the variability (or reproducibility) of data					
Field considerations		Laboratory considerations		Comments	
• SOPs appropriate and complied with	☑	Analysis of: • laboratory and interlaboratory duplicates • field duplicates • laboratory-prepared volatile trip spikes	☑ ☑ ☒	Measured by the coefficient of variance or standard deviation of the mean or by RPDs Field duplicates measure field and laboratory precision Laboratory duplicates measure analytical precision Minor discrepancy given the low probability of impacts due to volatile compounds	☑ ☑ ☑ ☒

Comment:

The data show reasonable consistency and are considered to be reproducible despite some deficiencies and omissions in QA/QC samples taken in the investigation and validation works. Duplicates were taken at a rate of 10%. In their analysis of DQOs consultants found the reproducibility of the data to be high since RPDs in field and laboratory duplicate samples as well as laboratory QA/QC were generally within acceptable ranges. PB considered that the laboratory data is suitable for the validation of the remediation works. Given the omissions in QA/QC the auditor expects some variation in data.

Part E

<table>
<tr><td colspan="6">ACCURACY (BIAS)
A quantitative measure of the closeness of reported data to the true value</td></tr>
<tr><td>Field considerations</td><td></td><td colspan="2">Laboratory considerations</td><td colspan="2">Comments</td></tr>
<tr><td>• SOPs appropriate and complied with</td><td>☑</td><td>Analysis of:
• field blanks
• rinsate blanks
• reagent blanks
• method blanks
• matrix spikes
• matrix spike duplicates
• surrogate spikes
• reference materials
• laboratory control samples
• laboratory-prepared spikes</td><td>☑
☑
☑
☑
☑
☑
☑
☒
☑
☑</td><td>Bias introduced:
• by chemicals during handling or transport
• from contaminated equipment
• from contaminated reagents
• during laboratory analysis
• during laboratory preparation and analysis (may be high or low)
• precision of preparation and analytical method
• limited QA/QC samples taken in investigation and validation</td><td>☑☒
☑
☑
☑
☑
☑
☑☒</td></tr>
<tr><td colspan="6">Comment: Field spikes were taken as part of the PB investigation for soil and groundwater. No record of reference materials provided. The various consultants undertook review of laboratory QAQC. Loss of volatiles was noted during sampling/transport of groundwater samples by PB. Results were found to be broadly within acceptable ranges. Where exceedances were noted, laboratory report provided reasonable justifications.</td></tr>
</table>

Note: Key ☑ = complied
☒ = not complied
☑☒ = partially complied

The overall accuracy, precision and repeatability of the assessment (investigations) results and data obtained by the consultants during remedial validation sampling, and from the analytical laboratories, are considered to be acceptable and suitable for the purposes of forming an opinion on the condition of the site. Some departures from guidelines was noted, particularly in respect to the collection of a full range of field QA/QC samples, but the consultants provided a reasonable argument as to why these were not critical to the overall outcome of the investigations and validation works. These explanations have been accepted by the auditor as reasonable and are not considered to adversely affect the outcome of the audit in terms of the reliability of the site characterization or determination of the suitability of the site for the intended land use.

Analysis of field and laboratory DQOs by the consultants against the requirements of the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997) are as summarized below in Table 16.

Table 16: Summary of Field and Laboratory DQO Achievement

DQO	Assessment/Evaluation Criteria	Comments
Document Completeness	Instrument calibration records	Yes – information provided by consultants
	Borehole logs	Yes – bore logs/test pit logs/well logs and sample descriptions provided by all consultants
	Chain of Custody	Yes – COCD and SRNs provided by consultants and laboratories respectively. COCD generally signed/stamped/dated upon receipt
	NATA Test Certificates	Yes – NATA laboratory test reports provided for all testing events
Data Completeness	Sampling Density (Area)	Sampling density achieved according to the Sampling Design Guidelines, NSW EPA 1995 in non- AEC with focused sampling at a generally higher density in identified AEC
	Sampling Density (Vertical)	Vertical sampling was sufficient in filled areas and in non filled areas where contamination was likely to be surficial. Sufficient sampling was undertaken to characterize localized areas of filling
	Range of Analytes Based on Site History	Range of analytes was suitable based on identified land uses and practices in both investigation and validation programs.
	Number of Analytes	Number of analytes was generally satisfactory in both investigation and validation programs
Data Comparability	Sampling Methods	Sampling methods were generally suitable but augers, test pits and trowels (disturbed samples) used in some locations rather than push tubes/SPTs, possibly leading to a risk of volatile loss (however not likely to be a significant problem on this site), other than in groundwater samples. Validation

DQO	Assessment/Evaluation Criteria	Comments
	 Sample storage, handling etc Laboratory procedures	(soil) sampling was generally via gloved hand. Bailers used for collection of groundwater may have led to loss of some volatiles during sampling / transport as noted by PB. Satisfactory Satisfactory
Data Representativeness	Sampling Coverage Representative Samples Over Site Area	Satisfactory in all sampling events Satisfactory (see above)
Accuracy and Precision of Sampling Data (Field)	Adequately Trained Field Staff Blind Duplicates collected >10% of original samples Other Field Check Samples – Rinsate and field blanks/spikes etc Calibration of Screening Gear RPD <30% or <50% for organic species	Yes Yes Yes Yes Generally achieved with some exceedances – generally attributed to heterogeneity of sampled matrix (fill material) or variability of sample (groundwater)
Accuracy and Precision of Laboratory Data	Laboratory Quality Control	Satisfactory

Auditor's Opinion

The narrative by the consultants on the evaluation of the field and laboratory data in respect to the achievement of the stated DQOs in terms of QA/QC was generally satisfactory. Some deficiencies relating to the number and type of field QA/QC samples taken were noted in the consultants' sampling programs, but these were adequately justified and are not considered to unduly compromise the data set in any significant way. Groundwater sampling from 2006 – 2010 included a suitable range of QA/QC samples including rinsates, trip blanks, trip spikes, duplicates and triplicates. Some loss of volatiles was noted. Matrix interference was noted by laboratories which may be due to the presence of PSH or 'oily water' in some samples.

The level of uncertainty that these departures and deficiencies introduce in the overall reliability of QA/QC in terms of data completeness and accuracy is considered largely insignificant to the outcome of the assessment and therefore to the audit process.

Overall it is considered that the results obtained were satisfactory and representative of the previous (investigations) and more recent assessment of the (validation and groundwater) status of the site, and thus are of sufficient quality to conclude that where necessary the site has been adequately remediated (soil) and characterised (groundwater) for the purposes of devising and implementing a suitable remediation strategy for the site.

7. Reporting Standards

Consultant's reports dealing with the contamination status of the site and related issues were principally prepared by SKM, ITE/Coffey, URS, ERM, PB, E2W, EnRiskS. The consultants provided assessment reports on soil investigations, groundwater investigations and remediation and validation and risk assessment reports.

Generally the reports provided were prepared in a manner consistent with the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997), and in most cases were provided to the auditor for review prior to each stage of the investigation, remediation planning and validation as a series of drafts, eliciting auditor comments.

Commentary on the submitted versions of the reports by the consultants was mainly related to technical clarifications, and/or the request for additional information. Generally this information was supplied by the consultant and helped to elucidate the final outcome of each stage of the work undertaken.

Where departures from the published guidelines were noted these are not considered to overly detract from the overall outcome or conclusions stemming from the consultants reports. For example the QA/QC discussions provided in the reports was considered brief and did not address the format of DQO and DQI as provided in Appendix IV and V of the Guidelines for the NSW Site Auditor Scheme (NSW EPA, 2006). Where issues regarding the quality or outcomes of the report were considered worthy of further comment these matters were discussed in correspondence. Relevant correspondence between the auditor, consultants and other parties can be found in **Appendix C**.

Auditor's Opinion

The reports prepared principally by SKM, ITE/Coffey, URS, ERM, PB, E2W, EnRiskS and the investigation and validation data set contained in the reports are considered sufficient to form a view on the original site conditions, the proposed and implemented remedial approach and site validation. The reports are also considered suitable to determine the current suitability of the site and the likely suitability for the intended land uses.

8. Future Environmental and Human Health Risks

The site can be divided into the two main areas for the consideration of future environmental and human health risk, viz.

- The 'Impacted Zone'[10]; and
- The remainder (majority) of the site outside the 'Impacted Zone'.

With regards to the majority of the site outside the 'Impacted Zone', from the results of remedial works, the consultants (PB) were able to conclude that:

'Based on the results of these works and within the limitations of environmental analyses and reporting, PB considers that the site soils have been validated and that the site is suitable for residential land use (with access to soils), based on comparison with the appropriate criteria (the lower of Column 1 and Column 5 as defined in "Soil investigation levels for urban development sites in NSW" in Appendix II of Guidelines for the NSW Site Auditor Scheme (2nd Edition) (DEC, 2006)'

The exception was the former creosote tank pit (Tank pit 10), where some PAHs/TPH contamination remained in the sandstone at depth along the western excavation wall of the creosote pit excavation. As the excavation became large (over 5,000 m^3), it was decided to abandon the 'dig and dump' strategy and instead, to assess whether the risks associated with the remaining contamination were acceptable to allow these materials to remain on site.

The future environmental and human health risk posed by the remaining PAH/TPH in the soil at depth in this location was the subject of the risk assessment (ERM, April 2006), with the conclusion that there was no apparent unacceptable risk to receptors through groundwater and that based on the concentrations in soil the hypothetical risk to future residents and short-term exposure risks to construction workers were below acceptable levels. It was considered that additional excavation of the creosote pit area was not warranted, and it was recommended that the pit be backfilled. The excavations were later backfilled with validated imported VENM and topsoil.

Based on these results, the auditor concurs with the opinion of ERM, URS, PB and EnRiskS that the presence of the remaining contaminated material does not constrain the potential range of uses for the site and the future environmental and human health risk posed by the remaining contaminated soil is low.

Groundwater contaminated with TPH, BTEX, and PAH remains at the site and is considered to have been caused by previous activities and structures on the site. The presence of phase separated hydrocarbons (PSH) has also been noted in groundwater at the site, despite remediation efforts (MPEAT).

A Human Health Risk Assessment (HHRA) was undertaken to investigate the likely risk to human health posed by the groundwater contamination at the site. The conclusions derived from the HHRA by EnRiskS (2011) were as follows:

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[10] The survey of the 'Impacted Zone' is provided in **Appendix D**.

- *'Risks During Construction and Intrusive Works - Potential exposures by workers involved in construction of new buildings on-site and intrusive works to maintain services, in particular inhalation exposures within excavations, are considered to be low. No unacceptable risk issues have been identified for these workers. Hence no additional risk management measures are required, over and above those required by legislation and industry. In the event that deep excavations are placed above impacted groundwater, risks remain acceptable, however petrol type odours may be noticeable (depending on the proximity of works to the contamination).*

- *Risks Following Development*
  - *Residential Use - Potential exposures by future residents who may reside/use the central portion of the site have been assessed for a number of potential scenarios, which include:*
    - > *Construction of a new residential building (slab-on-grade) above the groundwater plume: If a new building were constructed directly above the impacted groundwater, and residential homes were constructed on the ground floor, then there is the potential for exposures to volatile petroleum compounds within the home to be elevated and risks potentially unacceptable. If such a building were to be constructed vapour mitigation measures would need to be designed into the building to address vapour risks.*
    - > *Construction of a new residential building (slab-on-grade) above the groundwater plume with a ground level car-park: If the new building were constructed with a ground-level car-park, with residents living on the 1st floor, then exposures are low, and no unacceptable risks have been identified.*
  - *No buildings are constructed directly above the groundwater plume, however a building is constructed adjacent to the plume and the area above the plume is used as an outdoor area (which may include a playground);*
    - > *If a new building were constructed that was adjacent to the groundwater plume, exposures, derived from lateral vapour migration would be low and no unacceptable risks have been identified. This conclusion is relevant for residential buildings adjacent to the groundwater plume regardless of the future use of the area above the plume;*
    - > *Exposures in outdoor areas located above the groundwater plume are low and no unacceptable risks have been identified.*

- *Environmental Risk - On the basis of the available data, including additional data/observations collected as part of this assessment, the potential for impacted groundwater derived from the site to migrate to and adversely affect the freshwater aquatic environment'*

Noting the above conclusions by EnRiskS, the (final) beneficial uses of the land defined as the 'Impacted Zone' are restricted to use as roadway, public car parking or public open space with no buildings to be constructed within the 'Impacted Zone'.

In this regard, Campbelltown Council has been consulted and is in broad agreement that any future re-development of the site could be designed around these requirements and that these restricted uses can be appropriately notified to the public via appropriate notations on a planning certificate (issued under Section 149(2) of the *Environmental Planning and Assessment Act, 1979*) or a covenant registered on the title to land under section 88B of the *Conveyancing Act 1919* and that an EMP can be similarly implemented for the long-term management of the 'Impacted Zone'. In the event that

Campbelltown City Council does not implement the above management, Endeavour Energy will retain ownership of the Impacted Zone and manage future uses and the EMP.

As no development application is currently in place for the site, the eventual end-use of the land is not known. The current land-use is special uses 5(a). The consultants have based their works on the assumption that future development will be low to medium density residential use with slab on grade construction and no deep basements. The consultants have concluded that the site will be acceptable for this residential use for the site (with the exemption of the 'Impacted Zone') despite the uncertainty regarding the actual details of the proposed development. The auditor concurs with this view, but recommends that a Statutory Site Audit should be undertaken when a formal development application is lodged and the nature of the proposed development is specified.

The auditor further notes that in the unlikely event that the future development involves deep basements or other (deep) underground structures there is the risk that such excavations or structures may alter the groundwater system (i.e. flow regime) and therefore change the nature and extent of the 'Impacted Zone'. Any change to the system or the extent of the 'Impacted Zone' would inevitably need to be dealt with in a revised EMP specific to the development (including areas which may currently fall outside the impacted zone). A revised HRA may also be required to assess the risks associated with basement car parks or other underground structures adjacent to the plume, but which may fall outside the current footprint of the 'Impacted Zone'.

The potential for off-site migration of contaminated groundwater has been considered by PB, E2W and EnRiskS in relation to likely beneficial reuse of groundwater in the receiving water body (McBarron Creek, and ultimately Botany Bay). As such, likely uses of groundwater include:

- Supporting aquatic ecosystems;
- Recreation (including swimming and boating); and
- Abstraction for irrigation, recreational use (swimming pools).

Groundwater modelling undertaken by E2W shows the impacted groundwater plume to be stable and that groundwater impacts are not likely to extend as far as the Creek or indeed off-site. The aquifer at the site is low yielding and groundwater is considered non-potable due to high concentrations of sulphate which render it unsuitable for use as drinking water based on odour and taste. As such, it is considered highly unlikely that abstraction of groundwater for any plausible beneficial use would occur within or downgradient of the 'Impacted Zone'.

Nevertheless, based on the presence of the hydrocarbon plume in the 'Impacted Zone' and given the presence of PSH in one groundwater well on the site (MW06), an EMP has been produced for the site and will be enforced via a notice or restrictive covenant as noted above. The EMP will restrict development on the 'Impacted Zone' as also described above as well as restricting groundwater use within the 'Impacted Zone'.

Based on the results obtained from the investigations and remediation as well as the results of the HHRA the likelihood of unacceptable odours or vapour emissions from the soil or groundwater contamination remaining within the 'Impacted Zone' or indeed the remainder of the site is not considered to pose a risk to human health or environment (and subject to the above provisos). From the sampling results, the auditor considers that impacts on structures are unlikely, although issues related to urban soil salinity have not been considered in this audit report.

9. Conclusions

Based on the investigation undertaken by various consultants (as outlined in the foregoing) the auditor considers that the site known as Lot 1 DP 620265 Sark Grove and Pembroke Road, Minto, NSW has been suitably investigated, remediated and validated for the purposes of identifying and remediating potential contaminants in the soil and groundwater.

Based on the information presented by the consultants, the auditor therefore concludes that:

Soil:

- Site investigation and sampling have been undertaken in a generally appropriate manner which meets or exceeds the minimum requirement for a site of 5.9 hectares i.e. as defined in the Sampling Design Guidelines, NSW EPA, 1995;
- Based on the historical information (SKM/ITE), potential AECs associated with previous site uses included underground fuel tanks and bowsers, above ground fuel tanks, creosote tank, vehicle maintenance and repair areas, washing down and maintenance area, pole storage areas, former substation in north west corner, filling, coal tar emulsion storage, creosote storage and building materials;
- Potential contaminants of concern included heavy metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc), total petroleum hydrocarbons (TPH), benzene, toluene, ethyl benzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyl (PCBs), phenols/creosols and asbestos;
- Investigations and subsequent work revealed contamination associated with the former structures and operations at the site, in particular the fuel storage area and the creosote storage area;
- Initial remediation works from 2003-2006 included removal of 10 underground storage tanks (USTs) including Creosote – 5,000 L UGST, Diesel – 25,000 L UGST, Diesel – 20,000 L UGST, ULP – 55,000 L UGST, ULP – 50,000 L UGST, ULP – 25,000 L UGST, Waste oil – 5,000 L UGST and 3 creosote – 500 L truck tanks;
- Tank pits were excavated and validated to the extent possible. Some material was not able to be chased from the creosote tank pit (Tank pit 10) and the excavation was completed at 6.5 m depth. Exceedances of TPH, toluene and PAH remain in base and wall samples at depth in Tank pit 10;
- A risk assessment was undertaken by ERM in 2006 to address the issue of remaining material in the creosote pit (at depth). The conclusion was that the long-term risk to future residents (via vapour inhalation) and short-term exposure risks to construction workers (via accumulation of vapours to trenches) on the site were below acceptable levels. The risk to potential future receptors was estimated to be insignificant i.e. no significant health risks were predicted;
- Further remediation works were undertaken in 2006 and validation reports were provided for a series of site subsections. Works involved excavation and backfill of remediation areas, asbestos remediation and remediation of areas beneath building footprints etc;
- Testing has shown that the site soil has been rendered suitable for its existing land use (designated as Special Uses) and has also been made suitable for a range of other potential future land uses, including residential with access to soils as defined under Column 1 Appendix II of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC (EPA), 2006 (Soil Investigation Levels for Urban Redevelopment Sites in NSW).

Groundwater and Vapour:

- Groundwater quality has been affected by the previous operations and structures at the site, in particular in the location of the former fuel storage area;
- COCs in groundwater included monocyclic aromatic hydrocarbons (MAHs) (including BTEX compounds), volatile organic compounds (VOCs) and methyl tertiary butyl ether (MTBE);
- Residual impacts identified in groundwater beneath the central portion of the site comprise phase separate petroleum hydrocarbons (PSH) and dissolved phase impacts where total TPH and MAH, including BTEX have been reported. This area was therefore defined as the 'Impacted Zone' by the consultants and was considered separately to the remainder of the site for remediation and validation works relating to groundwater and vapour;
- PSH has been identified at the site (in limited thickness and distribution) and a groundwater plume has been delineated to the central portion of the site in the vicinity of the former fuel storage area. A thin PSH layer is confined to fractured sandstone which exhibits limited PSH mobility and recoverability;
- Groundwater remediation via multi-phase extraction and air treatment (MPEAT) was undertaken on a number of occasions and was found to be effective in reducing PSH in groundwater for short periods. However, eventual rebound of PSH was observed. Also, the effect of MPEAT on the contaminant levels in groundwater was not significant enough to render this method a viable option for further groundwater remediation;
- For the remainder of the site (outside the 'Impacted Zone') it is considered that the plausible beneficial uses of groundwater are not precluded by the condition of groundwater at the site and no further remediation or management is required.
- However, testing has determined that groundwater within the 'Impacted Zone' has been contaminated by the release of hydrocarbons from a series of former underground storage tanks and related facilities (now removed). The contaminants although having been cleaned-up to the extent practical still remain at depth in dissolved form and in places as residual PSH. These contaminants reside within the 'Impacted Zone' which remains on site (see Survey Plan attached demarcating Impacted Zone) and which restricts the utility of the land within the footprint of the 'Impacted Zone'. Accordingly any deeper excavations which may alter the groundwater flow regime within the site or within the Impacted Zone, and thus potentially extend the boundaries of an 'Impacted Zone', should not be undertaken without further consideration;
- Assessment of natural attenuation variables and contaminant fate and transport modelling has determined that natural attenuation processes are robust and sufficient to demonstrate long-term stability based on the low permeability of the formation and low velocity of groundwater, as well as the stability and overall reduction of the groundwater plume (size, volume and concentrations). Furthermore, there is a low risk to off-site receptors due to the stability of the plume which is not expected to migrate off-site or discharge to surface waters. In addition, the use of groundwater for beneficial uses, such as drinking water, is unlikely based on the low yield, taste and odour issues and the presence of an alternative town water supply in the area;
- Volatile petroleum hydrocarbons detected in soil vapour, in particular benzene, hexane, heptane, cyclohexane, 2,2,4-trimethylpentane, and TPH and also MTBE were included as COPC in the HHRA based on the results of soil vapour sampling undertaken within in the 'Impacted Zone';

- The findings of the HHRA indicate that various development scenarios would be acceptable for the site, however, some scenarios will necessitate the incorporation of vapour mitigation measures in building design within the 'Impacted Zone';
- An Environmental Management Plan (EMP) has been prepared by the consultants which addresses the requirements for the management of contamination within the 'Impacted Zone' of the site and includes restrictions on groundwater use and on related building layout and design (e.g. excavations). The EMP requires to be legally enforceable and accordingly provisions have been made to this effect through liaison with Campbelltown City Council. In the absence of implementation through planning mechanisms, administered by Campbelltown Council, Endeavour Energy has agreed to implement the EMP; and
- The EMP restricts future land use in the vicinity of the 'Impacted Zone' (defined as the area of the impacted groundwater wells and a 10 m wide buffer) and which precludes groundwater abstraction. The EMP also requires that the status of this part of the site is notified to future land holders and that the EMP is appropriately enforced.

Under the above circumstances the consultants considered that the site has been suitably remediated with regard to soil and groundwater. The remaining issues relating to groundwater and vapour (soil gases) within the 'Impacted Zone' are recognized within the provisions of the Environmental Management Plan (EMP).

In respect to substrate conditions within the 'Impacted Zone', the auditor considers a suitable body of evidence exists to support the consultants' appraisal of the groundwater contamination and remediation works and their conclusions regarding the suitability of natural attenuation as a remediation strategy.

Ongoing monitoring has not been proposed by the consultant, and the auditor supports the view that the existing data set (2006-2011) can be relied upon to demonstrate natural attenuation of hydrocarbons is occurring and is likely to continue over time and that the plume dimensions and concentrations will gradually reduce.

Endeavour Energy notified EPA of the groundwater contamination issue at the site and EPA are understood to have determined that formal regulation will not be required under the Contaminated Land Management Act 1997 (See correspondence from EPA dated 9 February 2012 in Appendix C), although formal notification to this effect has not been made at the time of writing. In the auditor's opinion the site does not require regulation, but it is noted that the final decision in this regard rests with the Authority.

The consultants have presumed, based on advice from the client, that the future land-use of the site will be low to medium density residential housing with slab on grade construction for the areas outside the 'Impacted Zone', and with roadways, public car parking or public open space within the 'Impacted Zone'. However, as no development application is currently in place for the site, uncertainty remains regarding the nature and type of any future re-development which may be proposed.

Accordingly, and particularly in the event that deeper excavations are proposed which may alter the site's groundwater flow regime and thus the extent of the 'Impacted Zone', it is recommended that a Statutory Audit is commissioned for the site once details of any proposed development are known (i.e. a planning application has been made to Council).

The statutory audit would, inter alia, review the details of the proposed development and assess any associated need to amend the existing EMP to cater for any potential impacts on groundwater flow, and thus contaminant plume characteristics, which may be occasioned by the development.

In addition any amendments to the existing EMP which are deemed necessary as a result of any future development should include, *inter alia*, a detailed review of all relevant design and construction issues, including excavations for basements or any other underground structures. In particular the review should examine the relationship between the development and its potential impact on the groundwater flow regime and on the groundwater contaminant plume which remains within and could potentially extend beyond the 'Impacted Zone'.

If the proposed structures are considered likely to change or influence the nature and extent of the 'Impacted Zone', or the plume characteristics in any way, the existing HRA and EMP for the site would require to be revised in respect to any specified redevelopment and should accordingly be audited under the provisions of the Contaminated Land Management Act.

Noting the provisions stated above, a Non Statutory Site Audit Statement (No DPNS/7) has been prepared to accompany this site audit report. The NS SAS and audit report conclude that the site is suitable for a range of land-uses, including residential houses with gardens and accessible soils, with the exception of the 'Impacted Zone' which will be restricted to uses including roadway access, public car parking or public open space as defined in the EMP. A survey plan demarcating the 'Impacted Zone' is attached to the NS SAS and is provided in **Appendix D** herein.

The auditor therefore recommends that a Statutory Audit should be required and commissioned once the nature and details of any future development application for the site are known.

