ATTACHMENT 1 - RECOMMENDED CONDITIONS

1.0 - General Conditions of Consent

The following conditions of consent are general conditions applying to the development.

(1) **Engineering Specifications** - The entire development shall be designed and constructed in accordance with Council's Engineering Specifications and the relevant DCP.

(2) **Acoustic Barrier Servicing Outdoor Play Areas** - A timber lapped and capped acoustic fence at least 1.8m high (relative to ground levels of outdoor play areas) is to be constructed around the entire perimeter of all outdoor play areas. The location of the fences are to be consistent with Figure 2 in the Acoustic report titled "Trinity Early Learning Centre 42 Waterworth Drive, Narellan Vale" prepared by Acouras dated 28 July 2016 (Ref: SYD2016-1037-R001C).

(3) **Building Code of Australia** - All building work shall be carried out in accordance with the BCA. In this clause, a reference to the BCA is a reference to that Code as in force on the date the application for the relevant Construction Certificate is made.

(4) **Pollutants** - Discharge of pollutants is strictly forbidden. Measures to prevent the pollution of waters, air and land shall be incorporated into the development to comply with the requirements of the *Protection of the Environment Operations Act 1997*.

Where there is potential for pollutant discharge, a report by a suitably qualified expert shall be provided to the PCA detailing the pollution mitigation measures incorporated into the building design so that any discharges comply with the requirements of the *Protection of the Environment Operations Act 1997*.

(5) **Approved Plans and Documents** - Development shall be carried out generally in accordance with the following plans and documentation, and all recommendations made therein, except where amended by the conditions of this development consent:

Plan Reference/ Drawing No.	Name of Plan	Prepared by	Date
DA01 A	Site Analysis	Architex	4 May 2016
DA02 C	Site Plan	Architex	22 September 2016
DA03 C	Ground Floor Plan	Architex	22 September 2016
DA04 E	Elevations 1 + 3	Architex	3 November 2016
DA05 E	Elevations 2 + 4	Architex	3 November 2016
DA06 C	Section A-A	Architex	22 September 2016
D00 A	Cover Sheet, Legend and Drawing Schedule	Loka Consulting Engineers Pty Ltd	29 April 2016
D01 D	Ground Floor/Site Stormwater	Loka Consulting Engineers Pty	10 October 2016

	Drainage Plan	Ltd	
D02 C	Stormwater Drainage Details	Loka Consulting Engineers Pty Ltd	12 October 2016
D03 A	Erosion and Sediment Control Plan and Details	Loka Consulting Engineers Pty Ltd	30 April 2016
D04 A	Music Result & Details	Loka Consulting Engineers Pty Ltd	3 May 2016
1342.L.01 D	Landscape Plan	Greenland Design Pty Ltd	6 October 2016
1342.L.02 D	Landscape Details & Specification	Greenland Design Pty Ltd	6 October 2016

Document Title	Prepared by	Date
Childcare Centre Acoustic Assessment	Acouras Consultancy	28 July 2016
Narellan Vale Education Centre Plan of Management	N/A	N/A
Arboricultural Impact Assessment	Redgum Horticultural	20 April 2016
Drains Model Plan and Result	Loka Consulting Engineers Pty Ltd	10 October 2016
Flood Evacuation Management Plan	Loka Consulting Engineers Pty Ltd	12 October 2016

(6) **Modified Documents and Plans** - The development shall be modified as follows:

a) A 1.8m high open style metal boundary fence (child proof and coloured black) is to be provided along the site's boundaries forward of the building line. The section of the fence along the site's frontage must be stepped back within the landscaping by 1m.

b) Gates that open inwards to the site or are sliding, of a height and style that match the fencing required by point a) above, are to be provided at the site's entrance driveway.

c) The external waste bin storage area must be roofed and enclosed to prohibit the infiltration of rainwater. The height of the roof is to be no higher than the proposed 1.5m high timber screen wall. This area must also be graded and drained to sewer.

d) All pathways and ramps must have a non-slip surface.

e) All gates must be self closing.

Amended plans or documentation demonstrating compliance shall be provided to the Certifying Authority and Council prior to the issue of a Construction Certificate.