10. References and Bibliography

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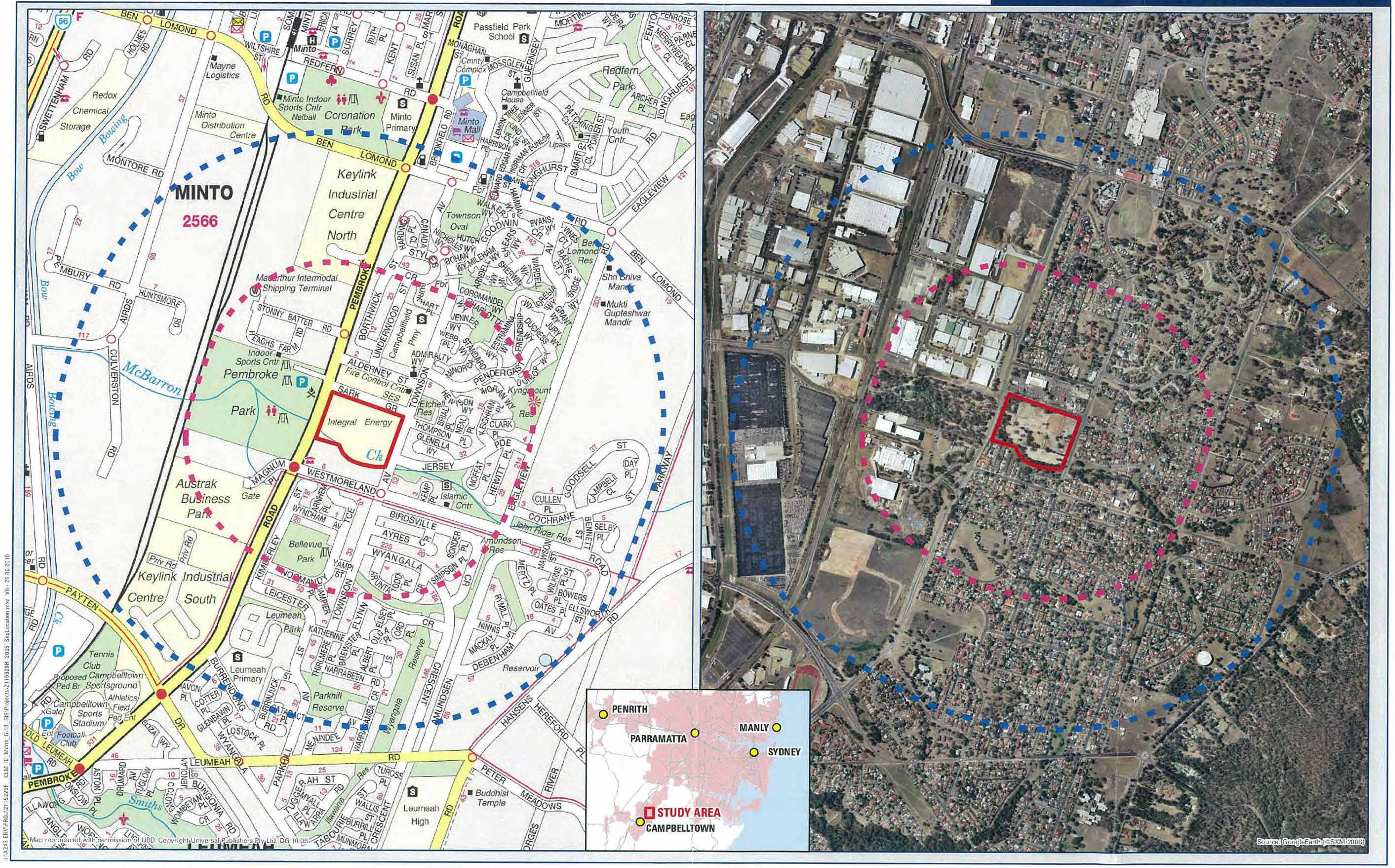
Douglas Partners Pty Ltd

Appendix A

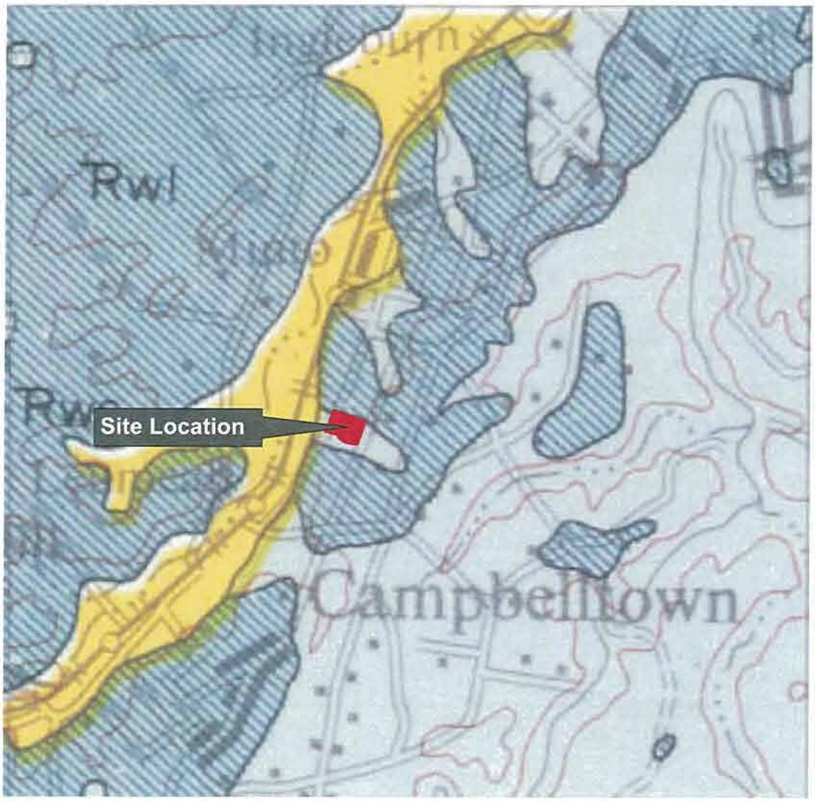
Figures



Site boundary | 500m radius | 1000m radius

0 — 500 METRES

Figure 1: Site location
Former Integral Energy Depot, Sark Grove, Minto, NSW



G/Jobs/2006/0043782 F2 06 02 2006 JPM Environmental Resources Management Australia Pty Ltd

ERM

Legend

Quaternary Alluvial Deposits

Ashfield Shale

Hawkesbury Sandstone

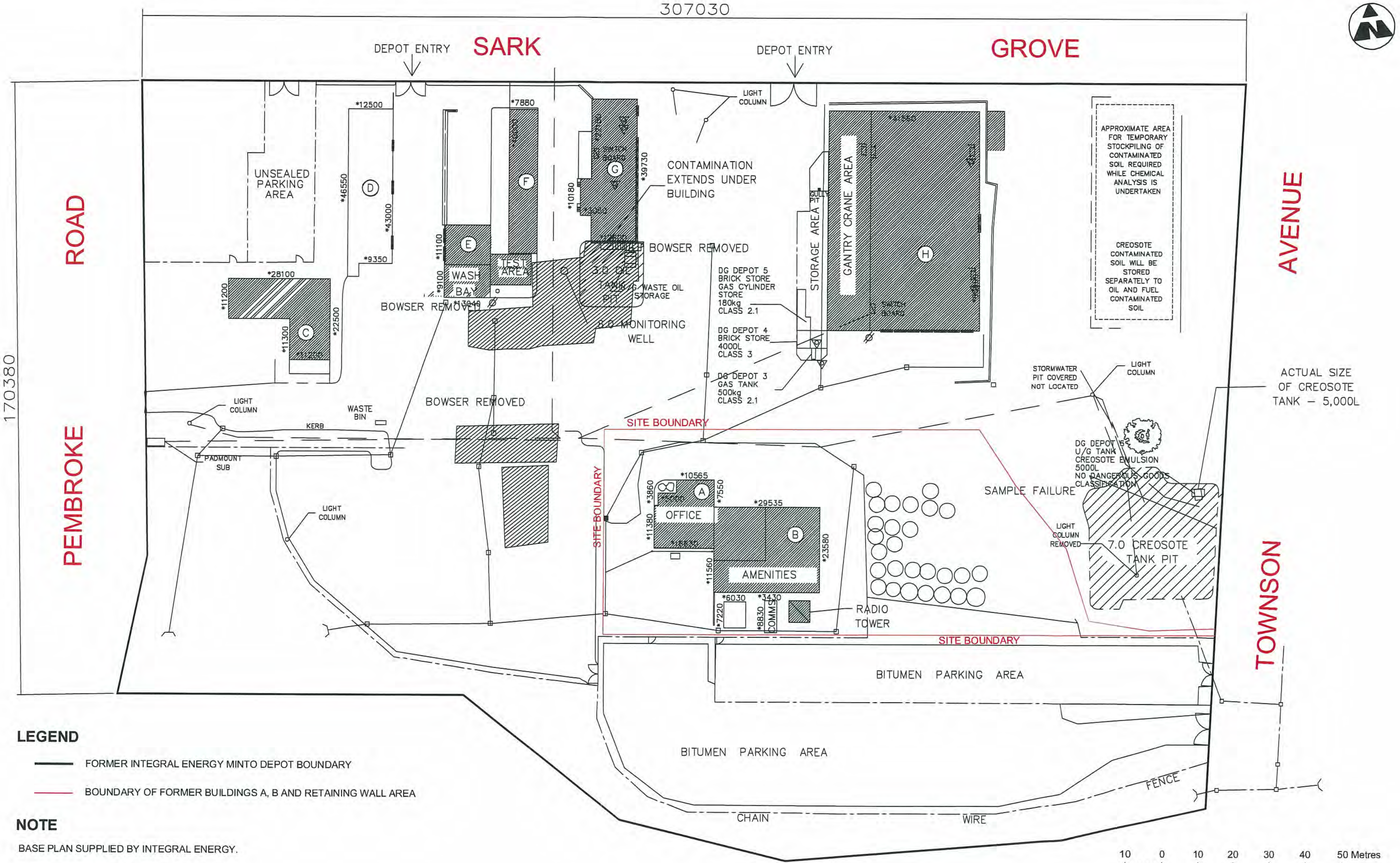
Regional Geology

Integral Energy, Minto, CSM

Figure 3

Client: INTEGRAL ENERGY
Project: FORMER BUILDINGS A, B & RETAINING WALL AREA VALIDATION REPORT
Location: FORMER INTEGRAL ENERGY DEPOT, SARK GROVE MINTO N.S.W.

PARSONS BRINCKERHOFF



LEGEND

FORMER INTEGRAL ENERGY MINTO DEPOT BOUNDARY

BOUNDARY OF FORMER BUILDINGS A, B AND RETAINING WALL AREA

NOTE

BASE PLAN SUPPLIED BY INTEGRAL ENERGY.

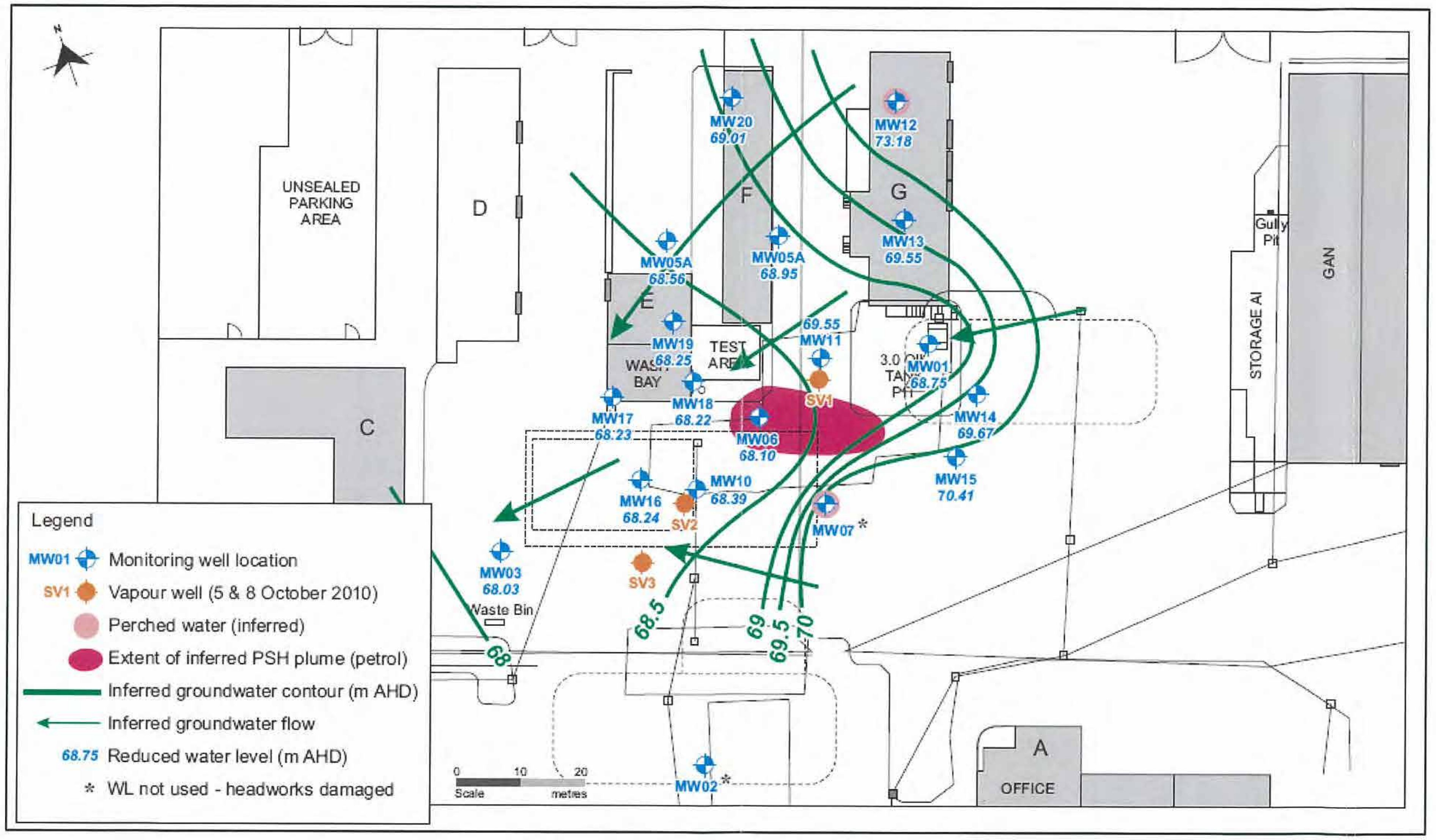
10 0 10 20 30 40 50 Metres

Scale 1: 1000 (A3)

FORMER SITE FEATURES

FIGURE 2

Plot Date: 30/07/10 - 16:41 Cad File: J:\A354-HAZ\PROJ\2115098A_CLM_Minto_Depot\09_Drafting\001\ACAD\DRAWINGS\2115098A-ENV-002A BUILDINGS A & B.dwg

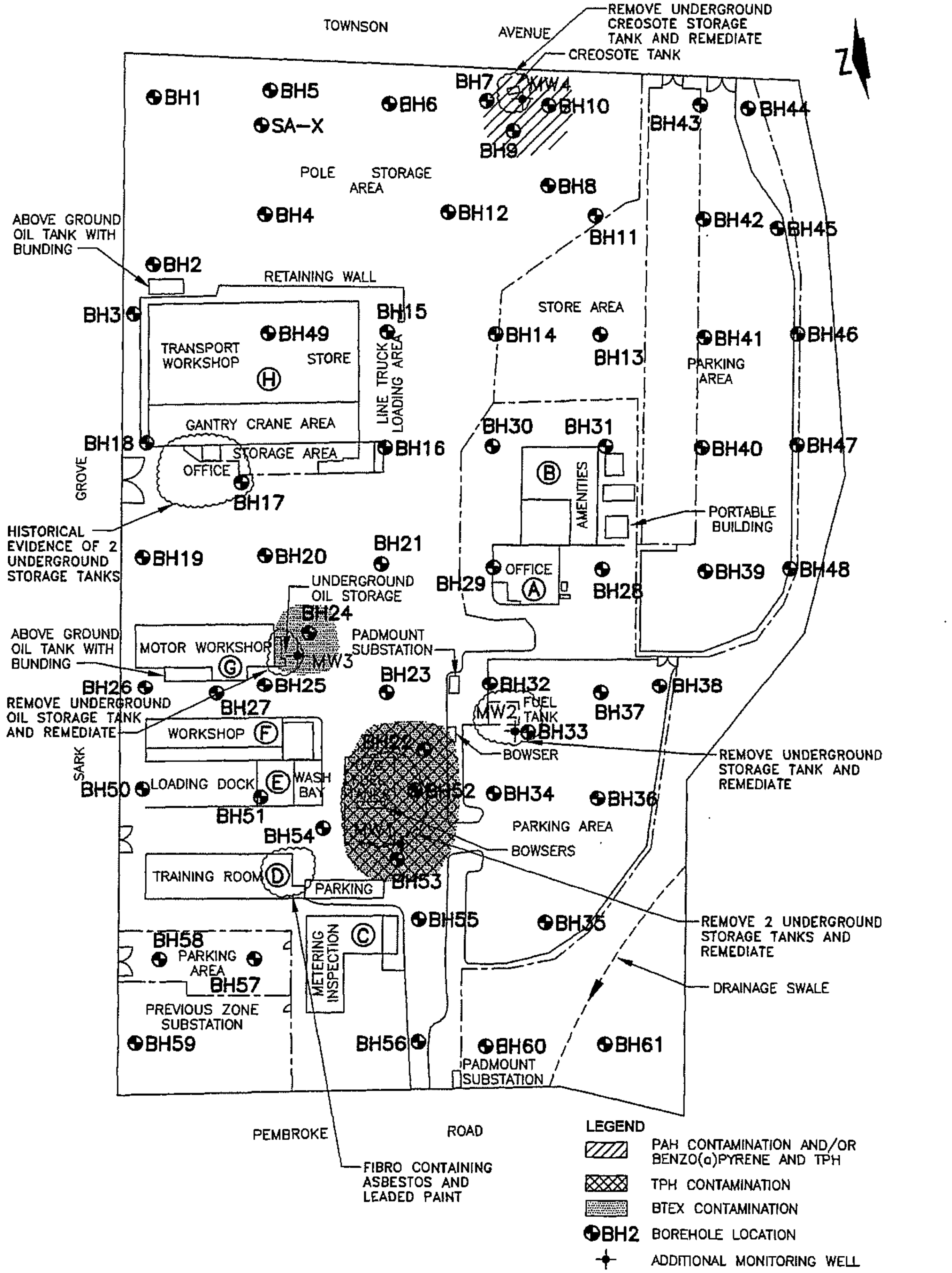


Site Layout & Inferred Groundwater Flow Regime (5 October 2010, from E2W)

Figure 4

SINCLAIR KNIGHT MERZ

Figure 5
REMEDIAL WORK
Minto



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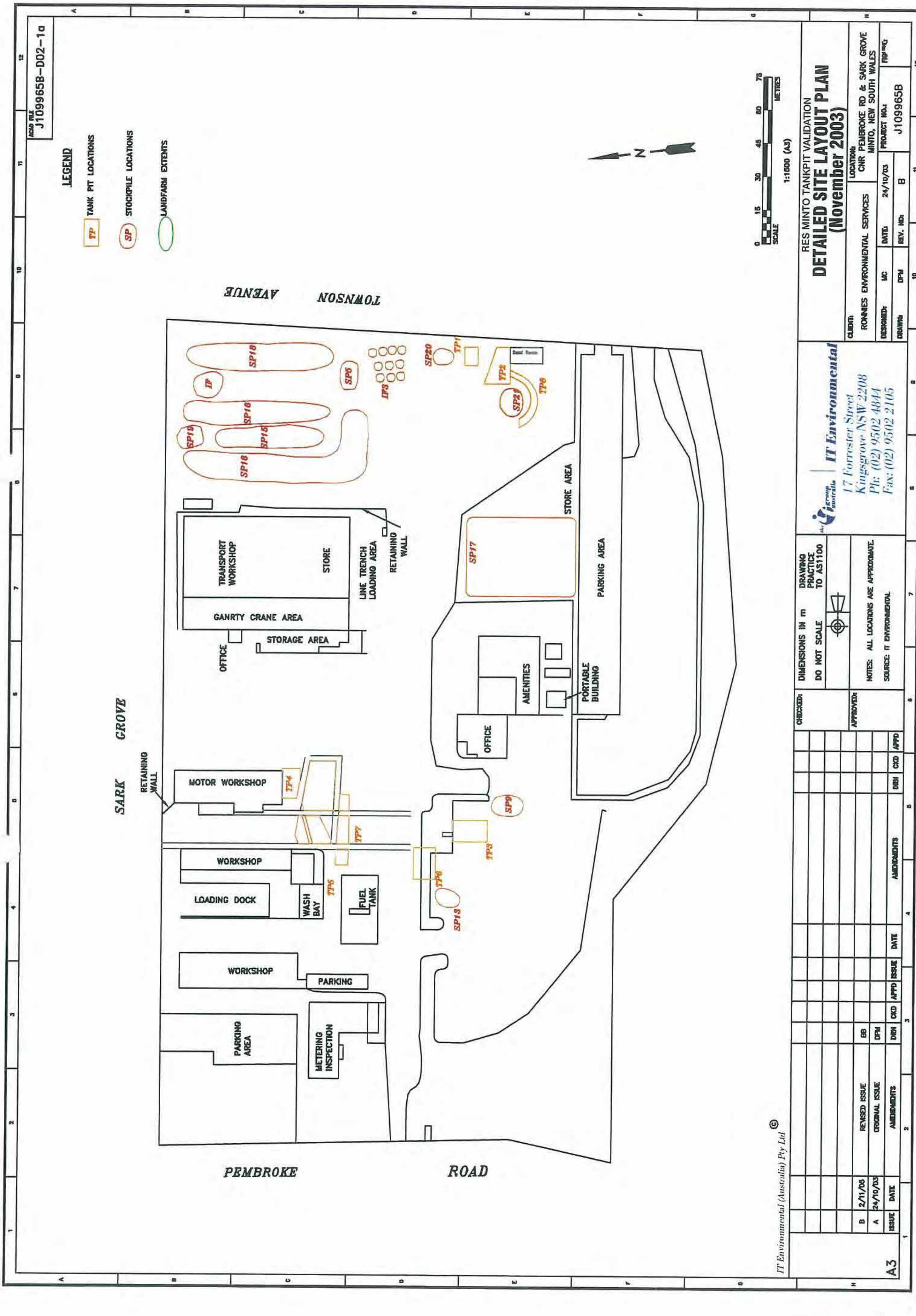
DATE: 21-03-2000 13:56
XREF:

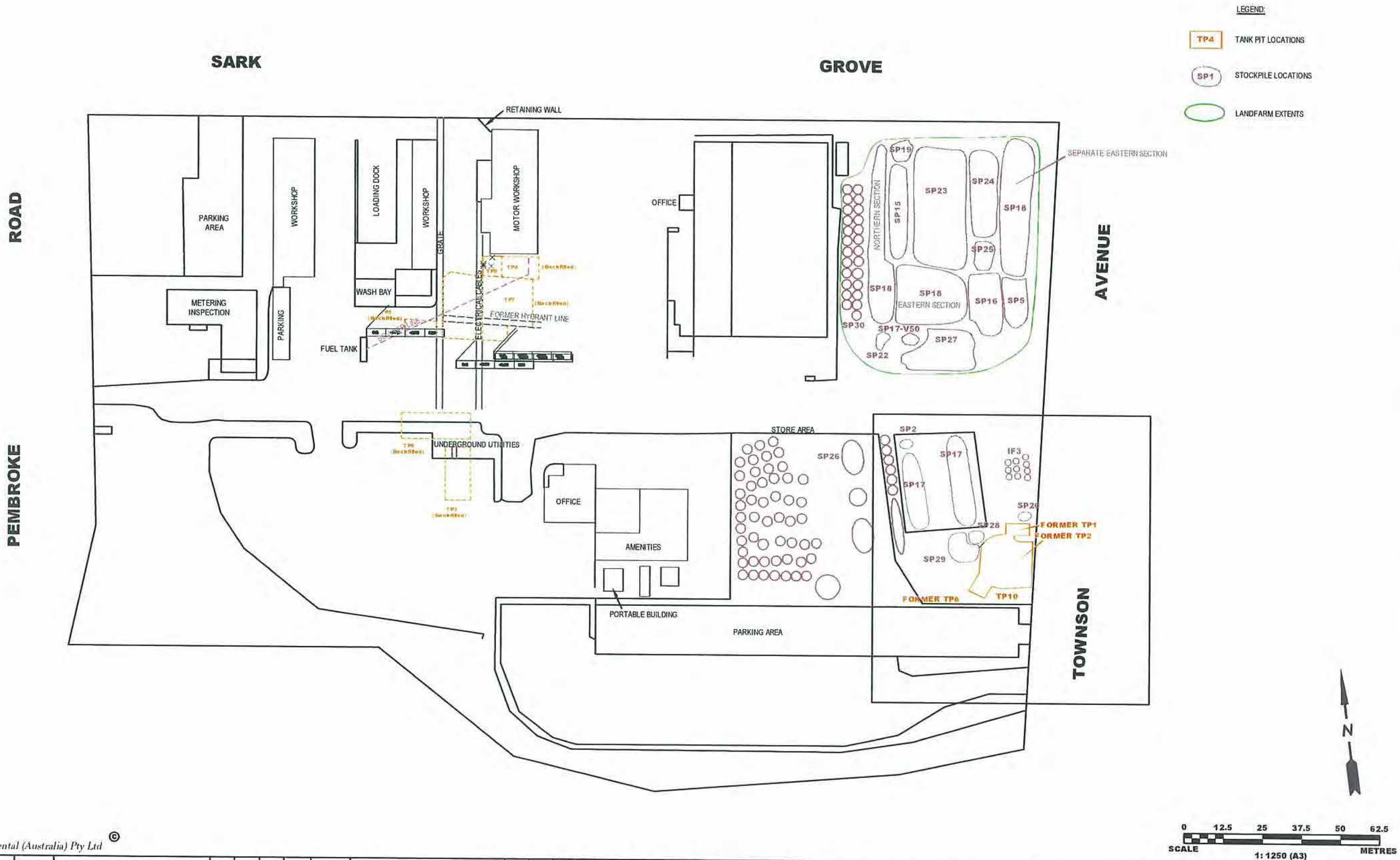
Figure 5



J109965B-D02-1a
LEGEND
TP TANK PIT LOCATIONS
SP STOCKPILE LOCATIONS
LANDFARM EXTENTS
TOWNSON AVENUE
SARK GROVE
PEMBROKE ROAD
RETAINING WALL
MOTOR WORKSHOP
WORKSHOP
LOADING DOCK
WASH BAY
FUEL TANK
WORKSHOP
PARKING
PARKING AREA
METERING INSPECTION
OFFICE
STORAGE AREA
GANRTY CRANE AREA
TRANSPORT WORKSHOP
STORE
LINE TRENCH LOADING AREA
RETAINING WALL
STORE AREA
PARKING AREA
AMENITIES
PORTABLE BUILDING
OFFICE
SP18
SP15
SP16
SP19
SP5
SP20
SP21
SP17
SP9
SP13
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
IP
IP3
SCALE 0 15 30 45 60 75 METRES
1:1500 (A3)
N
RES MINTO TANKPIT VALIDATION
DETAILED SITE LAYOUT PLAN
(November 2003)
IT Environmental
17 Forrester Street
Kingsgrove NSW 2208
Ph: (02) 9502 4844
Fax: (02) 9502 2105
CLIENT: RONNIES ENVIRONMENTAL SERVICES
LOCATION: CNR PEMBROKE RD & SARK GROVE MINTO, NEW SOUTH WALES
DESIGNED: MC
DRAWN: DPM
DATE: 24/10/03
REV. NO: B
PROJECT NO.: J109965B
DIMENSIONS IN m
DO NOT SCALE
DRAWING PRACTICE TO AS1100
NOTES: ALL LOCATIONS ARE APPROXIMATE.
SOURCE: IT ENVIRONMENTAL
B 2/11/05 REVISED ISSUE BB
A 24/10/03 ORIGINAL ISSUE DPM
ISSUE DATE AMENDMENTS DRN CKD APPD
A3
IT Environmental (Australia) Pty Ltd ©

Figure 6

ACAD FILE: J109965B-D02-1b



Environmental (Australia) Pty Ltd ©

ISSUE	DATE	AMENDMENTS	DRN	CKD	APPD
C	2/11/05	REVISED ISSUE	BB		
B	26/08/05	REVISED ISSUE	NHP		
A	24/10/03	ORIGINAL ISSUE	DPM		

CHECKED:

APPROVED:

DIMENSIONS IN m — DO NOT SCALE — DRAWING PRACTICE TO AS1100

NOTES: ALL LOCATIONS ARE APPROXIMATE.

SOURCE: IT ENVIRONMENTAL

IT Environmental
17 Forrester Street
Kingsgrove NSW 2208
Ph: (02) 9502 4844
Fax: (02) 9502 2105

RES MINTO TANKPIT VALIDATION

DETAILED SITE LAYOUT PLAN (5 May 2004)

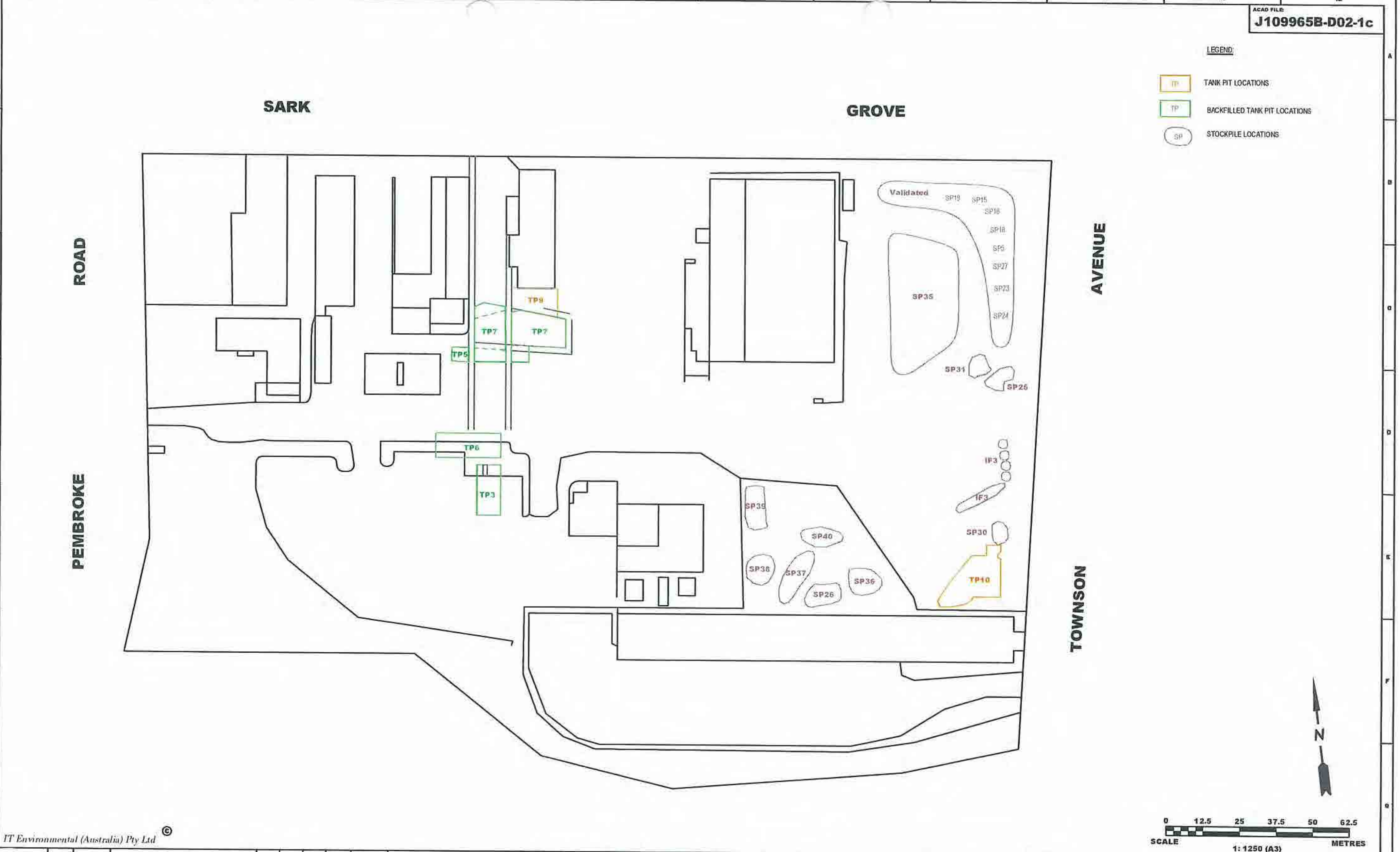
CLIENT: RONNIES ENVIRONMENTAL SERVICES

LOCATION: CNR PEMBROKE RD & SARK GROVE MINTO, NEW SOUTH WALES

DESIGNED: NHP | DATE: 25/08/05 | PROJECT NO.: J109965B | FIGURE:

DRAWN: NHP | REV. NO: C

Figure 7



ISSUE	DATE	AMENDMENTS	DRN	CKD	APPD
C	2/11/05	REVISED ISSUE	BS		
B	25/08/05	REVISED ISSUE	NHP		
A	24/10/03	ORIGINAL ISSUE	DPM		

CHECKED:

APPROVED:

DIMENSIONS IN m

DO NOT SCALE

DRAWING PRACTICE TO AS1100

NOTES: ALL LOCATIONS ARE APPROXIMATE.

SOURCE: IT ENVIRONMENTAL

IT Environmental

17 Forrester Street
Kingsgrove NSW 2208
Ph: (02) 9502 4844
Fax: (02) 9502 2105

RES MINTO TANKPIT VALIDATION

DETAILED SITE LAYOUT PLAN (23 AUGUST 2005)

CLIENT: RONNIES ENVIRONMENTAL SERVICES

LOCATION: CNR PEMBROKE RD & SARK GROVE MINTO, NEW SOUTH WALES

DESIGNED: OC | DATE: 25/08/05 | PROJECT NO.: J109965B | FIGURE:

DRAWN: NHP | REV. NO: C

Figure 8

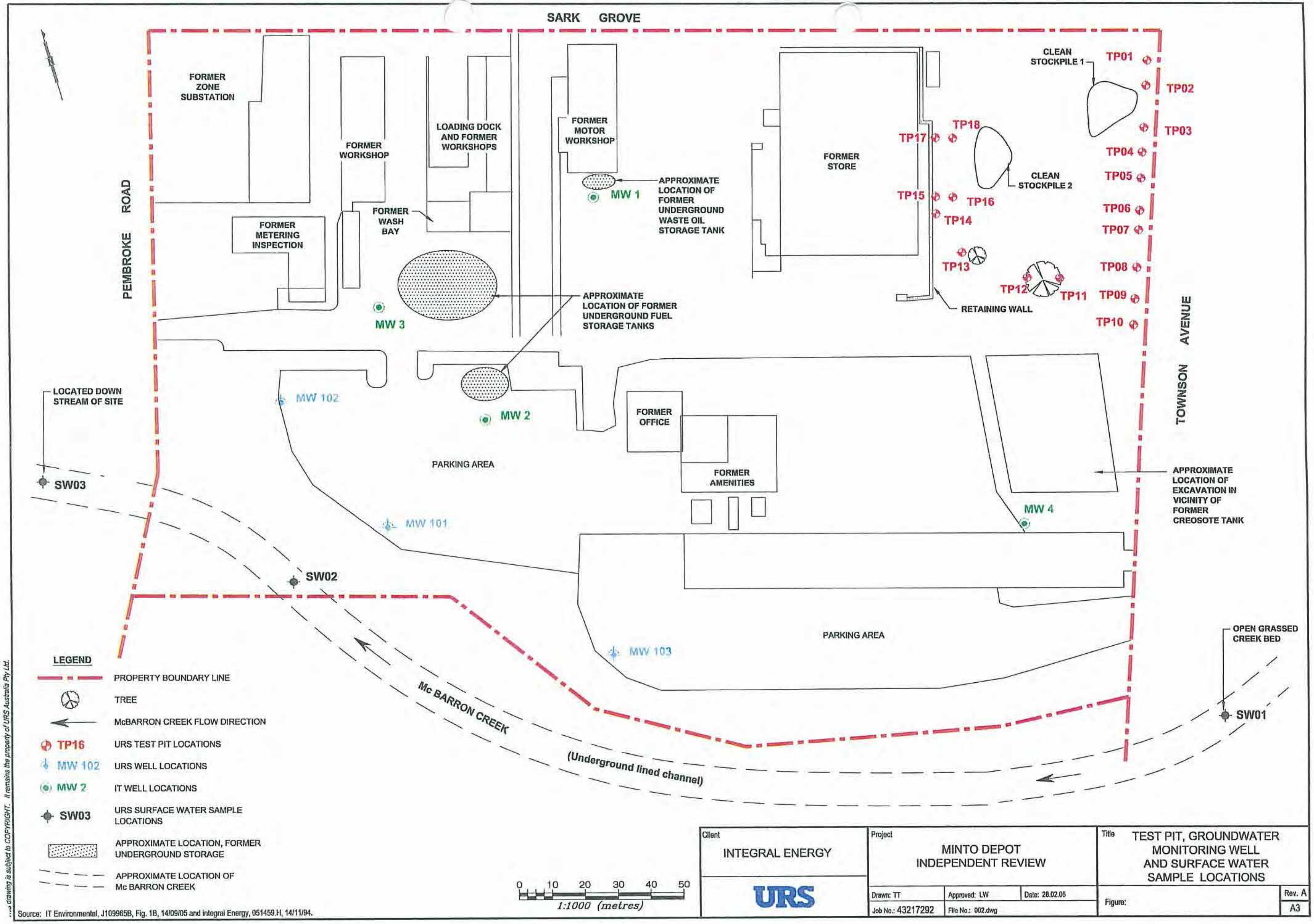
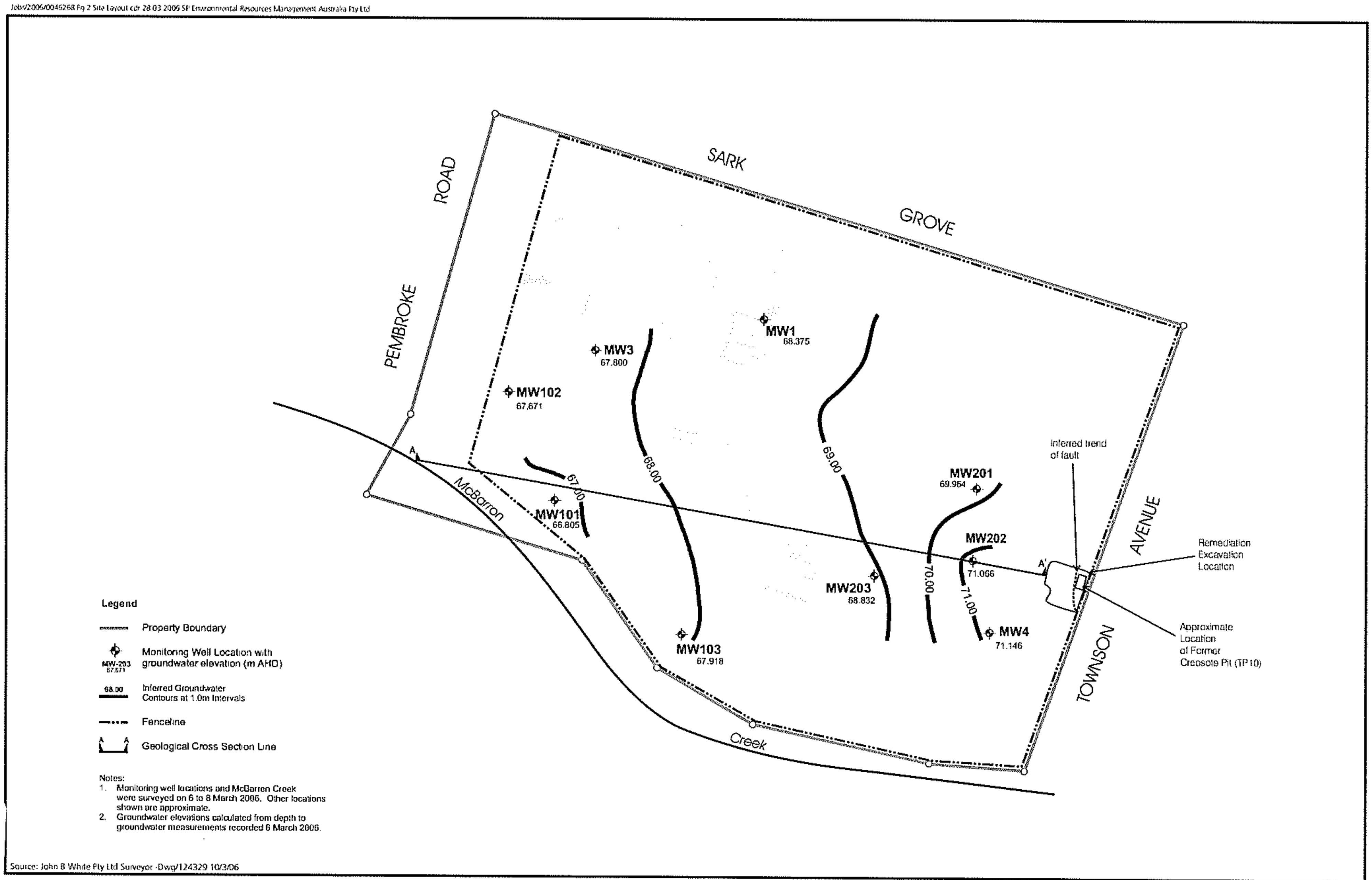

SARK GROVE
PEMBROKE ROAD
TOWNSON AVENUE
FORMER ZONE SUBSTATION
FORMER WORKSHOP
LOADING DOCK AND FORMER WORKSHOPS
FORMER MOTOR WORKSHOP
FORMER STORE
FORMER METERING INSPECTION
FORMER WASH BAY
MW 1
APPROXIMATE LOCATION OF FORMER UNDERGROUND WASTE OIL STORAGE TANK
APPROXIMATE LOCATION OF FORMER UNDERGROUND FUEL STORAGE TANKS
MW 3
MW 2
MW 4
MW 101
MW 102
MW 103
CLEAN STOCKPILE 1
CLEAN STOCKPILE 2
TP01
TP02
TP03
TP04
TP05
TP06
TP07
TP08
TP09
TP10
TP11
TP12
TP13
TP14
TP15
TP16
TP17
TP18
RETAINING WALL
FORMER OFFICE
FORMER AMENITIES
PARKING AREA
PARKING AREA
APPROXIMATE LOCATION OF EXCAVATION IN VICINITY OF FORMER CREOSOTE TANK
LOCATED DOWN STREAM OF SITE
SW01
SW02
SW03
OPEN GRASSED CREEK BED
Mc BARRON CREEK
(Underground lined channel)
LEGEND
PROPERTY BOUNDARY LINE
TREE
McBARRON CREEK FLOW DIRECTION
TP16 URS TEST PIT LOCATIONS
MW 102 URS WELL LOCATIONS
MW 2 IT WELL LOCATIONS
SW03 URS SURFACE WATER SAMPLE LOCATIONS
APPROXIMATE LOCATION, FORMER UNDERGROUND STORAGE
APPROXIMATE LOCATION OF Mc BARRON CREEK
0 10 20 30 40 50
1:1000 (metres)
Source: IT Environmental, J109965B, Fig. 1B, 14/09/05 and Integral Energy, 051459.H, 14/11/94.
Client
INTEGRAL ENERGY
URS
Project
MINTO DEPOT
INDEPENDENT REVIEW
Drawn: TT
Approved: LW
Date: 28.02.06
Job No.: 43217292
File No.: 002.dwg
Title
TEST PIT, GROUNDWATER MONITORING WELL AND SURFACE WATER SAMPLE LOCATIONS
Figure:
Rev. A
A3
...s drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

Figure 9



ERM

0 30m

Figure

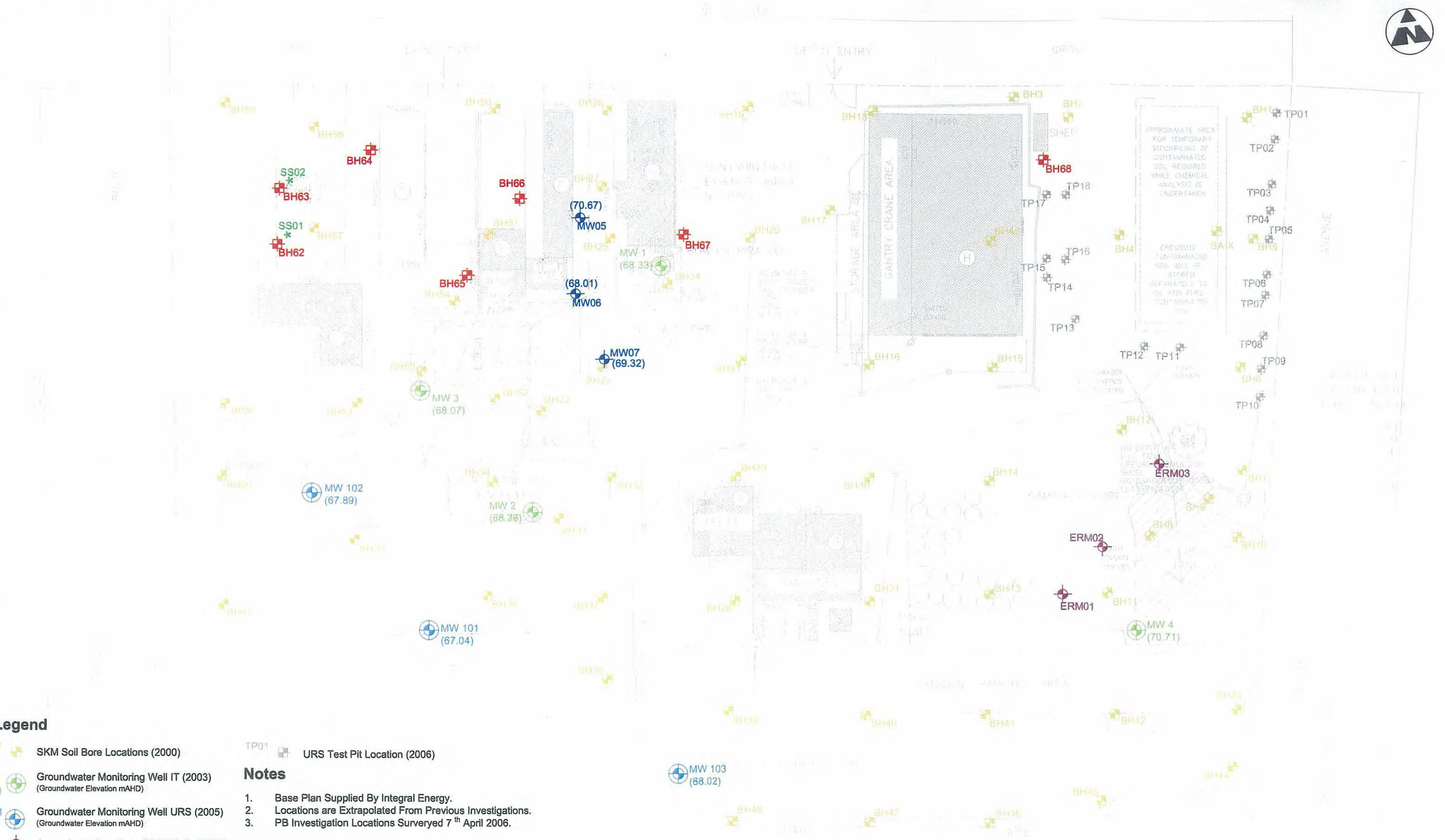
Site Layout and Monitoring Well Location Plan

Integral Energy, Minto NSW

Figure 10

Client: Integral Energy
Project: Minto Depot
Location: Sark Grove, Minto NSW

PARSONS BRINCKERHOFF



Legend

BH61	SKM Soil Bore Locations (2000)
MW 2 (68.77)	Groundwater Monitoring Well IT (2003) (Groundwater Elevation mAHD)
MW 101 (66.27)	Groundwater Monitoring Well URS (2005) (Groundwater Elevation mAHD)
	Approximate Location - ERM Wells (2006)
	MW - Groundwater Well & Soil Locations PB (2006) (Groundwater Elevation mAHD)
	BH - Soil Locations PB (2006)
	SS - Soil/Sludge Sample PB (2006)
TP01	URS Test Pit Location (2006)

Notes

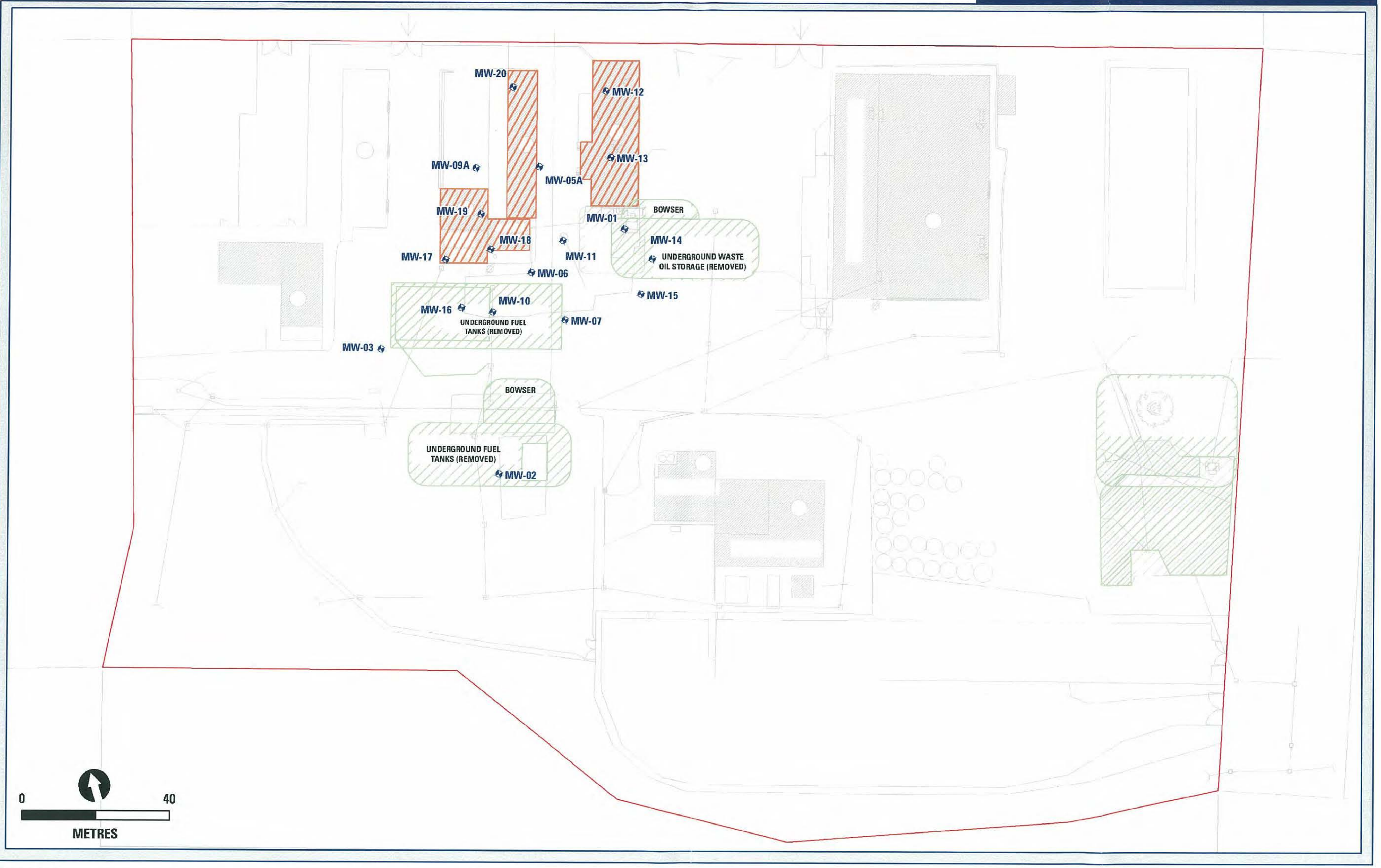
1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

10 0 10 20 30 40 50 Metres

Scale 1 : 1000

Plot Date: 30/05/06 - 17:02   Cad File: J:\A354-HAZ\PROJ\2115098A_CLM_Minto_Depot\09_Drafting\001\ACAD\DRAWINGS\2115098A-001-GEO-F002.dwg

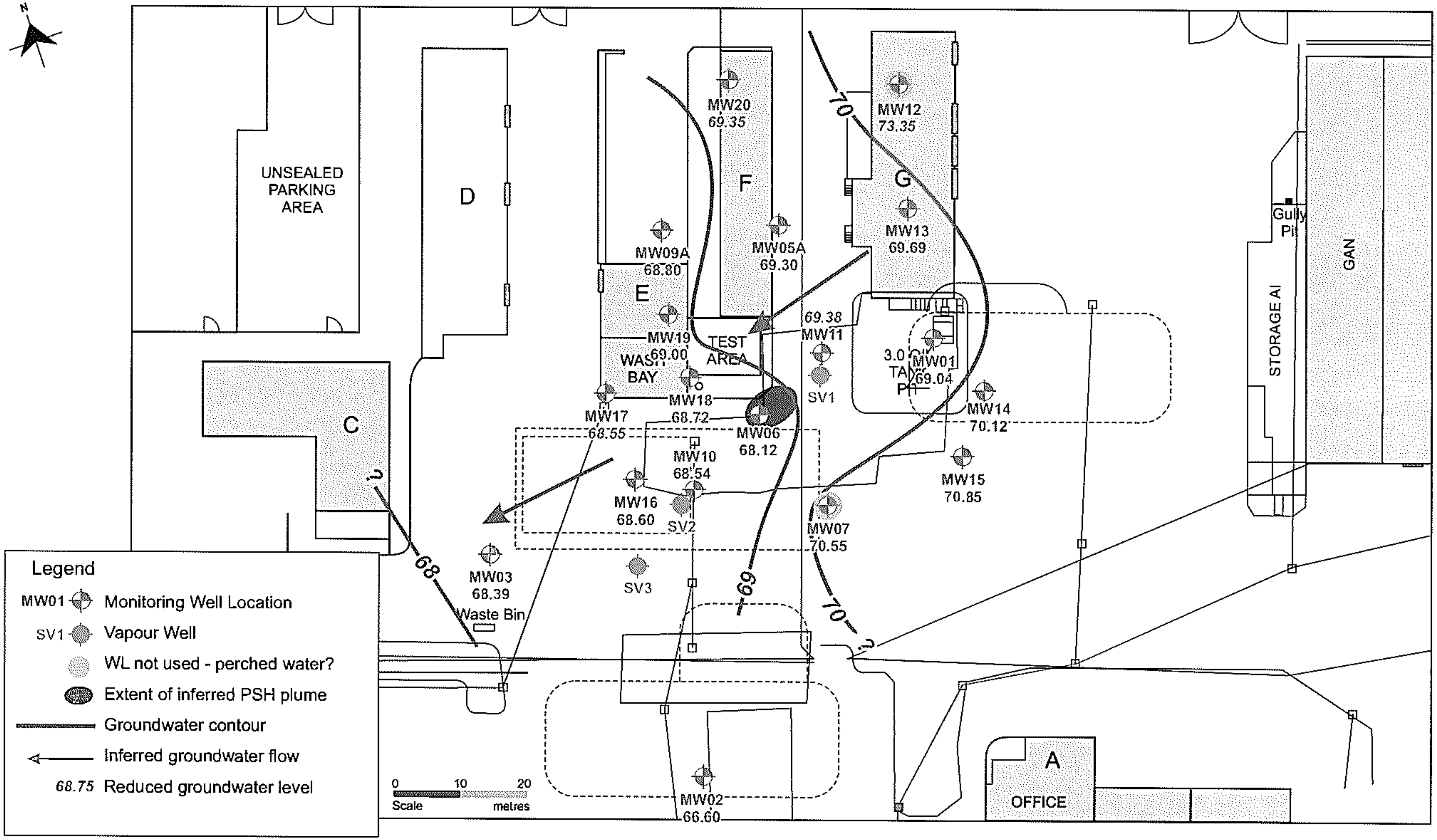
Site Plan
Boreholes & Monitoring Wells
Figure 11



Site boundary
Monitoring well
Previous site features
Former underground structures
Approximate locations of previous USTs and associated infrastructure

Figure : Monitoring well locations
Former Integral Energy Depot, Sark Grove, Minto, NSW

earth2water Pty Ltd
Environmental & Groundwater Consulting



Source: Parsons Brinkerhoff

SITE LAYOUT & INFERRED GROUNDWWATER LEVELS

ENDEAVOUR ENERGY - MINTO DEPOT

Date: *13 September 2011*

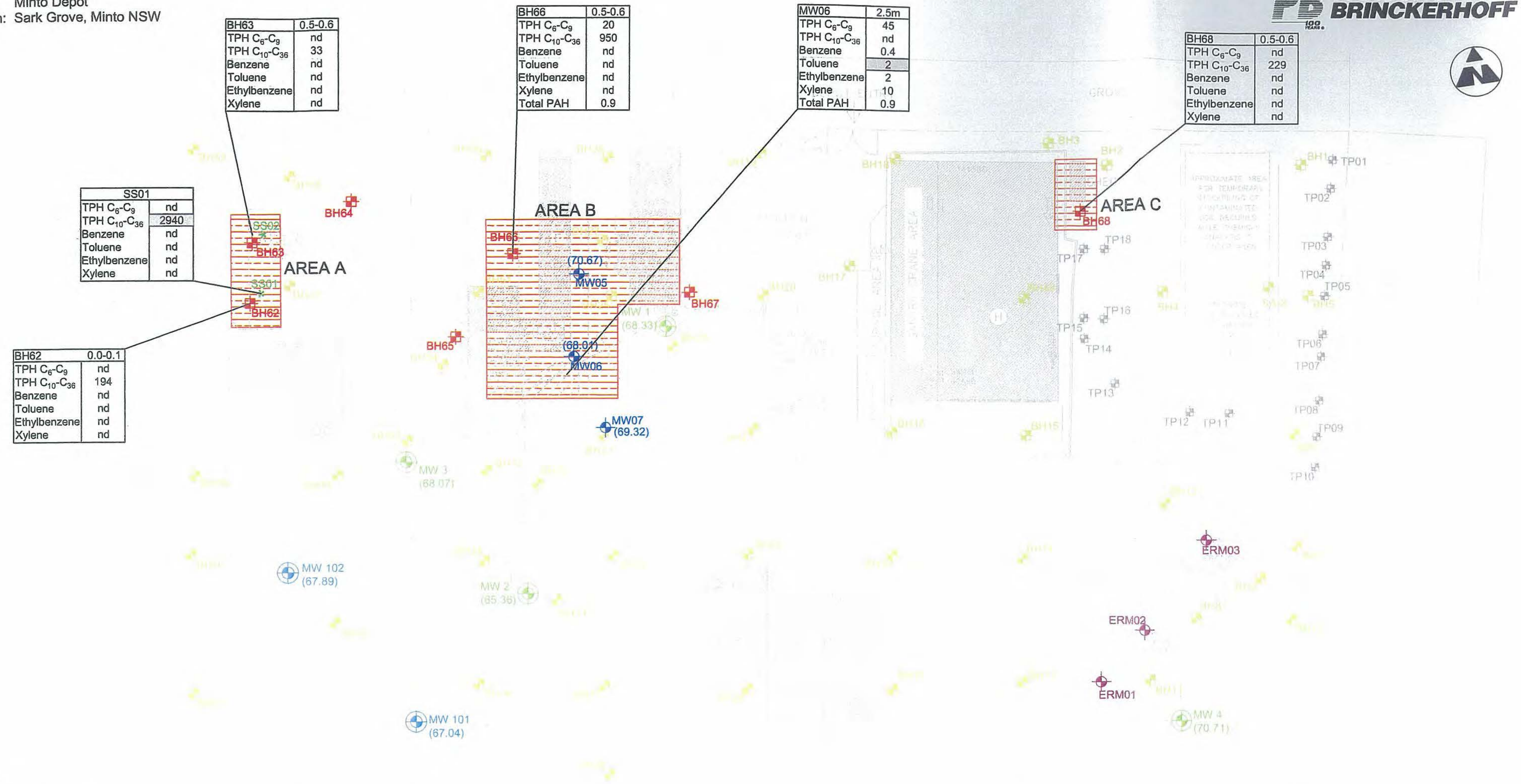
Reference: *E2W_153_01.cdr*

Figure

Figure 13

Client: Integral Energy
Project: Minto Depot
Location: Sark Grove, Minto NSW

PB PARSONS BRINCKERHOFF



BH63	0.5-0.6
TPH C_6-C_9	nd
TPH C_{10}-C_{36}	33
Benzene	nd
Toluene	nd
Ethylbenzene	nd
Xylene	nd

BH66	0.5-0.6
TPH C_6-C_9	20
TPH C_{10}-C_{36}	950
Benzene	nd
Toluene	nd
Ethylbenzene	nd
Xylene	nd
Total PAH	0.9

MW06	2.5m
TPH C_6-C_9	45
TPH C_{10}-C_{36}	nd
Benzene	0.4
Toluene	2
Ethylbenzene	2
Xylene	10
Total PAH	0.9

BH68	0.5-0.6
TPH C_6-C_9	nd
TPH C_{10}-C_{36}	229
Benzene	nd
Toluene	nd
Ethylbenzene	nd
Xylene	nd

SS01	
TPH C_6-C_9	nd
TPH C_{10}-C_{36}	2940
Benzene	nd
Toluene	nd
Ethylbenzene	nd
Xylene	nd

BH62	0.0-0.1
TPH C_6-C_9	nd
TPH C_{10}-C_{36}	194
Benzene	nd
Toluene	nd
Ethylbenzene	nd
Xylene	nd

Legend

- BH81 — SKM Soil Bore Locations (2000)
- MW 2 (68.77) — Groundwater Monitoring Well IT (2003) (Groundwater Elevation mAHD)
- MW 101 (66.27) — Groundwater Monitoring Well URS (2005) (Groundwater Elevation mAHD)
- Approximate Location - ERM Wells (2006)
- MW - Groundwater Well & Soil Locations PB (2006) (Groundwater Elevation mAHD)
- BH - Soil Locations PB (2006)
- * SS - Soil/Sludge Sample PB (2006)
- 2 — Concentration Exceeds Apoted Assessment Criteria
- TP01 — URS Test Pit Location (2006)
- Approximate Location for Soil Remediation works Based on Soil/Groundwater Investigation Results. Additional Locations to be Confirmed Following Demolition and Validation of Site During Removal of Buildings/Hardstand.