(7) **Outdoor Lighting** - The approved development must include lighting in all areas that complies with AS 1158 and AS 4282.

(8) **Glass Reflectivity** - The reflectivity of glass index for all glass used externally shall not exceed 20%.

(9) **Noxious Weeds** - Noxious weeds management shall occur in accordance with Camden Development Control Plan 2011.

(10) **Separate Approval for Signs** - A separate development application for any proposed signs shall be provided to, and approved by, the Consent Authority prior to the erection or display of any such signs (unless the display of that signage is exempt development pursuant to State Environmental Planning Policy (Exempt and Complying Development Codes) 2008).

(11) **General Terms of Approval/Requirements of State Authorities** - The general terms of approval/requirements from state authorities shall be complied with prior to, during, and at the completion of the development.

The general terms of approval/requirements are:

1. Letter from the Mine Subsidence Board dated 11 November 2016.
2. Letter from the Camden Local Area Command dated 1 June 2016 (excluding recommendation 6 under the heading 'Landscaping (Surveillance)').

(12) **Roof Mounted Equipment** - All roof mounted equipment such as air conditioning units, etc., required to be installed shall be integrated into the overall design of the building and not appear visually prominent or dominant from any public view. Any such equipment must not cause the maximum height of the approved development to exceed 9.5m from existing ground level.

2.0 – Prior to Issue of a Construction Certificate

The following conditions of consent shall be complied with prior to the issue of a Construction Certificate.

(1) **Structural Engineer's Certificate** - A certificate must be prepared by a practising structural engineer certifying that the building design is capable of withstanding the effects of water and water pressure due to flooding. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(2) **Evacuation Plan Required** - A plan indicating that permanent, fail-safe, maintenance free measures are incorporated in the development to ensure that timely, orderly and safe evacuation of people and potential pollutant material from the buildings on-site should a flood occur, must be provided. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(3) **Water Resisting Construction** - All external and internal partitions, framework, service and flooring must be constructed using flood compatible material. Details

demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(4) **Driveway Gradients and Design** - For all driveways that relate to the development, the driveway gradient and design shall comply with AS 2890.1-2004 'Off street car parking' and:

a) the driveway shall comply with Council's Access Driveway Specifications;

b) the driveway shall be at least 1m from any street tree, stormwater pit or service infrastructure;

c) the level for the driveway across the footpath area shall achieve a gradient of 4%; and

d) a Driveway Crossing Approval (PRA) must be obtained prior to the commencement of any works.

Details demonstrating compliance shall be provided to the Certifying Authority prior to issue of a Construction Certificate.

(5) **Flood Management Plan** - A flood management plan, prepared by a suitably qualified engineer in accordance with Camden Council's Flood Risk Management Policy, must be provided. Details demonstrating compliance shall be provided to the Certifying Authority.

(6) **Civil Engineering Plans** - Civil engineering plans indicating drainage, roads, accessways, earthworks, pavement design, details of line-marking, traffic management, water quality and quantity facilities including stormwater detention and disposal, shall be prepared in accordance with the approved plans and Council's Engineering Design and Construction Specifications. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

Note. Under the *Roads Act 1993*, only the Roads Authority can approve commencement of works within an existing road reserve.

(7) **Dilapidation Report – Council Property** - A Dilapidation Report prepared by a suitably qualified person, including a photographic survey of existing public roads, kerbs, footpaths, drainage structures, street trees and any other existing public infrastructure within the immediate area of the subject site. Details demonstrating compliance shall be provided to the Certifying Authority prior to issue of a Construction Certificate.

(8) **Traffic Management Plan** - A Traffic Management Plan (TMP) shall be prepared in accordance with Council's Engineering Specifications and AS 1742.3. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(9) **Retaining Walls** - All retaining walls shall be designed and certified by a suitably qualified structural engineer, in accordance with Council's Engineering Specifications.

(10) **Stormwater Detention and Water Quality** - An on-site detention system and water quality system shall be provided for the site and designed in accordance with Council's Engineering Specifications.

A detailed on-site detention and water quality report reflecting the Construction Certificate plans shall be provided to the Certifying Authority with the Construction Certificate application.