Notes

1. Base Plan Supplied By Integral Energy
2. Locations are Extrapolated From Previous Investigations
3. PB Investigation Locations Surveyed 7 th April 2006
4. Soil Samples Taken Between 16 th - 24th March 2006
5. Soil Analysis Results From Previous Investigations not Shown
6 Only Soil Results Detected Above PQL are Shown
7. nd = not detected

10 0 10 20 30 40 50 Metres
Scale 1 : 1000

Soil Contaminant Plan (TPH, BTEX & PAHs)

Figure 14

Plot Date: 01/06/06 - 08:35 Cad File: J:\A354-HAZ\PROJ\2115098A_CLM_Minto_Depot\09_Drafting\001\ACAD\DRAWINGS\2115098A-008-GEO-F003.dwg

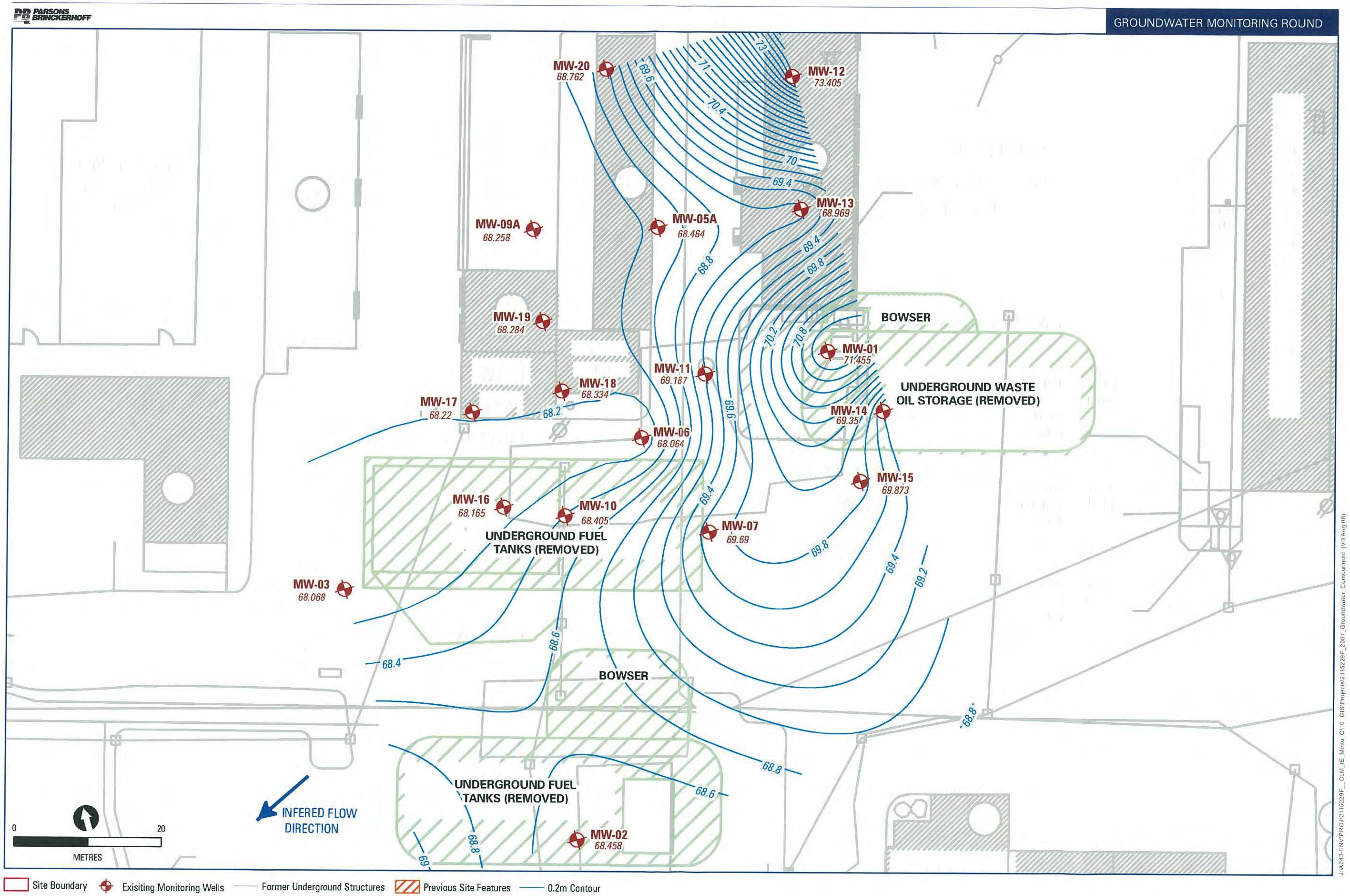


Figure : Groundwater Contour Plan

PARSONS BRINCKERHOFF

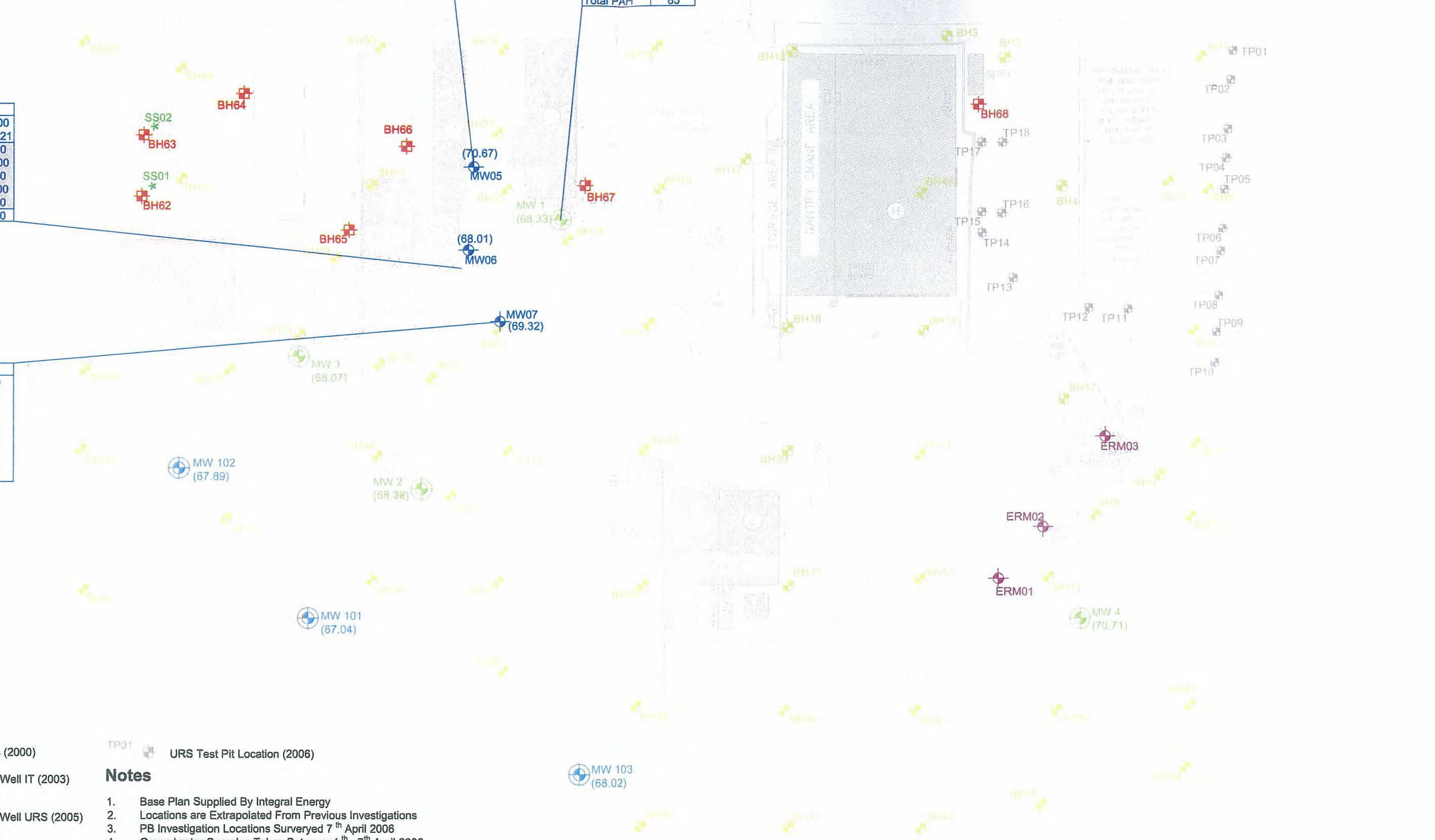
Monitoring well (mAHD) — Groundwater contour (mAHD) — Inferred groundwater flow direction

Figure : Groundwater contour plan
Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 16

Client: Integral Energy
Project: Minto Depot
Location: Sark Grove, Minto NSW

PARSONS BRINCKERHOFF



MW05	
TPH C_6-C_9	82,000
TPH C_{10}-C_{36}	34,070
Benzene	17,000
Toluene	30,000
Ethylbenzene	4,000
m + p Xylene	17,000
o - Xylene	7,000
Total PAH	950

MW1	
TPH C_6-C_9	7,100
TPH C_{10}-C_{36}	2,500
Benzene	350
Toluene	530
Ethylbenzene	570
m + p Xylene	2,200
o - Xylene	200
Total PAH	85

MW06	
TPH C_6-C_9	52,000
TPH C_{10}-C_{36}	100,521
Benzene	4,200
Toluene	23,000
Ethylbenzene	3,800
m + p Xylene	15,000
o - Xylene	6,200
Total PAH	2,200

MW07	
TPH C_6-C_9	120
TPH C_{10}-C_{36}	nd
Benzene	11
Toluene	10
Ethylbenzene	nd
m + p Xylene	3
o - Xylene	2
Total PAH	na

Legend

- BH61 — SKM Soil Bore Locations (2000)
- MW 2 (68.77) — Groundwater Monitoring Well IT (2003) (Groundwater Elevation mAHD)
- MW 101 (66.27) — Groundwater Monitoring Well URS (2005) (Groundwater Elevation mAHD)
- Approximate Location - ERM Wells (2006)
- MW - Groundwater Well & Soil Locations PB (2006) (Groundwater Elevation mAHD)
- BH - Soil Locations PB (2006)
- SS - Soil/Sludge PB (2006)
- TP01 — URS Test Pit Location (2006)

Notes

1. Base Plan Supplied By Integral Energy
2. Locations are Extrapolated From Previous Investigations
3. PB Investigation Locations Surveyed 7 th April 2006
4. Groundwater Samples Taken Between 4 th - 7th April 2006
5. Only Groundwater Results Detected Above PQL are Shown
6. Metal Analysis Results not Included
7. nd = not detected
8. na = not analysed

100 — Concentration Exceeds Adopted Assessment Criteria

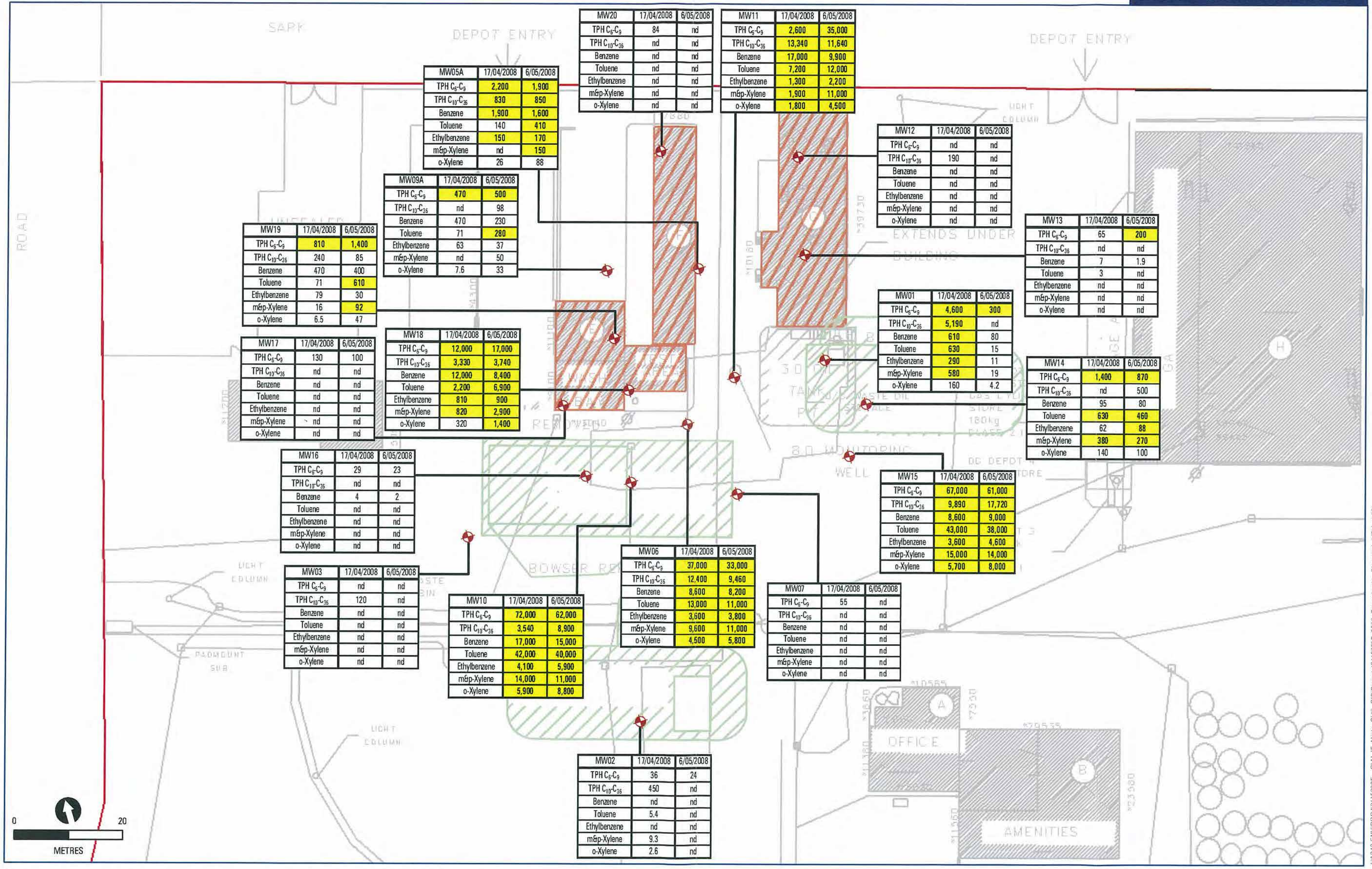
Plot Date: 01/06/06 - 08:40 Cad File: F:\A354-HAZ\PROJ\2115098A_CLM_Minto_Depot\03_Drafting\001\ACAD\DRAWINGS\2115098A-001-GEO-F004.dwg

Groundwater Contaminant Plan (TPH, BTEX & PAHs)

Figure 17

PARSONS BRINCKERHOFF

GROUNDWATER MONITORING ROUND



MW05A	17/04/2008	6/05/2008
TPH C_6-C_9	**2,200**	**1,900**
TPH C_{10}-C_{36}	**830**	**850**
Benzene	**1,900**	**1,600**
Toluene	140	**410**
Ethylbenzene	**150**	**170**
m&p-Xylene	nd	**150**
o-Xylene	26	88

MW20	17/04/2008	6/05/2008
TPH C_6-C_9	84	nd
TPH C_{10}-C_{36}	nd	nd
Benzene	nd	nd
Toluene	nd	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW11	17/04/2008	6/05/2008
TPH C_6-C_9	**2,600**	**35,000**
TPH C_{10}-C_{36}	**13,340**	**11,640**
Benzene	**17,000**	**9,900**
Toluene	**7,200**	**12,000**
Ethylbenzene	**1,300**	**2,200**
m&p-Xylene	**1,900**	**11,000**
o-Xylene	**1,800**	**4,500**

MW12	17/04/2008	6/05/2008
TPH C_6-C_9	nd	nd
TPH C_{10}-C_{36}	190	nd
Benzene	nd	nd
Toluene	nd	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW09A	17/04/2008	6/05/2008
TPH C_6-C_9	**470**	**500**
TPH C_{10}-C_{36}	nd	98
Benzene	470	230
Toluene	71	**280**
Ethylbenzene	63	37
m&p-Xylene	nd	50
o-Xylene	7.6	33

MW19	17/04/2008	6/05/2008
TPH C_6-C_9	**810**	**1,400**
TPH C_{10}-C_{36}	240	85
Benzene	470	400
Toluene	71	**610**
Ethylbenzene	79	30
m&p-Xylene	16	**92**
o-Xylene	6.5	47

MW13	17/04/2008	6/05/2008
TPH C_6-C_9	65	**200**
TPH C_{10}-C_{36}	nd	nd
Benzene	7	1.9
Toluene	3	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW01	17/04/2008	6/05/2008
TPH C_6-C_9	**4,600**	**300**
TPH C_{10}-C_{36}	**5,190**	nd
Benzene	**610**	80
Toluene	**630**	15
Ethylbenzene	**290**	11
m&p-Xylene	**580**	19
o-Xylene	160	4.2

MW17	17/04/2008	6/05/2008
TPH C_6-C_9	130	100
TPH C_{10}-C_{36}	nd	nd
Benzene	nd	nd
Toluene	nd	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW18	17/04/2008	6/05/2008
TPH C_6-C_9	**12,000**	**17,000**
TPH C_{10}-C_{36}	**3,330**	**3,740**
Benzene	**12,000**	**8,400**
Toluene	**2,200**	**6,900**
Ethylbenzene	**810**	**900**
m&p-Xylene	**820**	**2,900**
o-Xylene	320	**1,400**

MW14	17/04/2008	6/05/2008
TPH C_6-C_9	**1,400**	**870**
TPH C_{10}-C_{36}	nd	500
Benzene	95	80
Toluene	**630**	**460**
Ethylbenzene	62	**88**
m&p-Xylene	**380**	**270**
o-Xylene	140	100

MW16	17/04/2008	6/05/2008
TPH C_6-C_9	29	23
TPH C_{10}-C_{36}	nd	nd
Benzene	4	2
Toluene	nd	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW15	17/04/2008	6/05/2008
TPH C_6-C_9	**67,000**	**61,000**
TPH C_{10}-C_{36}	**9,890**	**17,720**
Benzene	**8,600**	**9,000**
Toluene	**43,000**	**38,000**
Ethylbenzene	**3,600**	**4,600**
m&p-Xylene	**15,000**	**14,000**
o-Xylene	**5,700**	**8,000**

MW06	17/04/2008	6/05/2008
TPH C_6-C_9	**37,000**	**33,000**
TPH C_{10}-C_{36}	**12,400**	**9,460**
Benzene	**8,600**	**8,200**
Toluene	**13,000**	**11,000**
Ethylbenzene	**3,600**	**3,800**
m&p-Xylene	**9,600**	**11,000**
o-Xylene	**4,500**	**5,800**

MW03	17/04/2008	6/05/2008
TPH C_6-C_9	nd	nd
TPH C_{10}-C_{36}	120	nd
Benzene	nd	nd
Toluene	nd	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW07	17/04/2008	6/05/2008
TPH C_6-C_9	55	nd
TPH C_{10}-C_{36}	nd	nd
Benzene	nd	nd
Toluene	nd	nd
Ethylbenzene	nd	nd
m&p-Xylene	nd	nd
o-Xylene	nd	nd

MW10	17/04/2008	6/05/2008
TPH C_6-C_9	**72,000**	**62,000**
TPH C_{10}-C_{36}	**3,540**	**8,900**
Benzene	**17,000**	**15,000**
Toluene	**42,000**	**40,000**
Ethylbenzene	**4,100**	**5,900**
m&p-Xylene	**14,000**	**11,000**
o-Xylene	**5,900**	**8,800**

MW02	17/04/2008	6/05/2008
TPH C_6-C_9	36	24
TPH C_{10}-C_{36}	450	nd
Benzene	nd	nd
Toluene	5.4	nd
Ethylbenzene	nd	nd
m&p-Xylene	9.3	nd
o-Xylene	2.6	nd

Site Boundary — Exisiting Monitoring Wells — Former Underground Structures — Previous Site Features

All results expressed as µg/L
nd = not detected above laboratory practical quantitation limits
Yellow & Bold = Concentration exceeds adopted assessment criteria

Figure : Groundwater Contaminant Plan

Figure 18

J:\A243-ENV\PROJ\2115229F_CLM_IE_Metro_G10_GIS\Projects\2115229F_2003_Groundwater_Plan.mxd (VB Aug 08)

PARSONS BRINCKERHOFF

GROUNDWATER MONITORING REPORT
(MAY 2009 - MARCH 2010)

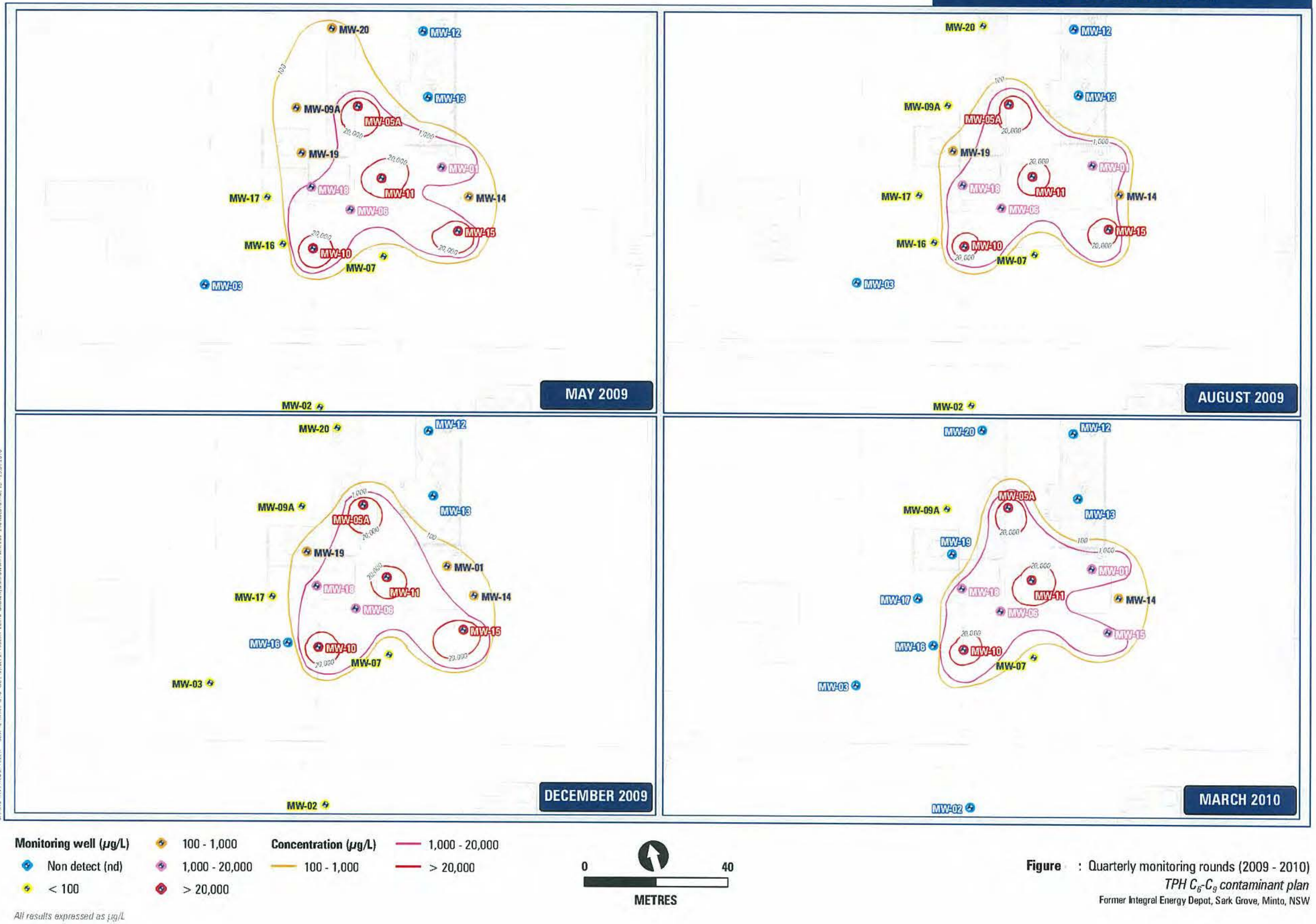


Figure : Quarterly monitoring rounds (2009 - 2010)

TPH C_6-C_9 contaminant plan

Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 19

PARSONS BRINCKERHOFF

GROUNDWATER MONITORING REPORT
(MAY 2009 - MARCH 2010)