(11) **Soil, Erosion, Sediment and Water Management** - An erosion and sediment control plan shall be prepared in accordance with Council's Engineering Specifications. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(12) **Amended Plans** - The plans provided for the proposed child care centre do not comply with Council and legislative requirements in the following manner:

a) Clarification/demonstration that adequate space has been provided for dry good storage, chilled and frozen, equipment, personal belongings and chemical storage.

b) Confirmation as to whether an oven and/or any other cooking appliance will be installed and if mechanical ventilation is required.

c) Confirmation that a dishwasher will be installed and whether it will require mechanical ventilation in accordance with AS4674-2003 and AS 1668.1 &1668.2.

d) No hand wash basin is shown on the provided plans in the kitchen. A hand wash basin will have to be provided with anti-bacterial liquid pump soap and single use paper towels, in a dispenser.

e) No details have been provided on floor, wall and ceiling finishing's. Details are required on the construction material to be used on the floor, wall and ceiling as confirmation that they comply with AS4674-2004.

f) Confirmation is required on the location of the fridge and freezer and that they are of commercial standard.

g) The provided plans do not indicate a food preparation sink, new plans detailing the location of the food preparation sink will have to be provided.

h) The bottle rooms needs to have one sink labelled as a hand wash basins, with one of the additional sinks made into a double bowl equipment sink complete with loading and drainage.

i) Confirmation is required that the waste bin storage area will be graded and drained to sewer.

Amended plans prepared by a suitably qualified person and demonstrating full compliance with these requirements. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(13) **Food Related Requirements** - Amended plans prepared by a suitably qualified person and demonstrating full compliance with the *Food Act 2003*, Food Regulation 2015, Food Safety Standards and AS 4674-2004 must be provided to the Certifying Authority.

(14) **Mechanical Exhaust System** - Mechanical exhaust system(s) shall comply with the BCA and AS 1668 Parts 1 and 2 (including exhaust air quantities and discharge location points). Details demonstrating compliance shall be provided to the Certifying Authority.

(15) **Section 94 Contributions – Monetary** - A contribution pursuant to the provisions of Section 94 of the *EP&A Act 1979* for the services and amounts detailed below.

Plan Name	Contribution Type	Indexed Rate	Amount Payable
Contributions Plan No. 3	Trunk Drainage, Water Quality Facilities and Professional Services - indexed Quarterly to the Road Cost Index.	$48,809 per hectare	$19,348
	Total		**$19,348**

A copy of the Section 94 Contributions Plan may be inspected at Council's Oran Park office at 70 Central Avenue, Oran Park or can be accessed on Council's website at www.camden.nsw.gov.au.

The amount of contribution payable under this condition has been calculated at the date of consent. In accordance with the provisions of the Contributions Plan, this amount shall be indexed at the time of actual payment in accordance with the applicable Index.

(16) **Alternative Ventilation for Rooms** - As required by acoustic report titled "Trinity Early Learning Centre 42 Waterworth Drive, Narellan Vale" prepared by Acouras and dated 28 July 2016 (Ref: SYD2016-1037-R001C), for rooms requiring windows and doors to be closed (but not necessarily sealed) to meet internal noise criteria, alternative ventilation (possibly mechanical provided there is a fresh air intake) that meets the requirements of the Building Code of Australia (BCA) will need to be provided to ensure fresh airflow inside the building. Consultation with a mechanical engineer to ensure that the BCA and AS1668 are achieved is required.

(17) **Building Treatments and Glazing** - The walls, roof, windows and doors of the centre building are to incorporate the construction requirements identified in tables 6 & 7 of the Acoustic report titled "Trinity Early Learning Centre 42 Waterworth Drive, Narellan Vale" prepared by Acouras and dated 28 July 2016 (Ref: SYD2016-1037-R001C).

(18) **Environmental Management Plan** - An Environmental Management Plan (EMP) prepared in accordance with Council's Engineering Design Specification shall be provided to the Certifying Authority.