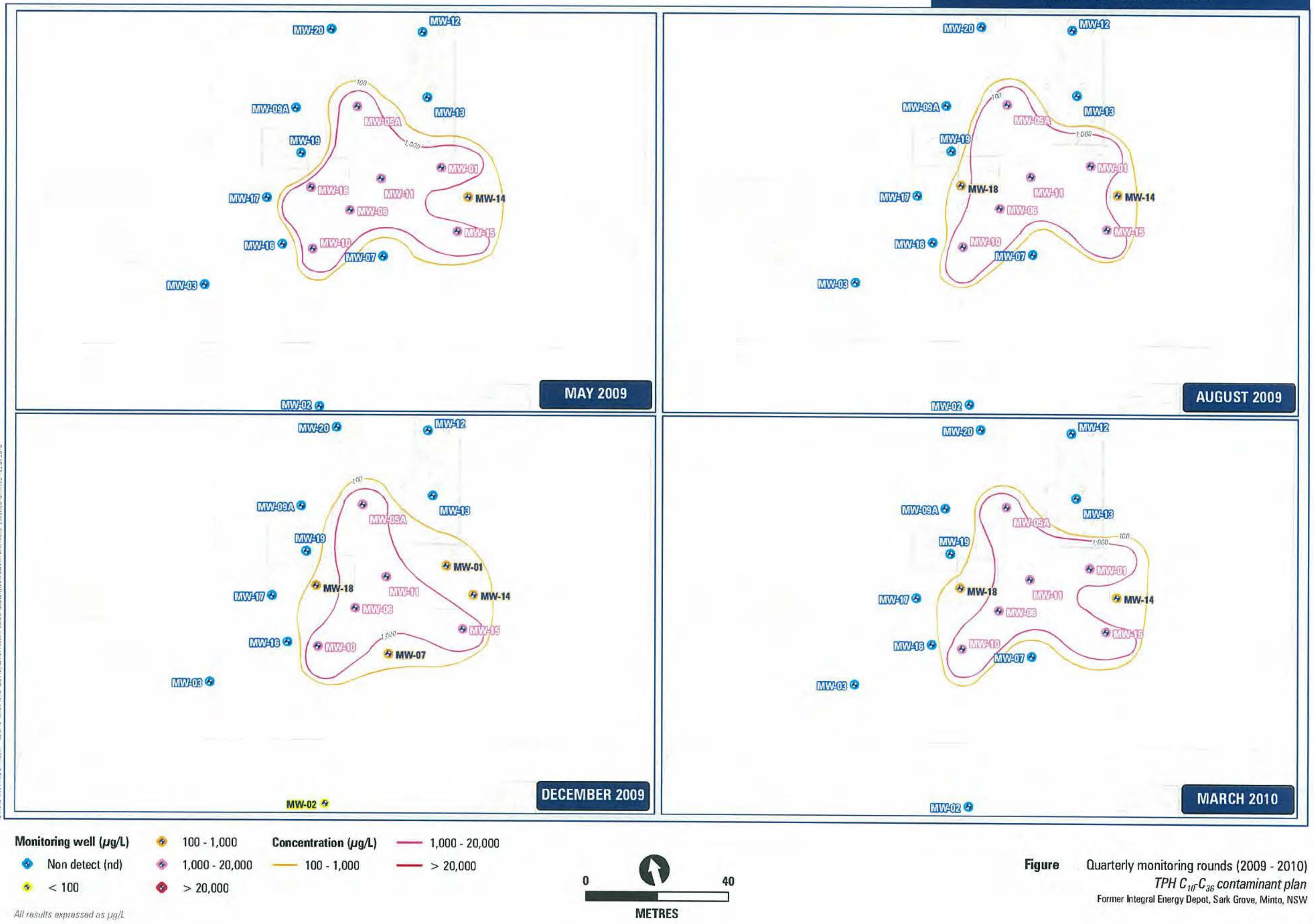


Figure Quarterly monitoring rounds (2009 - 2010)

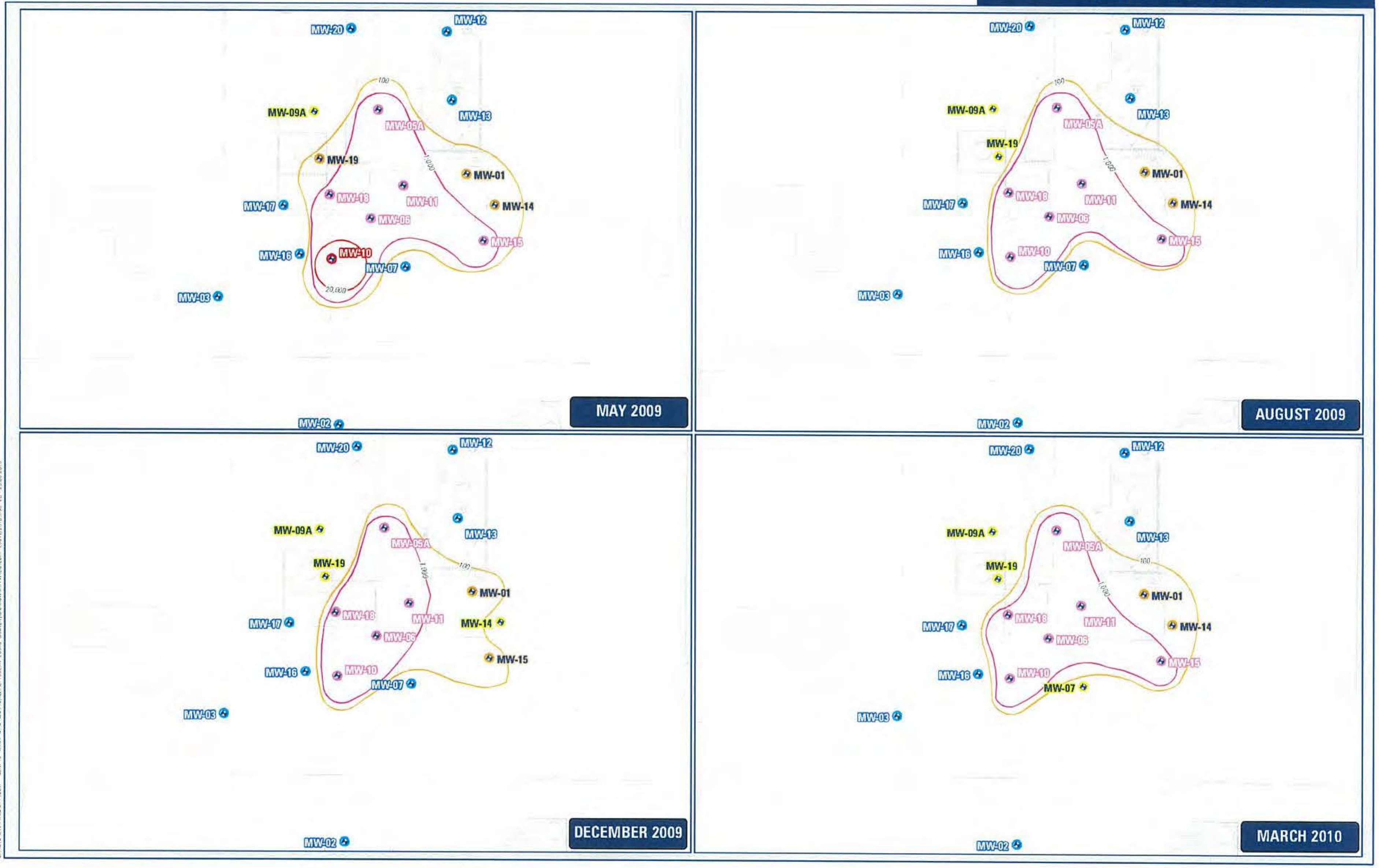
TPH C_{10}-C_{36} contaminant plan

Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 20

PARSONS BRINCKERHOFF

GROUNDWATER MONITORING REPORT
(MAY 2009 - MARCH 2010)



Monitoring well (µg/L)
- Non detect (nd)
- < 100
- 100 - 1,000
- 1,000 - 20,000
- > 20,000

Concentration (µg/L)
- 100 - 1,000
- 1,000 - 20,000
- > 20,000

All results expressed as µg/L

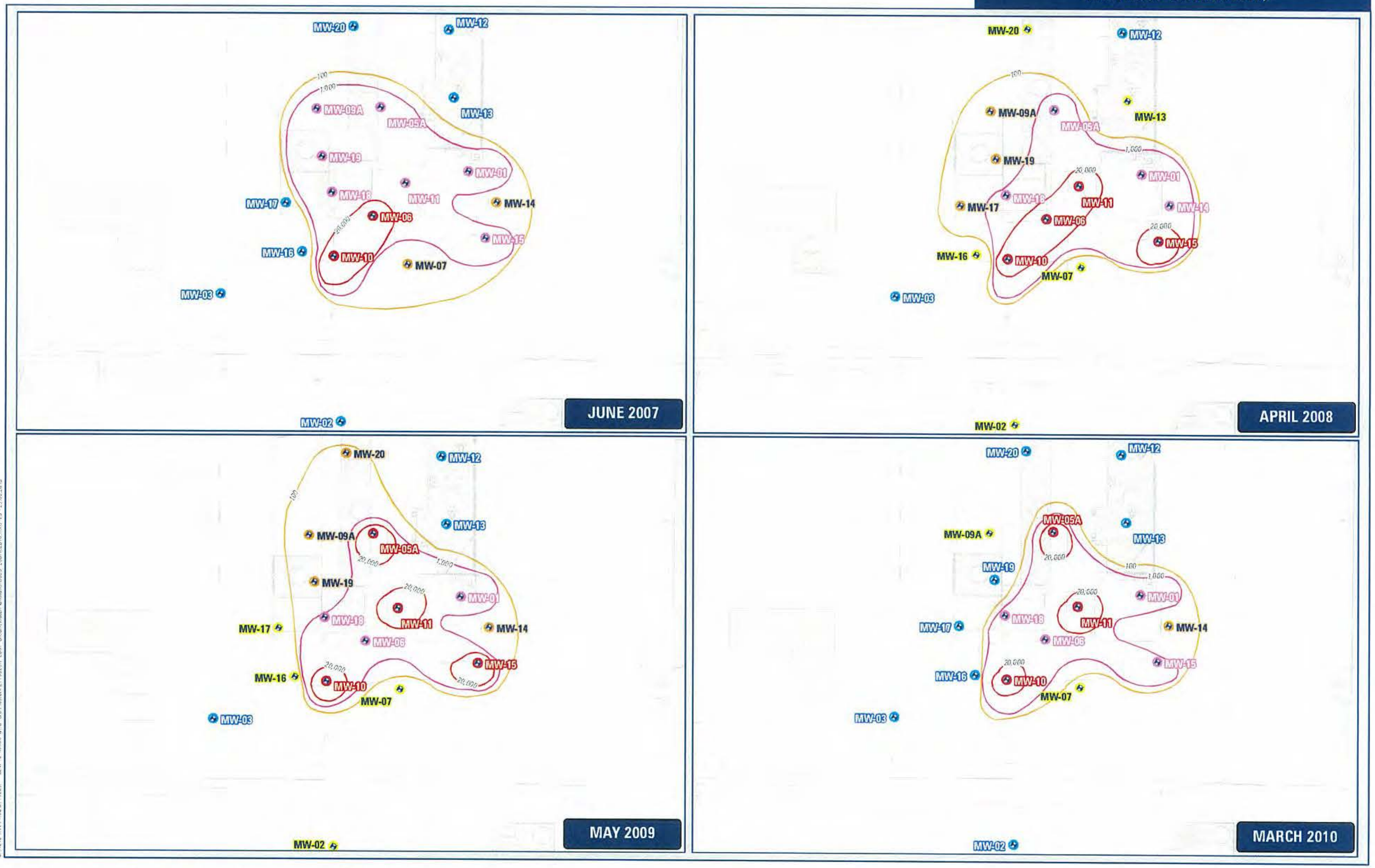
0 — 40 METRES

Figure Quarterly monitoring rounds (2009 - 2010)
Benzene contaminant plan
Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 21

PARSONS BRINCKERHOFF

GROUNDWATER MONITORING REPORT
(MAY 2009 - MARCH 2010)



Monitoring well (µg/L)
- Non detect (nd)
- < 100
- 100 - 1,000
- 1,000 - 20,000
- > 20,000

Concentration (µg/L)
- 100 - 1,000
- 1,000 - 20,000
- > 20,000

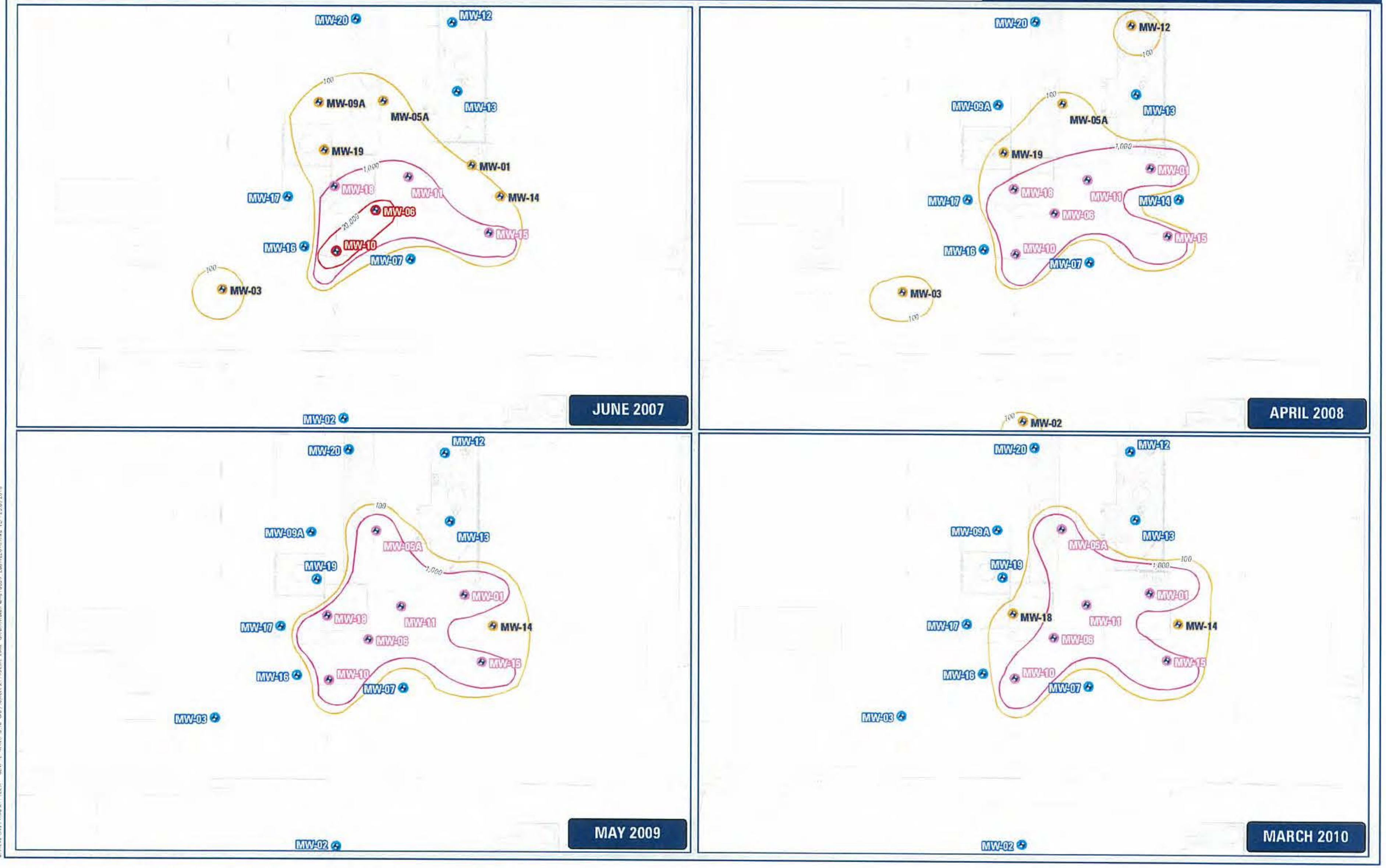
All results expressed as µg/L

0 — 40 METRES

Figure Annual monitoring rounds (2007 - 2010)
TPH C_6-C_9 contaminant plan
Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 22

PARSONS BRINCKERHOFF



Monitoring well (µg/L)
- Non detect (nd)
- < 100
- 100 - 1,000
- 1,000 - 20,000
- > 20,000

Concentration (µg/L)
- 100 - 1,000
- 1,000 - 20,000
- > 20,000

All results expressed as µg/L

0 — 40 METRES

Figure Annual monitoring rounds (2007 - 2010)
TPH C_{10}-C_{36} contaminant plan
Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 23

PARSONS BRINCKERHOFF

GROUNDWATER MONITORING REPORT
(MAY 2009 - MARCH 2010)

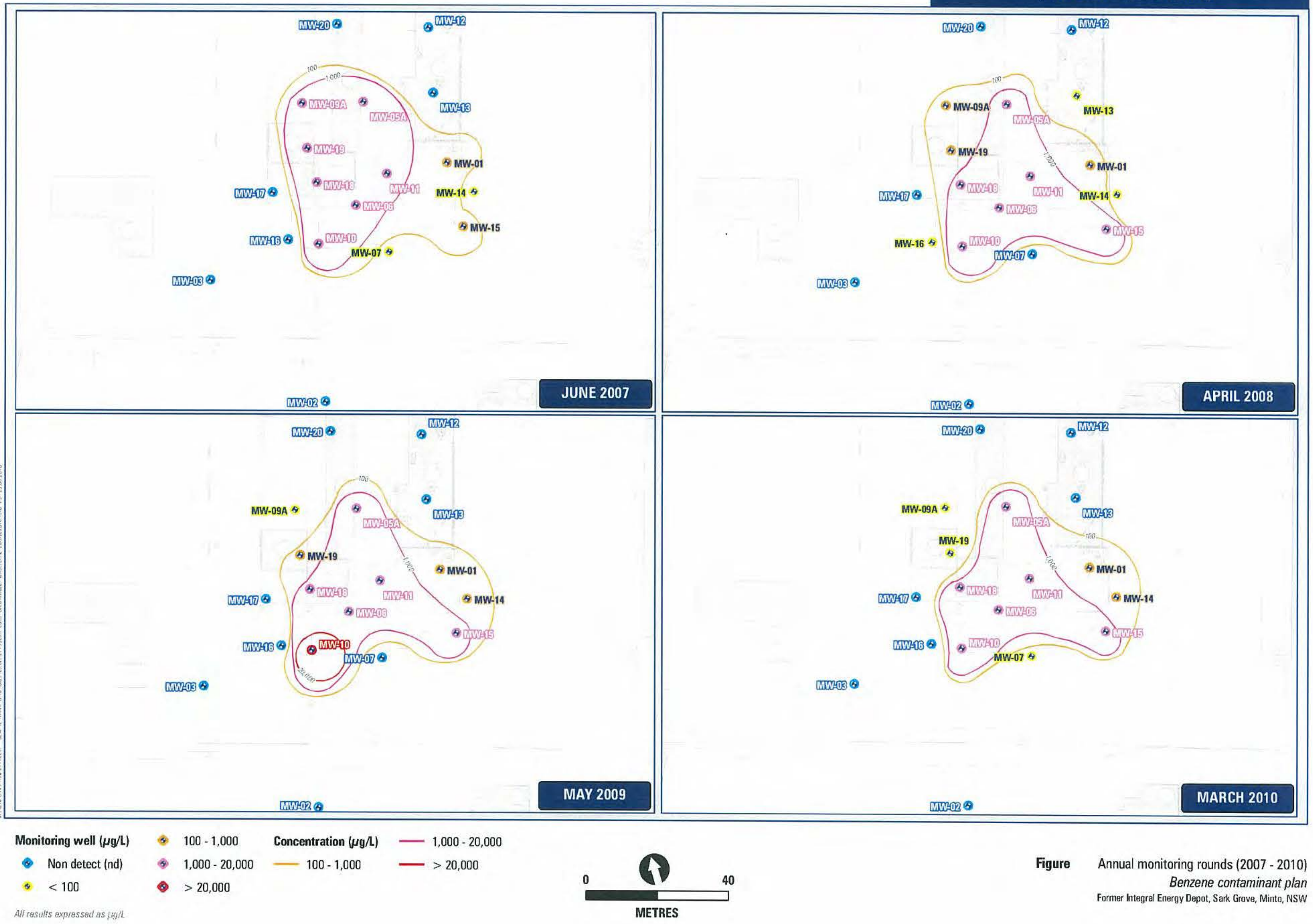
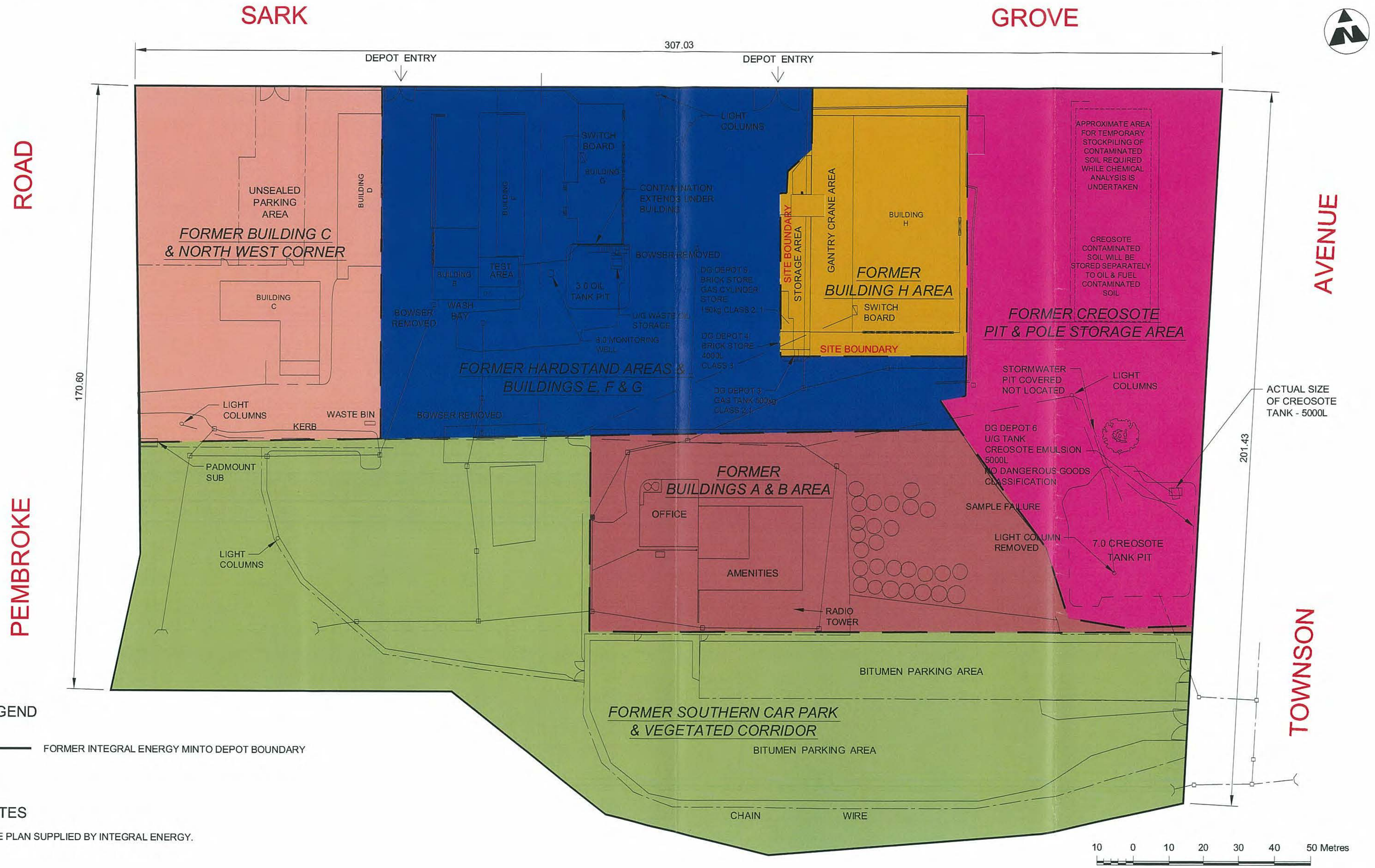


Figure Annual monitoring rounds (2007 - 2010)
Benzene contaminant plan
Former Integral Energy Depot, Sark Grove, Minto, NSW

Figure 24

Client: INTEGRAL ENERGY
Project: FORMER BUILDINGS A & B AREA
Location: FORMER INTEGRAL ENERGY DEPOT, SARK GROVE, MINTO N.S.W

PARSONS BRINCKERHOFF



LEGEND

FORMER INTEGRAL ENERGY MINTO DEPOT BOUNDARY

NOTES

BASE PLAN SUPPLIED BY INTEGRAL ENERGY.

10 0 10 20 30 40 50 Metres

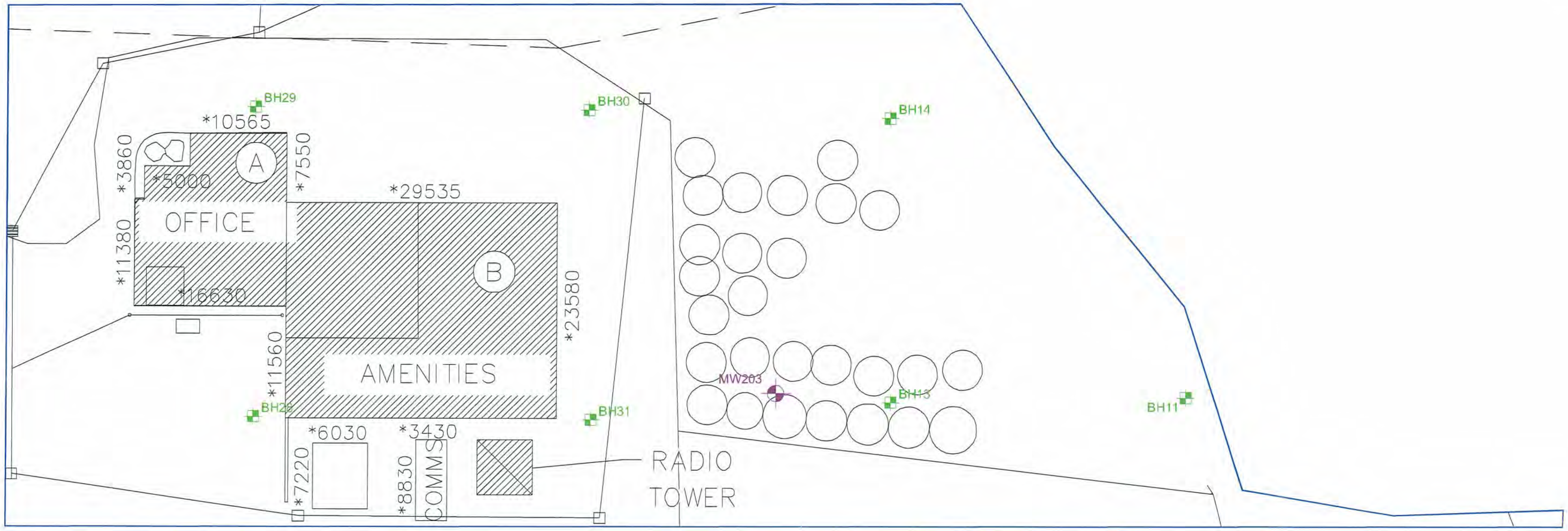
Scale 1: 1000 (A3)

MINTO DEPOT VALIDATION AREAS

Figure 25

Client: Integral Energy
Project: Former Buildings A, B and Retaining Wall Area Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

BH14 — SKM (1999) Bore Hole Locations

MW201 — ERM (2006) Wells

Boundary of Former Buildings A, B and Retaining Wall Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations from previous investigations are aproximate only as they were not Surveyed

5 0 5 10 15 20 25 Metres

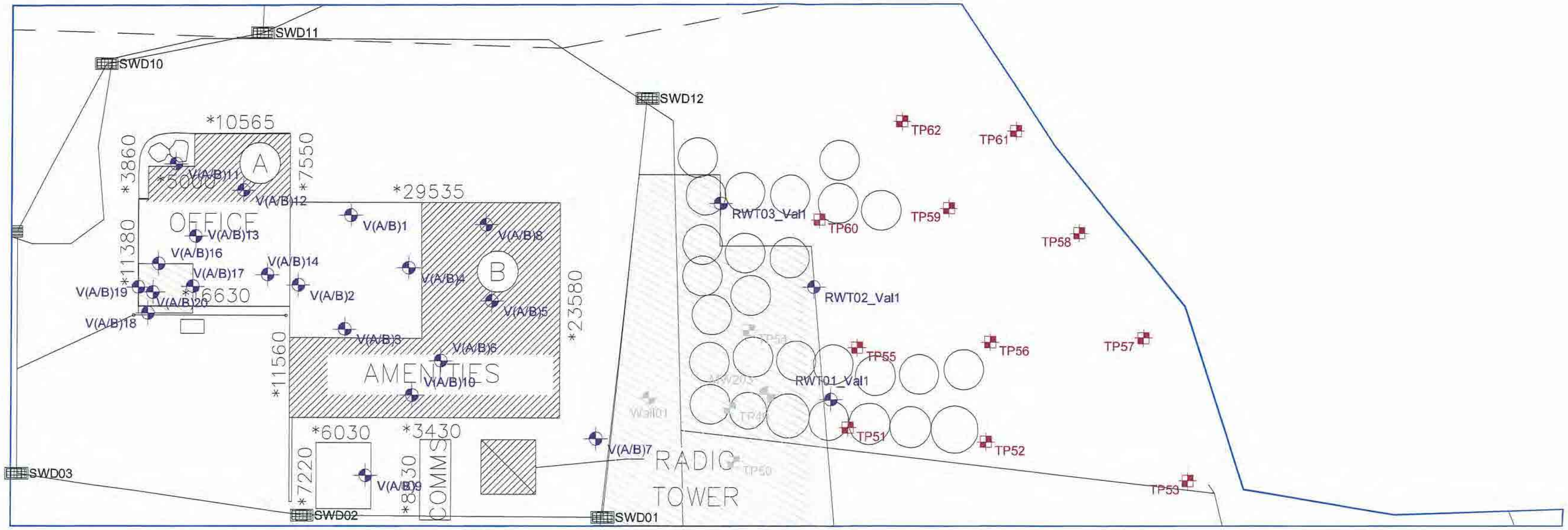
Scale 1 : 500

Previous Investigation Sampling Locations
Former Buildings A, B and Retaining Wall Area

Figure 26

Client: Integral Energy
Project: Former Buildings A, B and Retaining Wall Area Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

V(A/B)11 Surface Sample Locations

TP55 PB Test Pit Locations

TP49 Investigation Locations later removed (not validation locations)

SWD01 Stormwater Drain

Boundary of Former Buildings A, B and Retaining Wall Area (Site)

Exent of Excavation Area

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations from previous investigations are aproximate only as they were not Surveyed

5 0 5 10 15 20 25 Metres

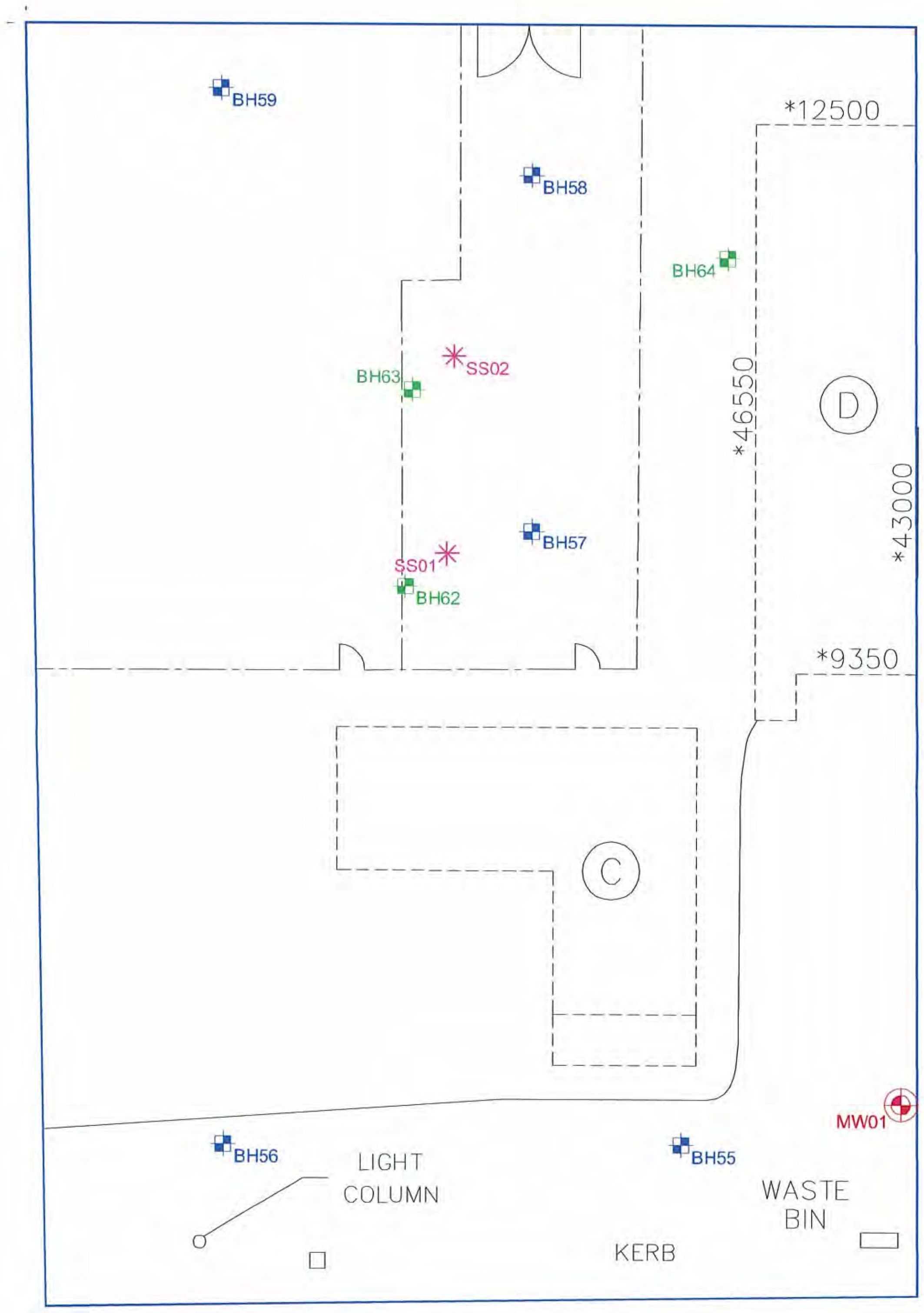
Scale 1 : 500

Validation Sampling Locations
Former Buildings A, B and Retaining Wall Area

Figure 27

Client: Integral Energy
Project: Former Building C and North West Corner Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

- BH53 — SKM (2000) Soil Bore Locations
- MW03 — IT (2003) Groundwater Monitoring Well
- SS01 — PB (2006) Soil / sludge Sample Locations
- BH62 — PB (2006) Soil Bore Locations
- Location of former building
- Boundary of Building C and North West Corner Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations from previous investigations are aproximate only as they were not Surveyed

5 0 5 10 15 20 25 Metres

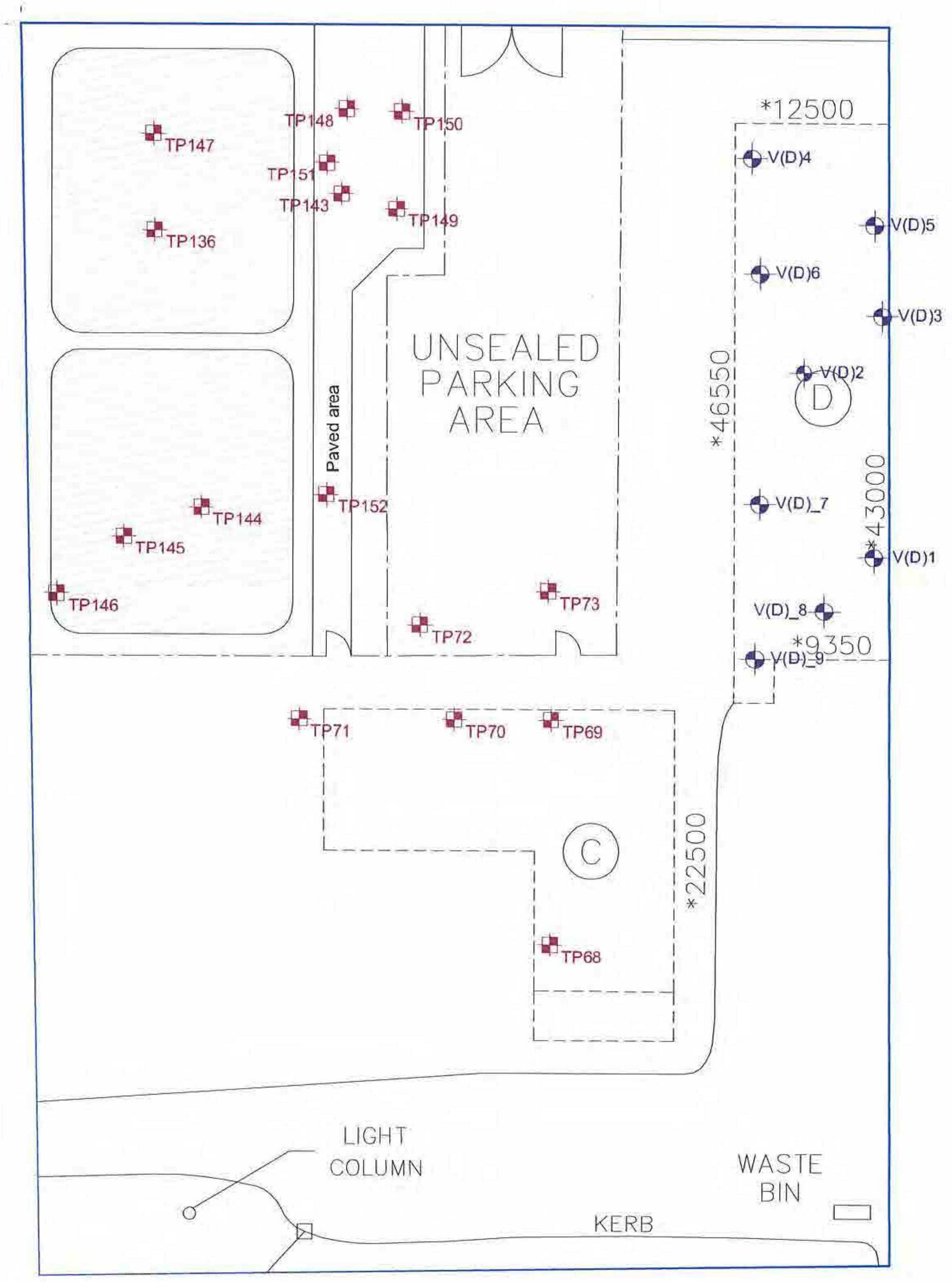
Scale 1 : 500

Figure 28

Previous Investigation Sampling Locations
Former Building C and North West Corner

Client: Integral Energy
Project: Former Building C and North West Corner Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

- TP50 — PB Test Pit Locations
- V(A/B)1 — Surface Sample Locations
- Fill mound locations
- Location of former building
- Boundary of Building C and North West Corner Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

5 0 5 10 15 20 25 Metres

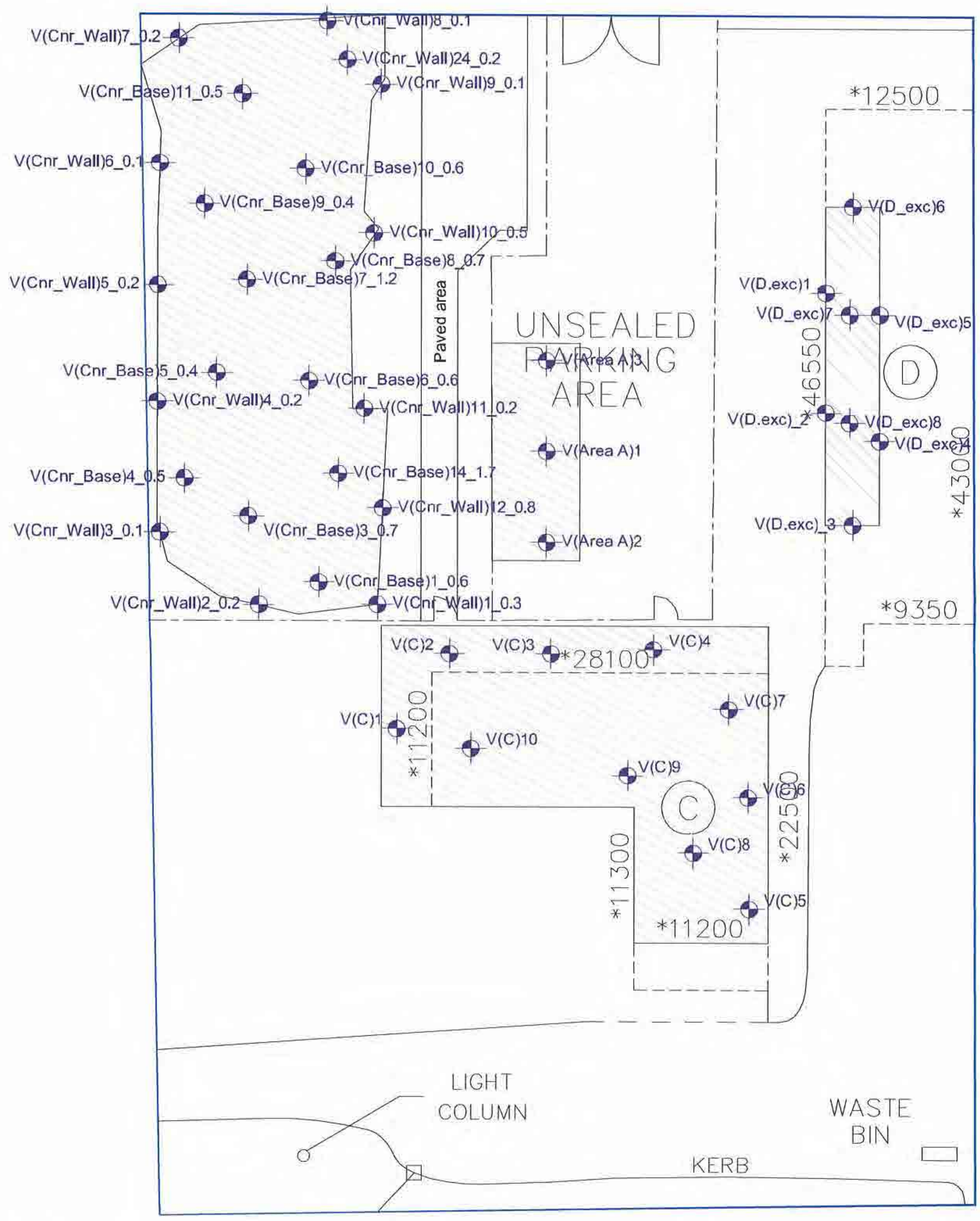
Scale 1 : 500

PB Validation Sample Locations
Former Building C and North West Corner

Figure 29

Client: Integral Energy
Project: Former Building C and North West Corner Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

V(A/B)1 — Excavation Validation Sample Locations

Excavation Area

Location of former building

Boundary of Building C and North West Corner Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

5 0 5 10 15 20 25 Metres

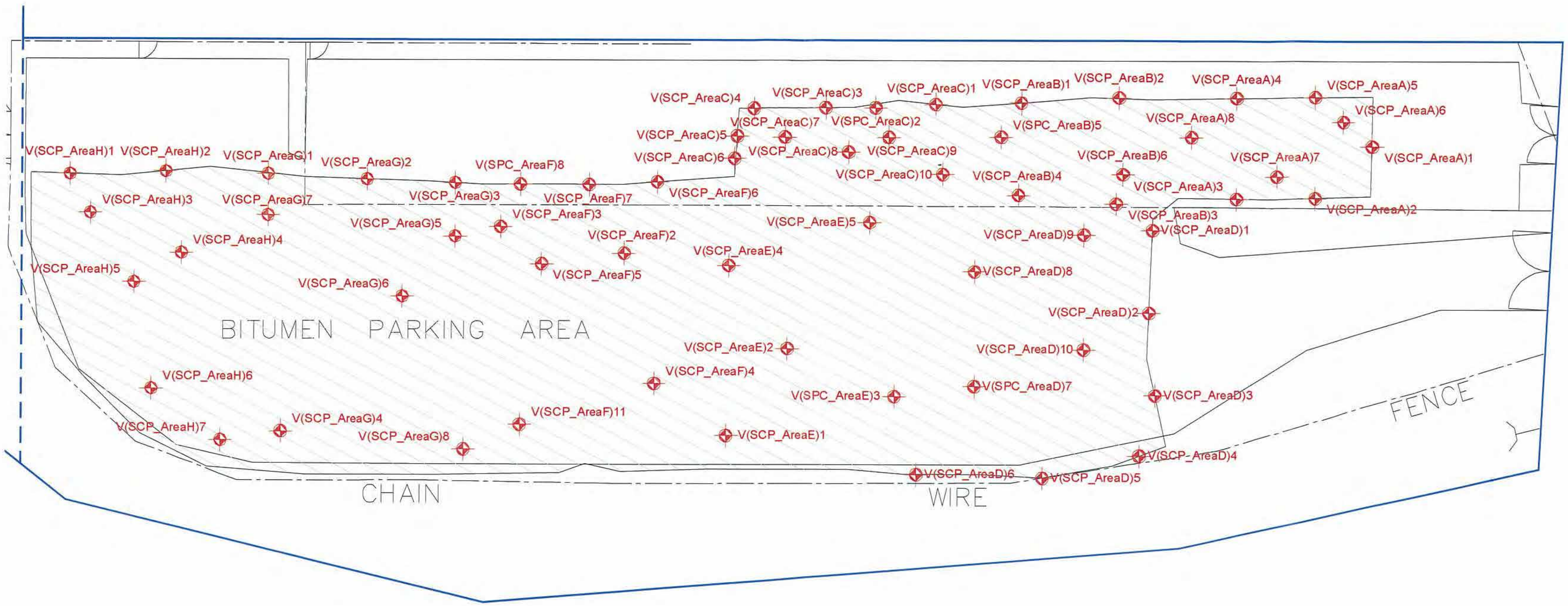
Scale 1 : 500

Figure 30

PB Excavation Validation Sample Locations
Former Building C and North West Corner

Client: Integral Energy
Project: Former Southern Carpark and Vegetated Corridor Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

V(SPC_AreaA) — Excavation Validation Sample Locations

Excavation Area

Boundary Southern Carpark and Vegetated Corridor Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

5 0 5 10 15 20 25 Metres

Scale 1 : 500

PB Southern Car Park Excavation Validation Sample Locations
Former Southern Carpark and Vegetated Corridor

Figure 31

Client: Integral Energy
Project: Former Southern Carpark and Vegetated Corridor Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF

Legend

V(SPC_Areal) — Excavation Validation Sample Locations

Excavation Area

Boundary Southern Carpark and Vegetated Corridor Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

5 0 5 10 15 20 25 Metres

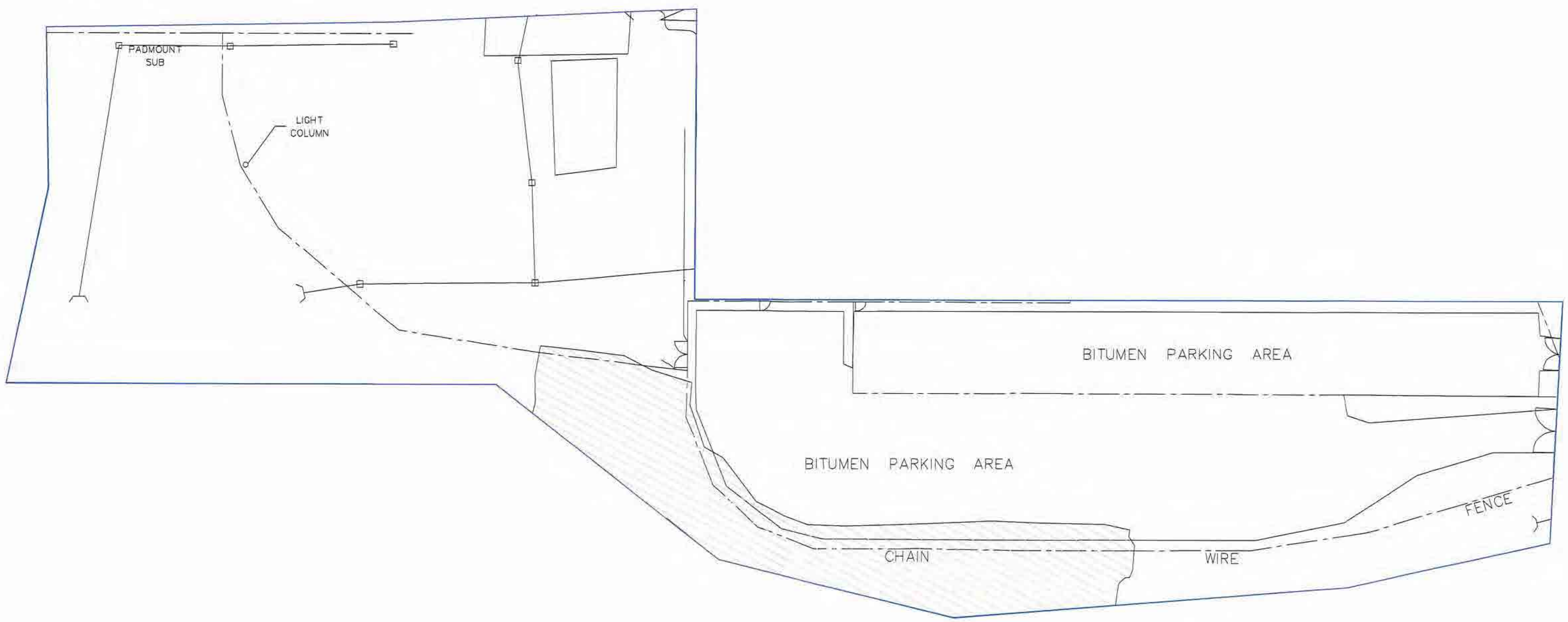
Scale 1 : 500

PB Southern Car Park Excavation Validation Sample Locations
Former Southern Carpark and Vegetated Corridor

Figure 32

Client: Integral Energy
Project: Former Southern Carpark and Vegetated Corridor Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PB PARSONS BRINCKERHOFF



Legend

V(A/B)1 Excavation Validation Sample Locations

Excavation Area

Location of former building

Boundary Southern Carpark and Vegetated Corridor Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

10 0 10 20 30 40 50 Metres

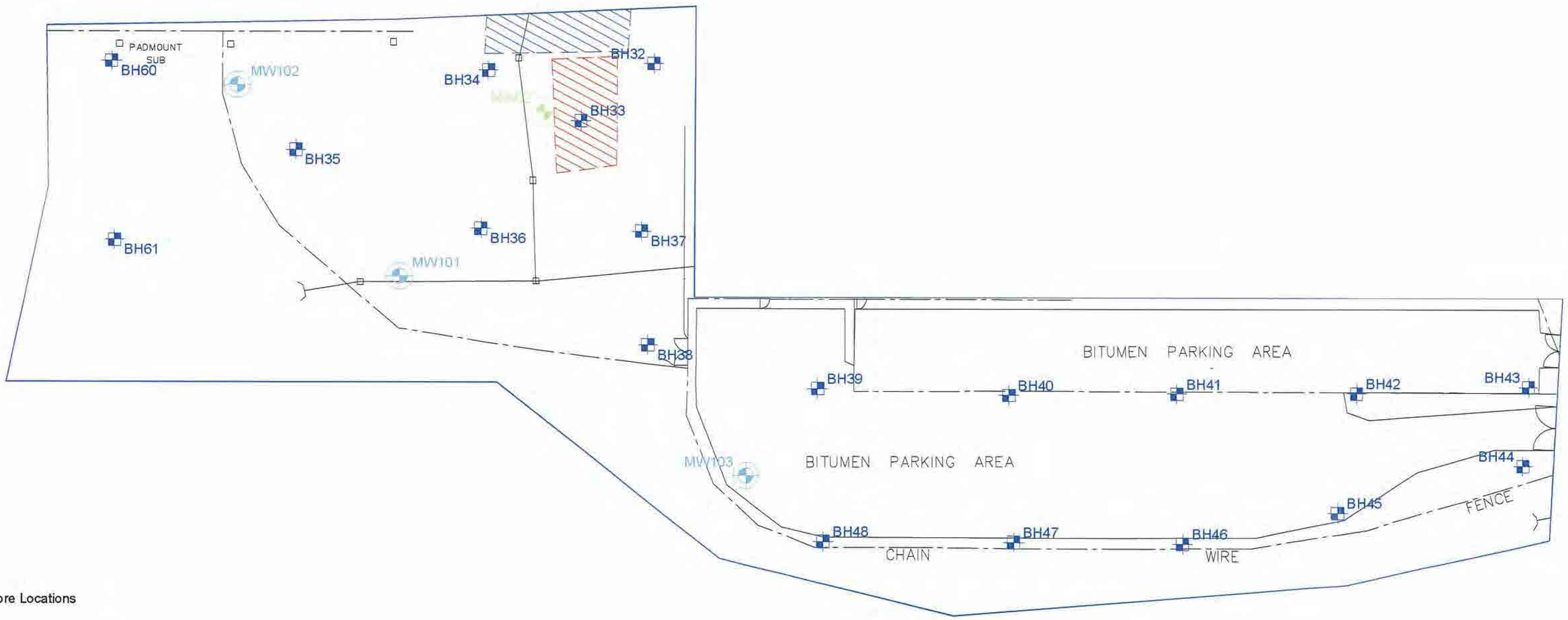
Scale 1 : 1000

PB Vegetated Corridor Excavation Validation Sample Locations
Former Southern Carpark and Vegetated Corridor

Figure 33

Client: Integral Energy
Project: Former Southern Carpark and Vegetated Corridor Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

BH61 SKM (2000) Soil Bore Locations

IT (2003) Groundwater Monitoring Well

MW 101 URS (2005) Groundwater Monitoring Well

Tank Pit 3 Excavation Area

Tank Pit 6 Excavation Area

Boundary of Southern Car Park and Vegetated Corridor Area

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

10 0 10 20 30 40 50 Metres

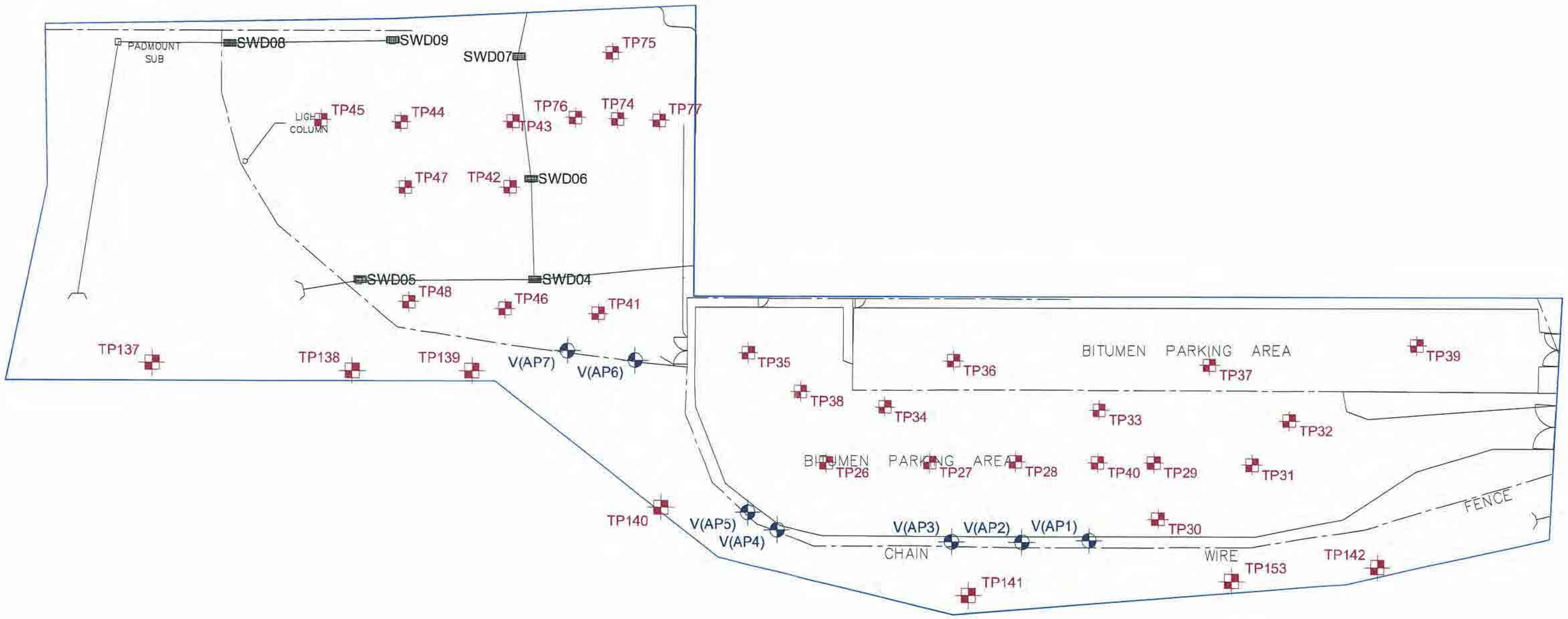
Scale 1 : 1000

Previous Investigation Sampling Locations
Former Southern Carpark and Vegetated Corridor

Figure 34

Client: Integral Energy
Project: Former Southern Carpark and Vegetated Corridor Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

V(AP5) Asbestos Pipe Locations

TP50 PB Test Pit Locations

SWD07 Stormwater Drain Locations

Boundary of Southern Carpark and Vegetated Corridor Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations are Extrapolated From Previous Investigations.
3. PB Investigation Locations Surveyed 7 th April 2006.