The EMP shall address the manner in which site operations are to be conducted and monitored to ensure that adjoining land uses and the natural environment is not unacceptably impacted upon by the proposal. The EMP shall include but not be necessarily limited to the following measures:

a) Measures to control noise emissions from the site;
b) Measures to suppress odours and dust emissions;
c) Soil and sediment control measures;
d) Measures to control air emissions that includes odour;
e) Measures and procedures for the removal of hazardous materials that includes waste and their disposal;
f) Any other recognised environmental impact; and
g) Community Consultation.

(19) **Building Platform** - This consent restricts excavation or fill for the purposes of creating a building platform. The building platform shall not exceed 2.0m from the external walls of the building. Where the external walls are within 2.0m of any property boundary, no parallel fill is permitted and a deepened edge beam to natural ground level shall be used. Details demonstrating compliance shall be provided to the Certifying Authority with the Construction Certificate application.

(20) **Long Service Levy** - In accordance with Section 34 of the *Building and Construction Industry Long Service Payments Act 1986*, the applicant shall pay a long service levy at the prescribed rate to either the Long Service Payments Corporation or Council for any work that cost $25,000 or more.

(21) **Structural Engineer's Details** - The piers/slabs/footings/structural elements shall be designed and certified by a suitably qualified structural engineer and shall take into consideration the recommendations of any geotechnical report applicable to the site. A statement to that effect shall be provided to the Certifying Authority.

(22) **Premises Standards** - Details shall be provided to the Certifying Authority demonstrating compliance with the requirements of *Disability (Access to Premises – Buildings) Standards 2010*.

(23) **Mine Subsidence Board Approval** - The amended plans approved by this development consent must also be approved in writing by the Mine Subsidence Board. All conditions or other requirements of the Mine Subsidence Board must be fully complied with.

3.0 - Prior to Commencement of Works

The following conditions of consent shall be complied with prior to any works commencing on the development site.

(1) **Public Liability Insurance** - The owner or contractor shall take out a Public Liability Insurance Policy with a minimum cover of $20 million in relation to the occupation of, and works within, public property (i.e. kerbs, gutters, footpaths, walkways, reserves, etc) for the full duration of the proposed works. Evidence of this Policy shall be provided to Council and the Certifying Authority.

(2) **Notice of PCA Appointment** - Notice shall be given to Council at least two (2) days prior to subdivision and/or building works commencing in accordance with Clause 103 of the EP&A Regulation 2000. The notice shall include:

a) a description of the work to be carried out;
b) the address of the land on which the work is to be carried out;
c) the registered number and date of issue of the relevant development consent;
d) the name and address of the PCA, and of the person by whom the PCA was appointed;
e) if the PCA is an accredited certifier, his, her or its accreditation number, and a statement signed by the accredited certifier consenting to being appointed as PCA; and
f) a telephone number on which the PCA may be contacted for business purposes.

(3) **Notice Commencement of Work** - Notice shall be given to Council at least two (2) days prior to subdivision and/or building works commencing in accordance with Clause 104 of the EP&A Regulation 2000. The notice shall include:

a) the name and address of the person by whom the notice is being given;
b) a description of the work to be carried out;
c) the address of the land on which the work is to be carried out;
d) the registered number and date of issue of the relevant development consent and construction certificate;
e) a statement signed by or on behalf of the PCA to the effect that all conditions of the consent that are required to be satisfied prior to the work commencing have been satisfied; and
f) the date on which the work is intended to commence.

(4) **Construction Certificate Required** - In accordance with the provisions of Section 81A of the *EP&A Act 1979*, construction or subdivision works approved by this consent shall not commence until the following has been satisfied:

a) a Construction Certificate has been issued by a Certifying Authority;
b) a Principal Certifying Authority (PCA) has been appointed by the person having benefit of the development consent in accordance with Section 109E of the *EP&A Act 1979*;
c) if Council is not the PCA, Council is notified of the appointed PCA at least two (2) days before building work commences;
d) the person having benefit of the development consent notifies Council of the intention to commence building work at least two (2) days before building work commences; and
e) the PCA is notified in writing of the name and contractor licence number of the owner/builder intending to carry out the approved works.