10 0 10 20 30 40 50 Metres

Scale 1 : 1000

PB Validation Sample Locations
Former Southern Carpark and Vegetated Corridor

Figure 35

Client: INTEGRAL ENERGY
Project: FORMER HARDSTAND AREAS & BUILDINGS E, F & G
Location: FORMER INTEGRAL ENERGY DEPOT, SARK GROVE, MINTO N.S.W

PARSONS BRINCKERHOFF

LEGEND

(red line)	BOUNDARY OF FORMER HARDSTAND AREAS AND BUILDINGS E, F & G
BH65	PB (2006) SOIL BOREHOLE LOCATIONS
BH52	SKM (2000) SOIL BOREHOLE LOCATIONS
MW10	PB (2006) GROUNDWATER MONITORING WELLS
MW01	IT (2003) GROUNDWATER MONITORING WELL
(hatching)	EXCAVATION OF TANK PITS TP4, TP5, TP7 & TP9
(hatching)	EXCAVATION OF TANK PIT TP6

PREVIOUS INVESTIGATION SAMPLING LOCATIONS FORMER HARDSTAND AREAS & BUILDINGS E, F & G

Figure 36

Client: INTEGRAL ENERGY
Project: FORMER HARDSTAND AREAS & BUILDINGS E, F & G
Location: FORMER INTEGRAL ENERGY DEPOT, SARK GROVE, MINTO N.S.W

PARSONS BRINCKERHOFF

LEGEND

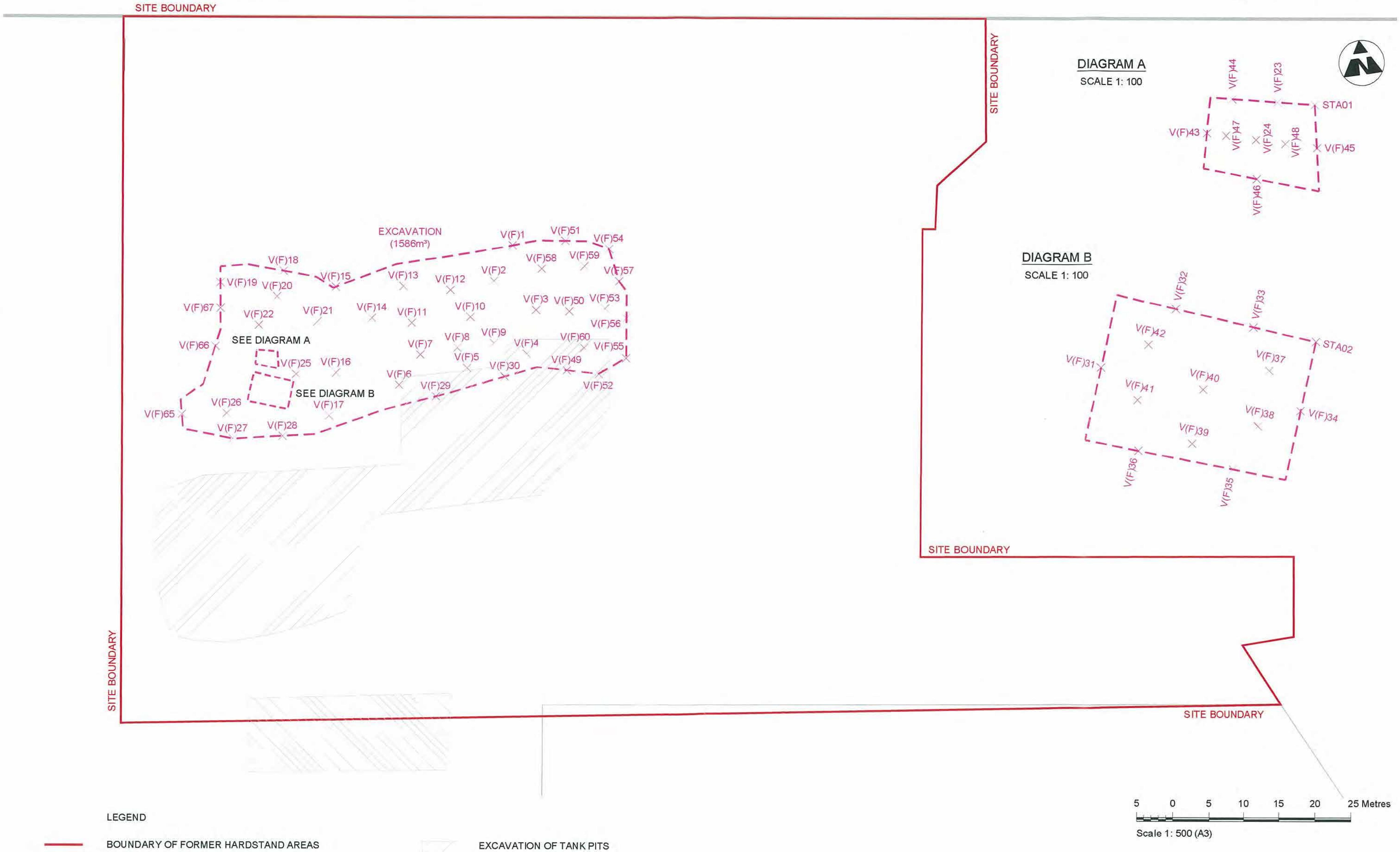
(red line)	BOUNDARY OF FORMER HARDSTAND AREAS AND BUILDINGS E, F & G
MW10	PB (2006) GROUNDWATER MONITORING WELLS
V(BldgE)1/V(G)1/AS06	PB SURFACE SAMPLE LOCATIONS
	PB TEST PIT LOCATIONS
MW12	PB GROUNDWATER MONITORING WELL
MW01	IT (2003) GROUNDWATER MONITORING WELL
	EXCAVATION OF TANK PITS TP4, TP5, TP7 & TP9
	EXCAVATION OF TANK PIT TP6
	PB STORMWATER DRAIN VALIDATION LOCATIONS

PB VALIDATION SAMPLE LOCATIONS
FORMER HARDSTAND AREAS & BUILDINGS E, F & G

Figure 37

Client: INTEGRAL ENERGY
Project: FORMER HARDSTAND AREAS & BUILDINGS E, F & G
Location: FORMER INTEGRAL ENERGY DEPOT, SARK GROVE, MINTO N.S.W

PARSONS BRINCKERHOFF



LEGEND

BOUNDARY OF FORMER HARDSTAND AREAS AND BUILDINGS E, F & G

EXTENT OF EXCAVATIONS

VALIDATION SURFACE SAMPLE LOCATIONS

EXCAVATION OF TANK PITS TP4, TP5, TP7 & TP9

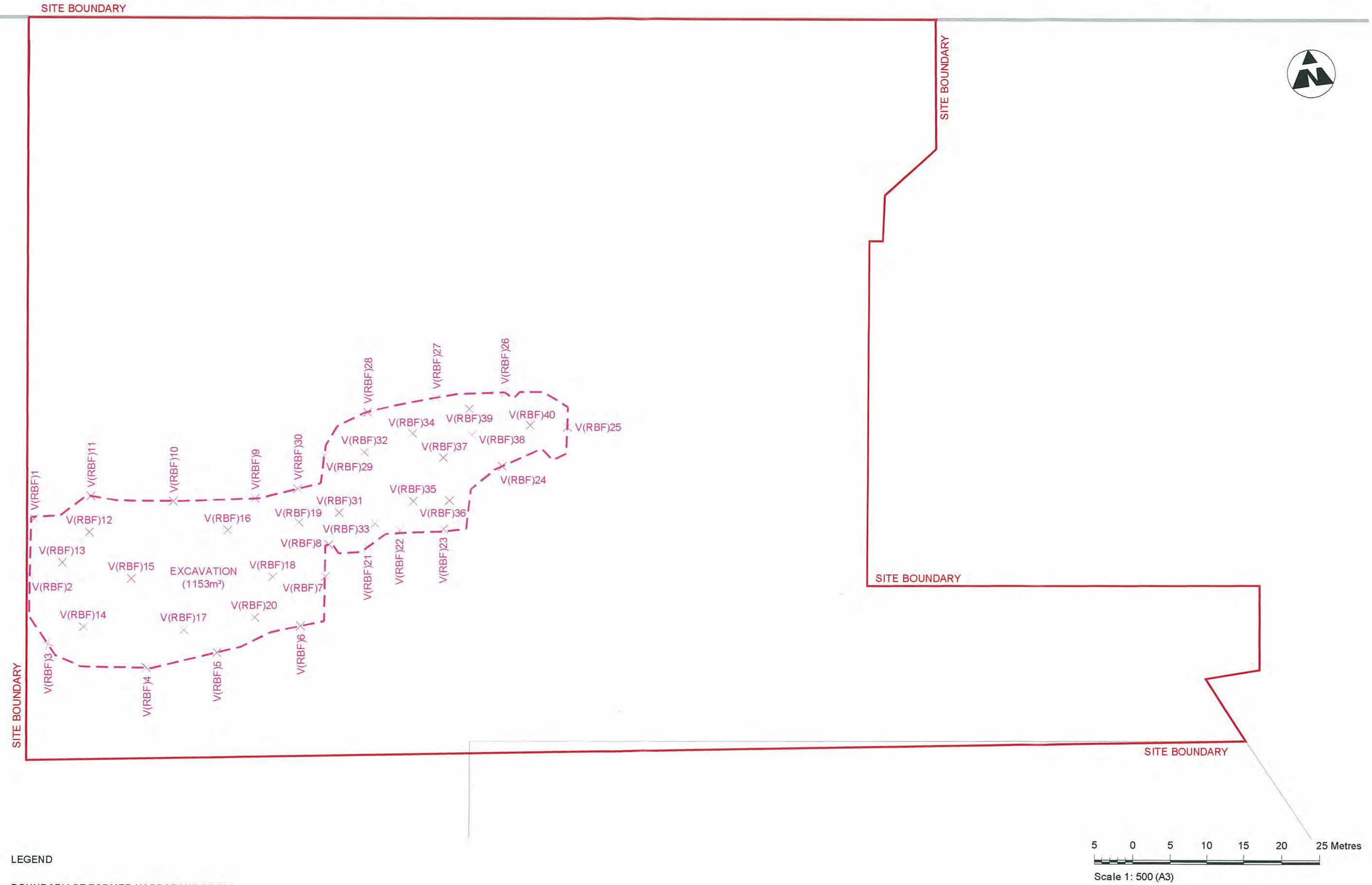
EXCAVATION OF TANK PIT TP6

BUILDINGS F & G EXCAVATION VALIDATION SAMPLE LOCATIONS

Figure 38

Client: INTEGRAL ENERGY
Project: FORMER HARDSTAND AREAS & BUILDINGS E, F & G
Location: FORMER INTEGRAL ENERGY DEPOT, SARK GROVE, MINTO N.S.W

PARSONS BRINCKERHOFF



LEGEND

BOUNDARY OF FORMER HARDSTAND AREAS AND BUILDINGS E, F & G

EXTENT OF EXCAVATIONS

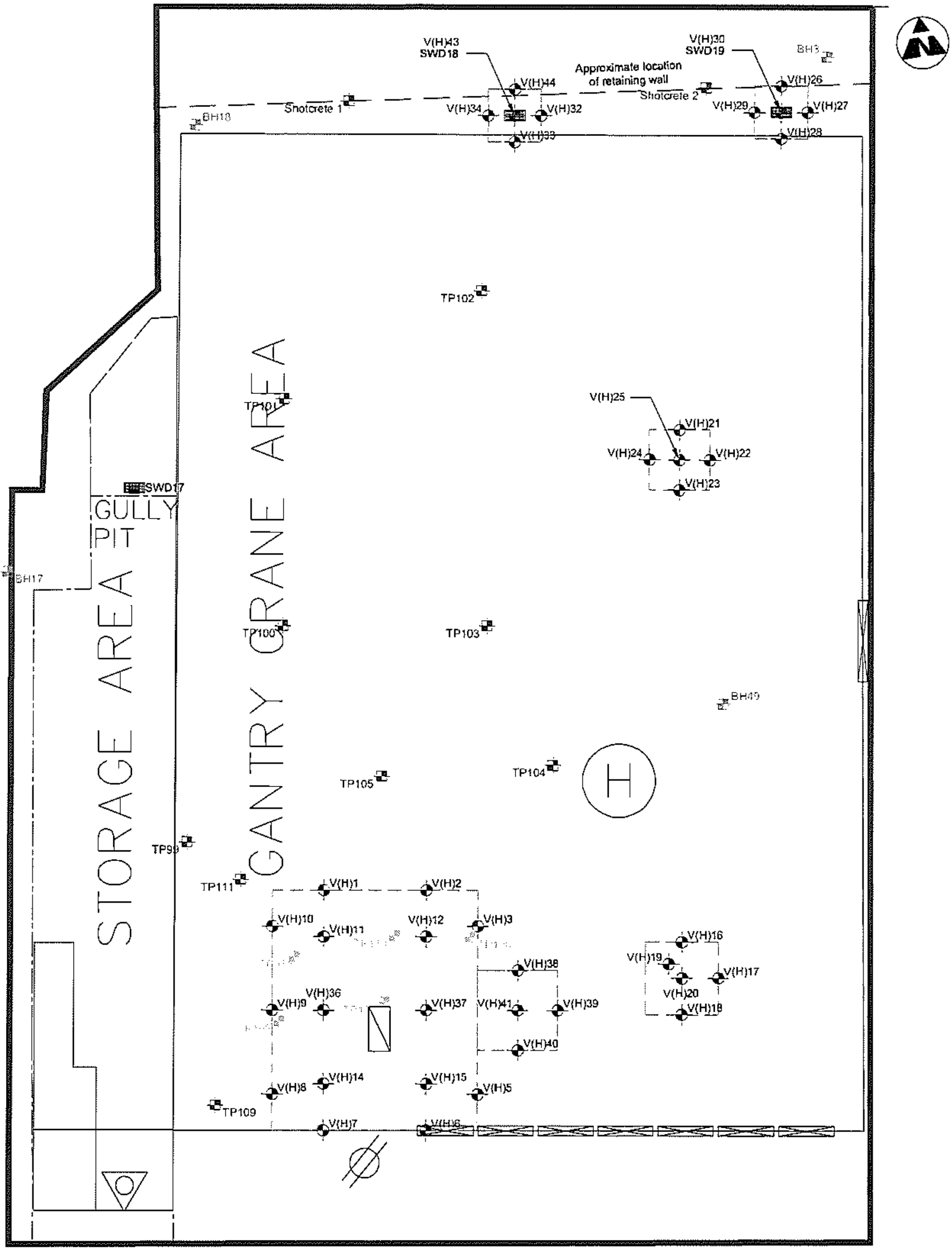
VALIDATION SURFACE SAMPLE LOCATIONS

TANK PIT AREA EXCAVATION SAMPLE LOCATIONS

Figure 39

Client: Integral Energy
Project: Former Building H Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

V(H)6	Excavation Validation Sample Locations
TP109	PB 2006 Test pit & shotcrete sample locations
	PB 2006 Test pit sample locations (removed)
BH3	SKM (2000) Soil Bore Locations
	Boundary of Former Building H Area (Site)
SWD17	Stormwater Drain Area

4 0 4 8 12 Metres

Scale 1 : 250

Notes

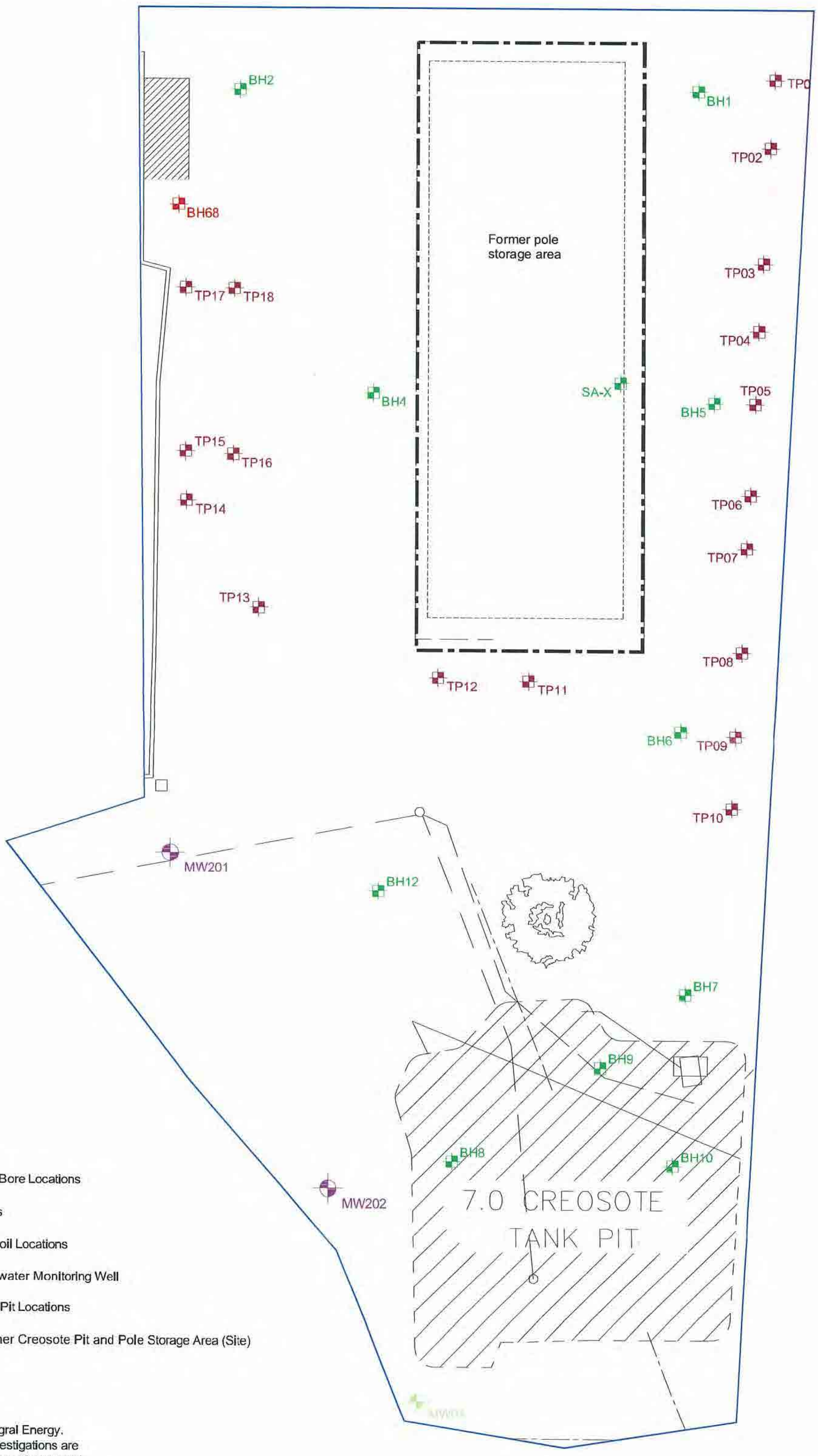
1. Base Plan Supplied By Integral Energy.

Sampling Locations
Former Building H

Figure 40

Client: Integral Energy
Project: Former Creosote Pit and Pole Storage Area Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

- BH8 — SKM (2000) Soil Bore Locations
- MW201 — ERM (2006) Wells
- BH68 — PB (2006) BH - Soil Locations
- IT (2003) Groundwater Monitoring Well
- TP01 — URS (2006) Test Pit Locations
- Boundary of Former Creosote Pit and Pole Storage Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. Locations from previous investigations are aproximate only as they were not surveyed.

5 0 5 10 15 20 25 Metres

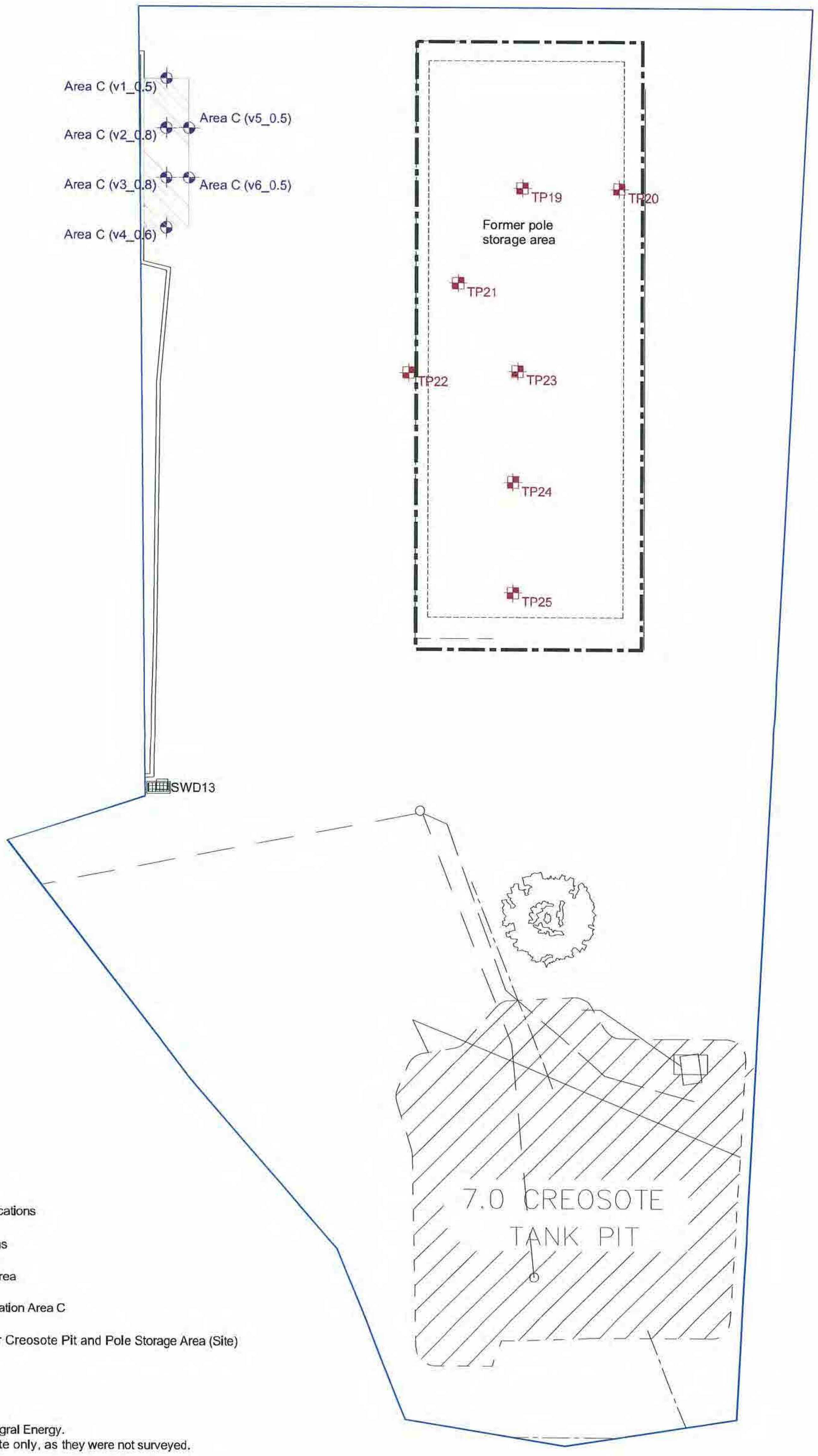
Scale 1 : 500

Figure 41

Previous Investigation Sampling Locations
Former Creosote Pit and Pole Storage Area

Client: Integral Energy
Project: Former Creosote Pit and Pole Storage Area Validation Report
Location: Former Integral Energy Depot, Sark Grove, Minto, NSW

PARSONS BRINCKERHOFF



Legend

- Area C (v1_0.5) — Surface Sample Locations
- TP22 — PB Test Pit Locations
- SWD13 — Stormwater Drain Area
- Remediation Excavation Area C
- Boundary of Former Creosote Pit and Pole Storage Area (Site)

Notes

1. Base Plan Supplied By Integral Energy.
2. PB Locations are aproximate only, as they were not surveyed.

5 0 5 10 15 20 25 Metres

Scale 1 : 500

PB Validation Sample Locations
Former Creosote Pit and Pole Storage Area

Figure 42

Appendix B

Site Photographs

PHOTO 1: View of tanks during remediation works

PHOTO 2: Excavation works during remediation works in 2006

PHOTO 3: View of UST Area following removal.

PHOTO 4: View of Remediation in Eastern Part of the Site.

PHOTO 5: View of oily water in tank pit (2004).

PHOTO 6: Stockpile of material excavated from Creosote tank pit (2003)

Appendix C

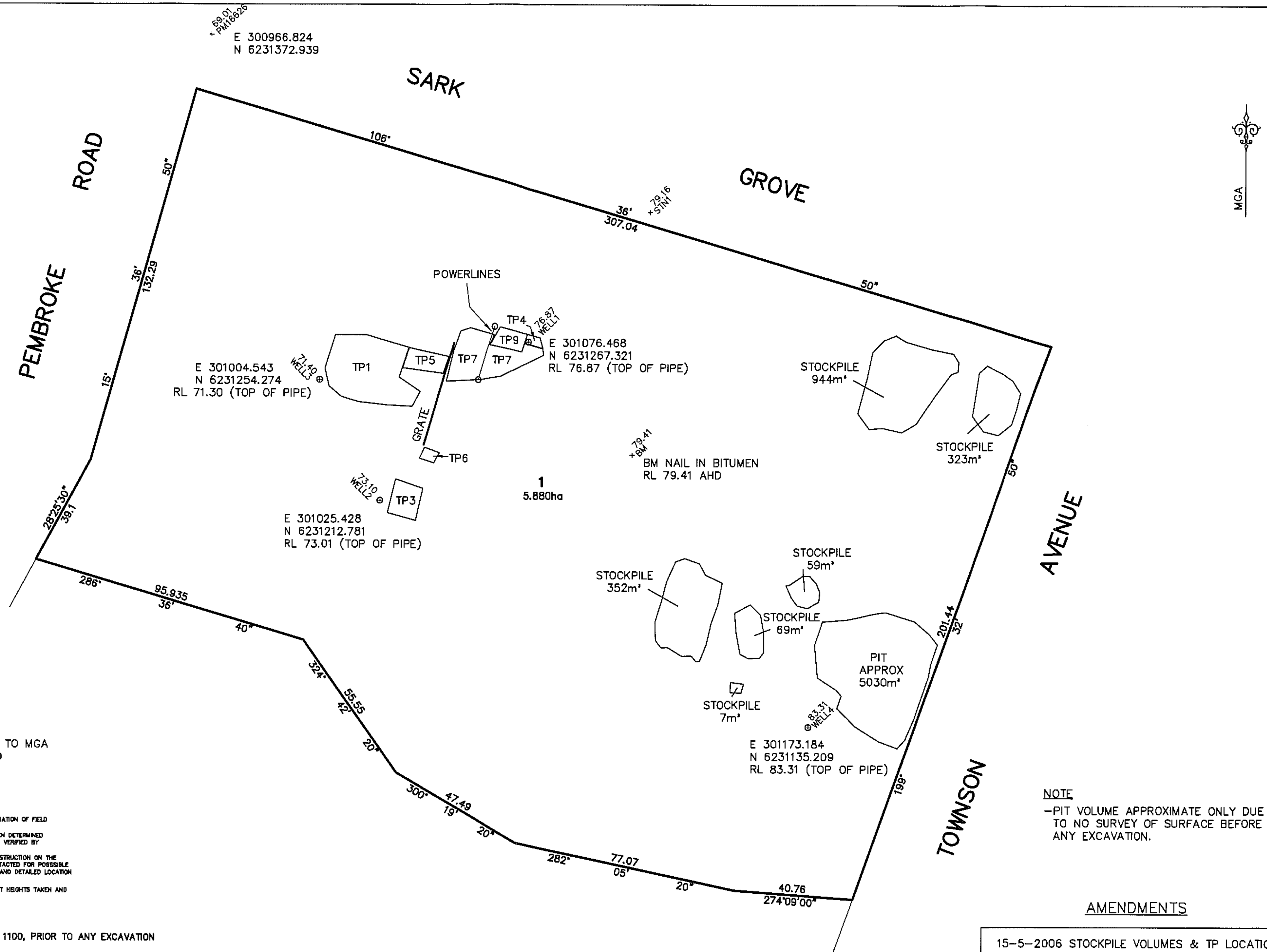
Correspondence Related to the Audit

(on CD)

Appendix D

Lot Information

and Survey of "Impacted Zone'



NOTE
- ALL CO-ORDINATES ARE TO MGA
- ALL LEVELS ARE TO AHD

NOTE:
- THIS PLAN HAS BEEN PREPARED FROM A COMBINATION OF FIELD SURVEY AND EXISTING RECORDS
- THE TITLE BOUNDARIES SHOWN HEREON HAVE BEEN DETERMINED BY PLAN DIMENSIONS ONLY AND HAVE NOT BEEN VERIFIED BY FIELD MEASUREMENTS
- PRIOR TO ANY DEMOLITION, EXCAVATION OR CONSTRUCTION ON THE SITE, THE RELEVANT AUTHORITY SHOULD BE CONTACTED FOR POSSIBLE LOCATION OF FURTHER UNDERGROUND SERVICES AND DETAILED LOCATION OF ALL SERVICES
- CONTOURS HAVE BEEN INTERPOLATED FROM SPOT HEIGHTS TAKEN AND ARE APPROXIMATE ONLY
- THIS NOTE IS AN INTEGRAL PART OF THIS PLAN

CONTACT DIAL BEFORE YOU DIG PH: 1100, PRIOR TO ANY EXCAVATION

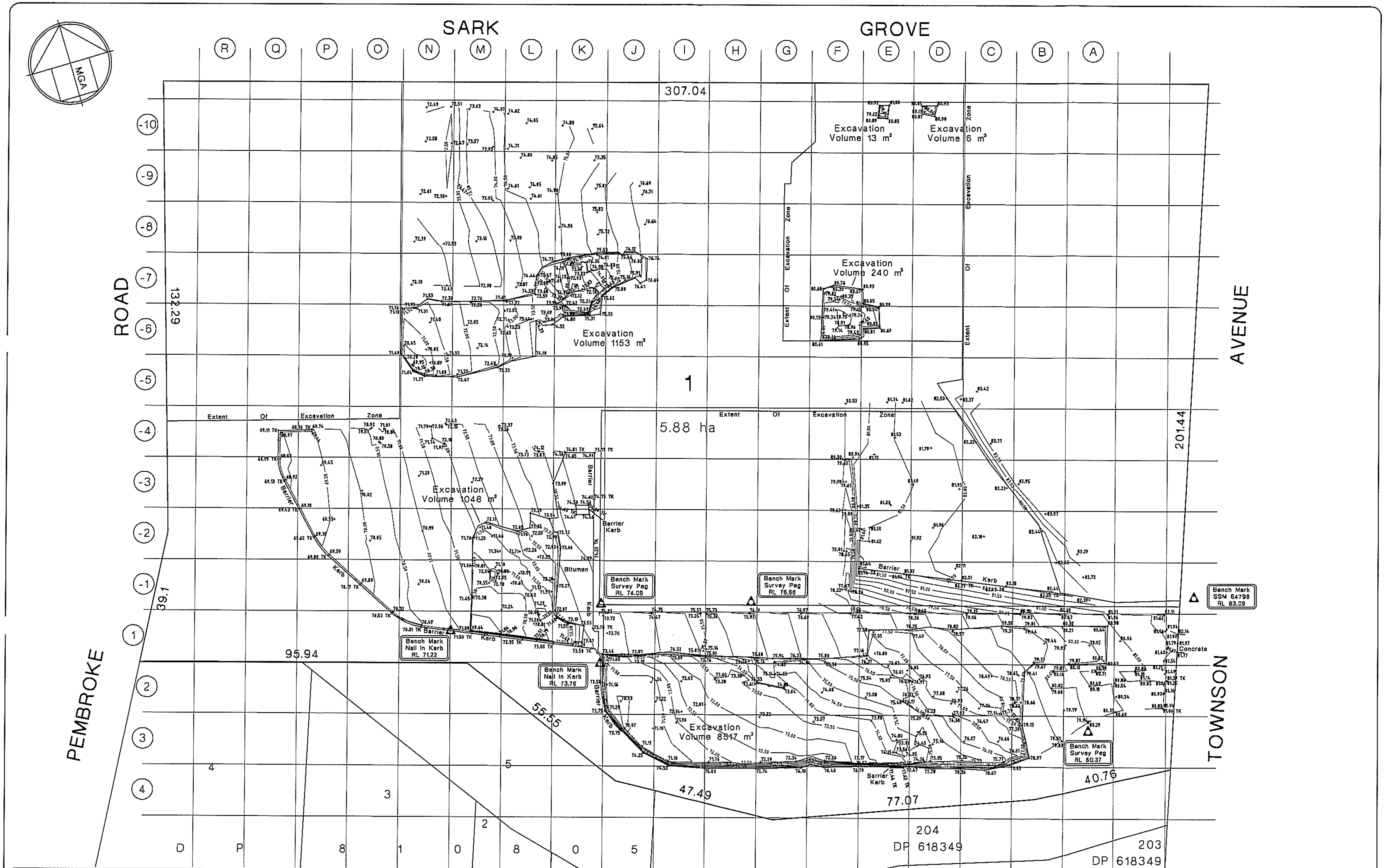
NOTE
- PIT VOLUME APPROXIMATE ONLY DUE TO NO SURVEY OF SURFACE BEFORE ANY EXCAVATION.

AMENDMENTS

15-5-2006 STOCKPILE VOLUMES & TP LOCATIONS ADDED

JSM SURVEYING
CONSULTING SURVEYORS & PROJECT MANAGERS
UNIT 2 No.8 MINTO ROAD, MINTO NSW 2566
POSTAL ADDRESS: P.O. BOX 149 MINTO NSW 2566
PHONE: (02) 9820 2429 FAX (02) 9603 1600
Email: jsmcd@jsmsurvey.com DX 3411 INGLEBURN

DATUM AHD	SCALE 1:1000 ON A2	DRAWN DF	DESCRIPTION PLAN SHOWING LEVEL AND CO-ORDINATES OF MONITORING WELLS AT LOT 1 IN D.P.620265 AT THE CORNER OF PEMBROKE RD & SARK GROVE, MINTO
ORIGIN OF LEVELS PM 16636	SUBURB MINTO	SURVEYED DF	
CONTOUR INTERVAL	L.G.A. CAMPBELLTOWN	CHECKED DF	
SHEET NO. 1 OF 1 SHEETS		DATE: 9-11-2005	SURVEYORS REFERENCE 051535



ISSUE	DATE	AMENDMENT	DRAWN	CHKD
G	1/5/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
F	12/4/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
E	20/3/07	EXCAVATIONS LOCATED AND VOLUMES CALCULATED	G.L.S.	
D	20/2/07	GRID LINES ADDED	G.L.S.	
C	2/2/07	HOLES WITHIN EXCAVATION DEFINED	G.L.S.	
B	11/1/07	FINISHED SURFACE OF FILL LOCATED	G.L.S.	
A	9/1/07	ORIGINAL ISSUE	G.L.S.	

LEGEND :-

+78.19 DENOTES SPOT HEIGHT.
+78.52 TK DENOTES TOP OF KERB LEVEL.

NOTES:-
1. NO BOUNDARY SURVEY HAS BEEN MADE. THE BOUNDARIES HAVE BEEN PLOTTED APPROXIMATELY ONLY. FURTHER DEVELOPMENT NEAR THE BOUNDARIES OF THE LOT WILL REQUIRE FURTHER SURVEY.
2. ORIGIN OF LEVELS SSM 64798 RL 83.09 AHD.
3. LOT DIMENSIONS AND AREA VIDE DP 620265.
4. CONTOURS ARE INDICATIVE ONLY.
5. CONTOUR INTERVAL 0.5.
6. CONTACT 'DIAL BEFORE YOU DIG' (Ph. 1100) PRIOR TO ANY EXCAVATION FOR MOST RECENT SERVICE LOCATION RECORDS.

SCALE :- 1:500 @ A1	DATUM :- A.H.D.
DATE :- 01/05/2007	DRAWN :- G.L.S.
JOB No. :- 22315	APPROVED
CLIENT :- QUANTUM ENVIRONMENTAL	

PREPARED BY:
PROUST&GARDNER
CONSULTING PTY LIMITED
SURVEYORS & PLANNERS
406 Pacific Highway
PO Box 132
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Lindfield NSW 2070
ACN 093 046 407
Tel: 9416 1335
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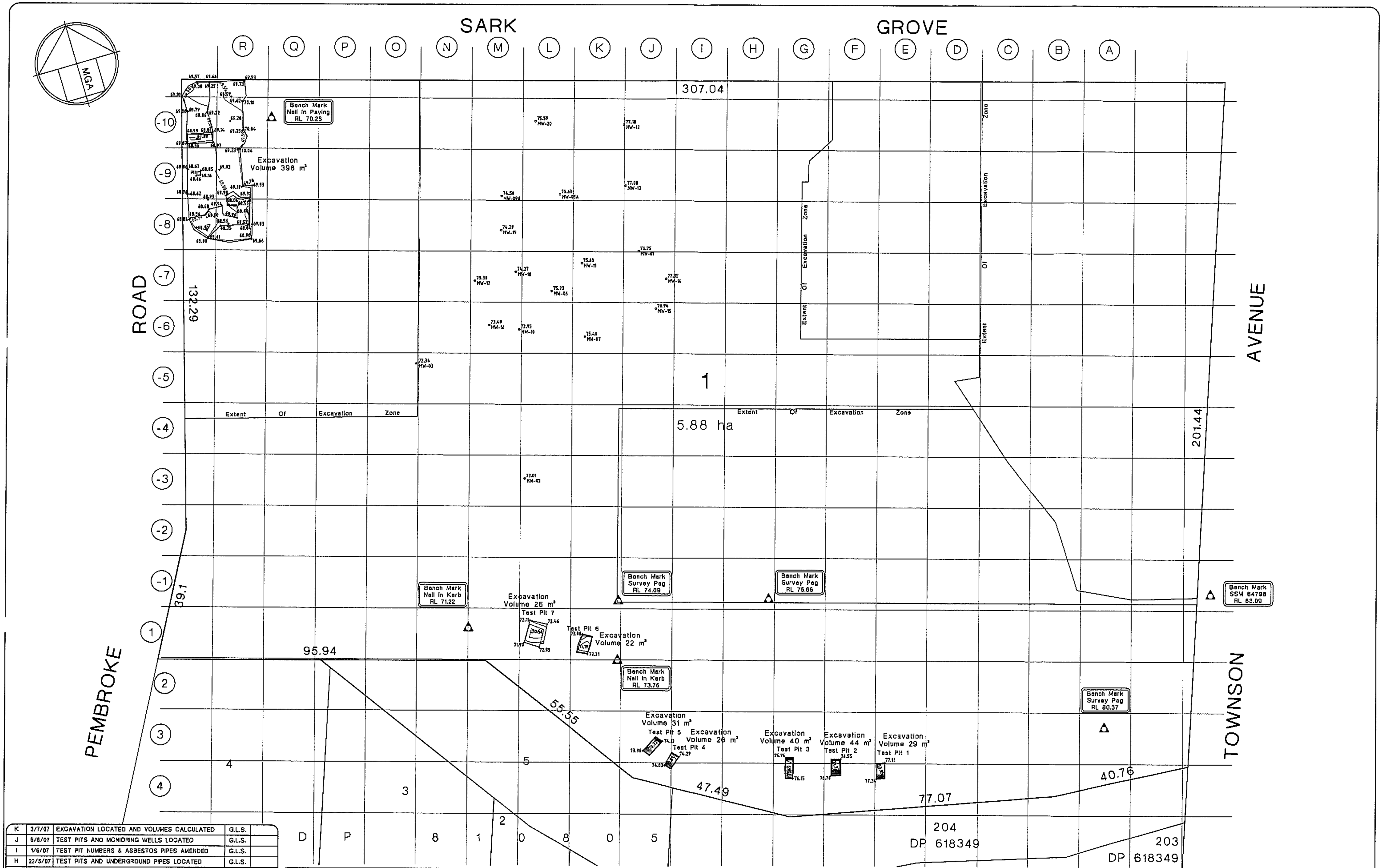
ABN 74 093 046 407

CITY OF CAMPBELLTOWN
LEVELS AND EXCAVATION

LOT 1 DP 620265
PEMBROKE ROAD
MINTO

REFERENCE :- 22315-DETAIL | SHEET No. 1 OF 1 | ISSUE :- G



ISSUE	DATE	AMENDMENT	DRAWN	CHKD
K	3/7/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
J	6/6/07	TEST PITS AND MONIORING WELLS LOCATED	G.L.S.	
I	1/6/07	TEST PIT NUMBERS & ASBESTOS PIPES AMENDED	G.L.S.	
H	22/5/07	TEST PITS AND UNDERGROUND PIPES LOCATED	G.L.S.	
G	1/5/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
F	12/4/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
E	20/3/07	EXCAVATIONS LOCATED AND VOLUMES CALCULATED	G.L.S.	
D	20/2/07	GRID LINES ADDED	G.L.S.	
C	2/2/07	HOLES WITHIN EXCAVATION DEFINED	G.L.S.	
B	11/1/07	FINISHED SURFACE OF FILL LOCATED	G.L.S.	
A	9/1/07	ORIGINAL ISSUE	G.L.S.	

LEGEND :-
- •75.59 DENOTES SPOT HEIGHT.
- •MW-01 DENOTES MONITORING WELL NUMBER.

NOTES:-
1. NO BOUNDARY SURVEY HAS BEEN MADE. THE BOUNDARIES HAVE BEEN PLOTTED APPROXIMATELY ONLY. FURTHER DEVELOPMENT NEAR THE BOUNDARIES OF THE LOT WILL REQUIRE FURTHER SURVEY.
2. ORIGIN OF LEVELS SSM 64798 RL 83.09 AHD.
3. LOT DIMENSIONS AND AREA VIDE DP 620265.
4. CONTOURS ARE INDICATIVE ONLY.
5. CONTOUR INTERVAL 0.5.
6. CONTACT 'DIAL BEFORE YOU DIG' (Ph. 1100) PRIOR TO ANY EXCAVATION FOR MOST RECENT SERVICE LOCATION RECORDS.
7. MONITORING WELL LEVELS ARE TOP OF PIPE LEVELS.

SCALE :- 1:500 @ A1	DATUM :- A.H.D.
DATE :- 03/07/2007	DRAWN :- G.L.S.
JOB No. :- 22315	APPROVED
CLIENT :- QUANTUM ENVIRONMENTAL	

PREPARED BY:
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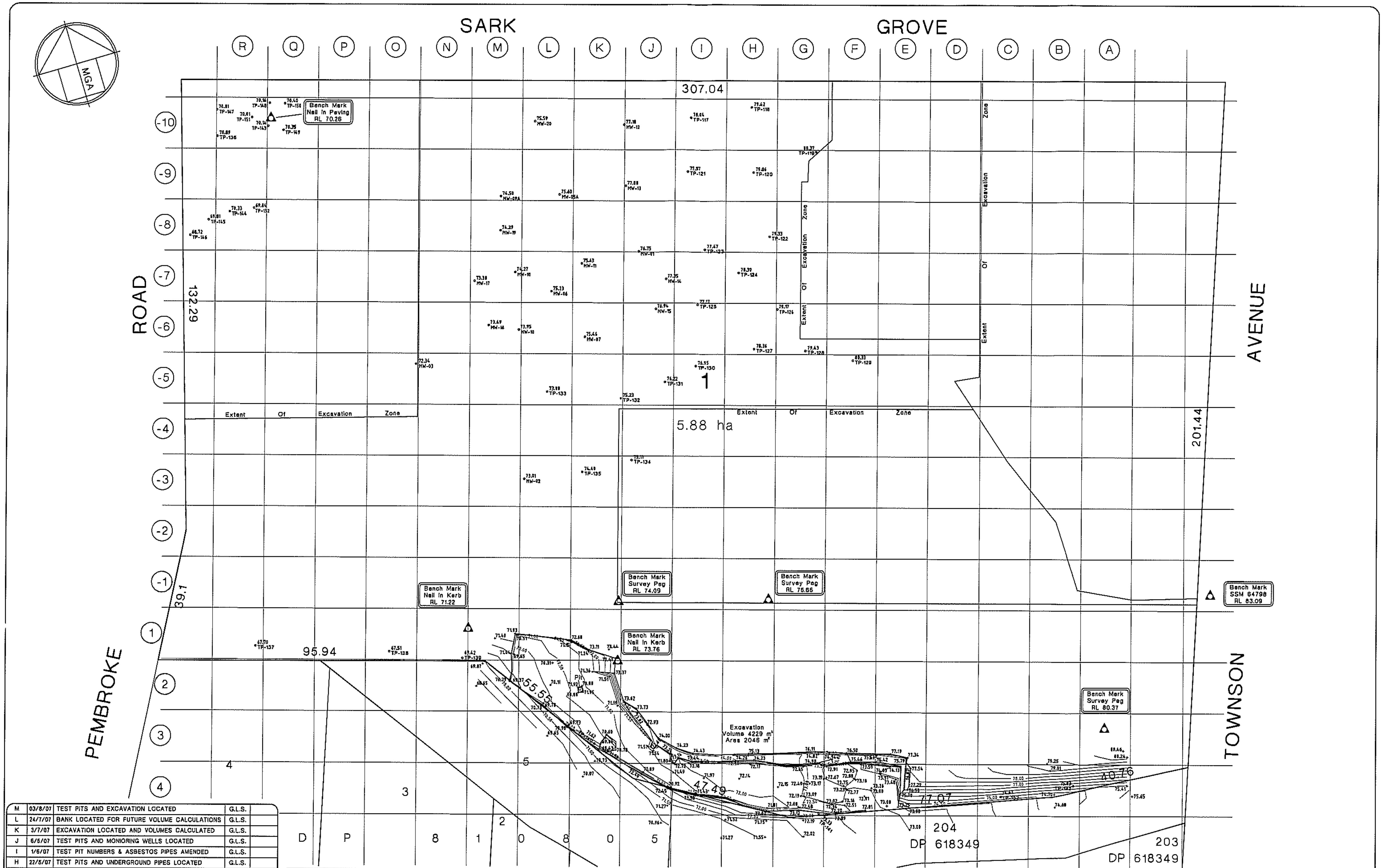
ABN 74 093 046 407

CITY OF CAMPBELLTOWN
LEVELS AND EXCAVATION

LOT 1 DP 620265
PEMBROKE ROAD
MINTO

REFERENCE :- 22315-DETAIL | SHEET No. 1 OF 1 | ISSUE :- K



ISSUE	DATE	AMENDMENT	DRAWN	CHKD
M	03/8/07	TEST PITS AND EXCAVATION LOCATED	G.L.S.	
L	24/7/07	BANK LOCATED FOR FUTURE VOLUME CALCULATIONS	G.L.S.	
K	3/7/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
J	6/6/07	TEST PITS AND MONIORING WELLS LOCATED	G.L.S.	
I	1/6/07	TEST PIT NUMBERS & ASBESTOS PIPES AMENDED	G.L.S.	
H	22/5/07	TEST PITS AND UNDERGROUND PIPES LOCATED	G.L.S.	
G	1/5/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
F	12/4/07	EXCAVATION LOCATED AND VOLUMES CALCULATED	G.L.S.	
E	20/3/07	EXCAVATIONS LOCATED AND VOLUMES CALCULATED	G.L.S.	
D	20/2/07	GRID LINES ADDED	G.L.S.	
C	2/2/07	HOLES WITHIN EXCAVATION DEFINED	G.L.S.	
B	11/1/07	FINISHED SURFACE OF FILL LOCATED	G.L.S.	
A	9/1/07	ORIGINAL ISSUE	G.L.S.	

LEGEND :-

•71.11	DENOTES SPOT HEIGHT.
•MW-01	DENOTES MONITORING WELL NUMBER.
•TP-147	DENOTES TEST PIT NUMBER.

NOTES:-

1. NO BOUNDARY SURVEY HAS BEEN MADE. THE BOUNDARIES HAVE BEEN PLOTTED APPROXIMATELY ONLY. FURTHER DEVELOPMENT NEAR THE BOUNDARIES OF THE LOT WILL REQUIRE FURTHER SURVEY.
2. ORIGIN OF LEVELS SSM 64798 RL 83.09 AHD.
3. LOT DIMENSIONS AND AREA VIDE DP 620265.
4. CONTOURS ARE INDICATIVE ONLY.
5. CONTOUR INTERVAL 0.5.
6. CONTACT 'DIAL BEFORE YOU DIG' (Ph. 1100) PRIOR TO ANY EXCAVATION FOR MOST RECENT SERVICE LOCATION RECORDS.
7. MONITORING WELL LEVELS ARE TOP OF PIPE LEVELS.

SCALE :- 1:500 @ A1	DATUM :- A.H.D.
DATE :- 03/08/2007	DRAWN :- G.L.S.
JOB No. :- 22315	APPROVED
CLIENT :- QUANTUM ENVIRONMENTAL	

PREPARED BY:
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ABN 74 093 046 407

CITY OF CAMPBELLTOWN

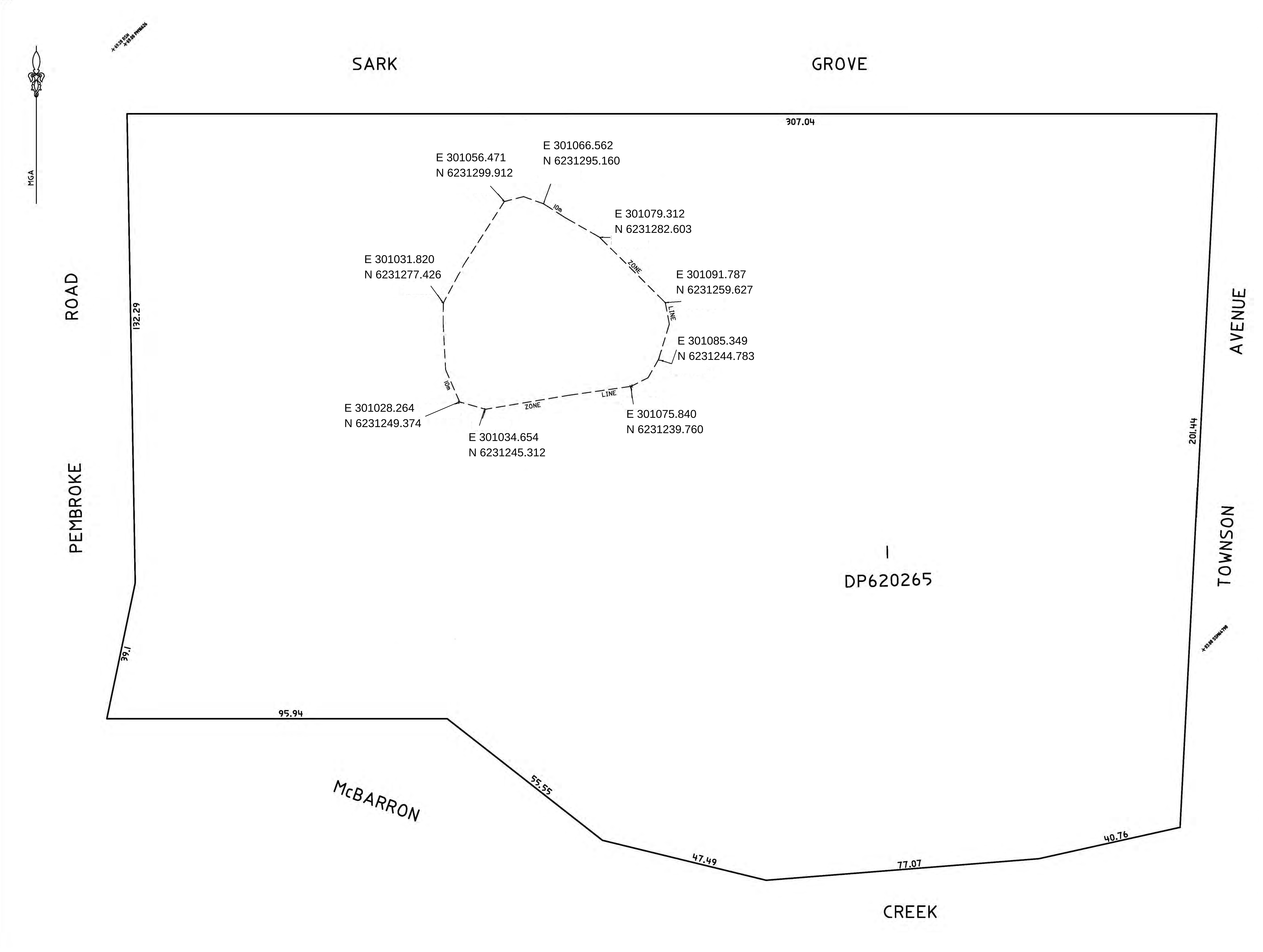
TEST PITS AND EXCAVATION VOLUME

LOT 1 DP 620265
PEMBROKE ROAD

MINTO

REFERENCE :- 22315-DETAIL | SHEET No. 1 OF 1 | ISSUE :- M

A1



NOTES

- **PRELIMINARY BOUNDARY DEFINITION ONLY (TITLE DIMENSIONS ONLY) - BOUNDARY DEFINITION IS SUBJECT TO FURTHER SURVEY.**
- **IF CONSTRUCTION ON OR NEAR BOUNDARIES IS REQUIRED IT IS RECOMMENDED THAT THE BOUNDARIES OF THE LAND BE MARKED.**
- THIS PLAN HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF ENVIRONMENTAL RISK SCIENCES PTY LTD.
- SERVICES HAVE NOT BEEN LOCATED. UNDERGROUND SERVICES HAVE NOT BEEN LOCATED. DIAL BEFORE YOU DIG SERVICES (ph 1100) SHOULD BE USED AND A FULL UTILITY INVESTIGATION, INCLUDING A UTILITY LOCATION SURVEY, SHOULD BE UNDERTAKEN BEFORE CARRYING OUT ANY CONSTRUCTION ACTIVITY IN OR NEAR THE SURVEYED AREA.
- THE INFORMATION IS ONLY TO BE USED AT A SCALE ACCURACY OF 1:500.
- DO NOT SCALE OFF THIS PLAN / FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALED READINGS.

HORIZONTAL DATUM:

CO-ORDINATE SYSTEM: MGA
MARK ADOPTED: PM.16626
EASTING: 300966.824
NORTHING: 6231372.939
SOURCE: S.C.I.M.S. (26/08/11)

VERTICAL DATUM:

DATUM: AUSTRALIAN HEIGHT DATUM (AHD)
B.M. ADOPTED: PM.16636
R.L. 72.336 (ORDER L2)
SOURCE: S.C.I.M.S. (26/08/11)

1	FIRST ISSUE	1/09/11

CLIENT:

ENVIRONMENTAL RISK SCIENCES PTY LTD
38 SIRIUS STREET
DUNDAS VALLEY NSW 2117

PLAN SHOWING LOCATION
OF IMPACTED ZONE
LOT 1 IN D.P.620265
SARK GROVE
MINTO NSW 2566

C.M.S. Surveyors Pty Limited
ACN: 096 240 201
PO Box 463 Dee Why
NSW 2099
1/32 Campbell Avenue,
Dee Why NSW 2099
Telephone: (02) 9971 4802
Facsimile: (02) 9971 4822
E-mail: info@cmssurveyors.com.au

LGA: CAMPBELLTOWN | SHEET 1 OF 1

SURVEYED	DRAWN	CHECKED	APPROVED
LJ	CJR	MG	DL

SURVEY INSTRUCTION	SCALE	DATE OF SURVEY
8525	1:500	25/08/11

DRAWING NAME: **8525detail**
CAD FILE: 8525detail 1.dwg
ISSUE: 1