(5) **Sign of PCA and Contact Details** - A sign shall be erected in a prominent position on the site stating the following:

a) that unauthorised entry to the work site is prohibited;
b) the name of the principal contractor (or person in charge of the site) and a telephone number on which that person can be contacted at any time for business purposes and outside working hours; and

c) the name, address and telephone number of the PCA.

The sign shall be maintained while the work is being carried out, and shall be removed upon the completion of works.

(6) **Performance Bond** - Prior to commencement of works a performance bond of $5,000 must be lodged with Council in accordance with Camden Council's Engineering Construction Specifications.

Note – An administration fee is payable upon the lodgement of a bond with Council.

(7) **Soil Erosion and Sediment Control** - Soil erosion and sediment controls must be implemented prior to works commencing on the site in accordance with 'Managing Urban Stormwater – Soils and Construction ('the blue book') and any Sediment and Erosion plans approved with this development consent.

Soil erosion and sediment control measures shall be maintained during construction works and shall only be removed upon completion of the project when all landscaping and disturbed surfaces have been stabilised (for example, with site turfing, paving or re-vegetation).

(8) **Bus Stop and Bay Relocation** - The adjacent bus bay, stop and all associated signage and infrastructure must be relocated along Waterworth Drive away from the position of the approved driveway at the applicant's expense.

Detailed plans demonstrating these works must be submitted to and approved by the local traffic committee.

(9) **Shoring and Adequacy of Adjoining Property** - If the approved development involves an excavation that extends below the level of the base of the footings of a building, structure or work on adjoining land, the person having the benefit of the consent shall, at the person's own expense:

a) protect and support the adjoining building, structure or work from possible damage from the excavation; and

b) where necessary, underpin the building, structure or work to prevent any such damage.

This condition does not apply if the person having the benefit of the consent owns the adjoining land or the owner of the adjoining land has given consent in writing to that condition not applying.

A copy of the written consent must be provided to the PCA prior to the excavation commencing.

(10) **Site is to be Secured** - The site shall be secured and fenced to the satisfaction of the PCA. All hoarding, fencing or awnings (associated with securing the site during construction) is to be removed upon the completion of works.

(11) **Sydney Water Approval** - The approved development plans shall be approved by Sydney Water.

4.0 - During Works

The following conditions of consent shall be complied with during the construction phase of the development.

(1) **Construction Hours** - All work (including delivery of materials) shall be restricted to the hours of 7.00am to 5.00pm Monday to Saturday inclusive. Work is not to be carried out on Sundays or Public Holidays.

(2) **Finished Floor Level** - A survey report prepared by a registered land surveyor confirming that the proposed floor level is at or above RL 107.6 metres AHD, shall be provided to the PCA prior to construction proceeding above that level.

(3) **Traffic Management Plan Implementation** - All construction traffic management procedures and systems identified in the approved Construction Traffic Management Plan shall be introduced and maintained during construction of the development to ensure safety and to minimise the effect on adjoining pedestrian and traffic systems.

(4) **Site Signage** - A sign shall be erected at all entrances to the site and be maintained until the development has been constructed. The sign shall be constructed of durable materials, be a minimum of 1200mm x 900mm, and read as follows:

"WARNING UP TO $1,500 FINE. It is illegal to allow soil, cement slurry or other building materials to enter, drain or be pumped into the stormwater system. Camden Council (02 4654 7777) – Solution to Pollution."

The wording shall be a minimum of 120mm high and the remainder a minimum of 60mm high. The warning and fine details shall be in red bold capitals and the remaining words in dark coloured lower case letters on a white background, surrounded by a red border.

(5) **Soil, Erosion, Sediment and Water Management – Implementation** - All requirements of the erosion and sediment control plan and/or soil and water management plan shall be maintained at all times during the works and any measures required by the plan shall not be removed until the site has been stabilised.

(6) **Offensive Noise, Dust, Odour and Vibration** - All work shall not give rise to offensive noise, dust, odour or vibration as defined in the *Protection of the Environment Operations Act 1997* when measured at the property boundary.

(7) **Erosion and Sedimentation Control** - Soil erosion and sedimentation controls are required to be installed and maintained for the duration of the works. The controls must be undertaken in accordance with version 4 of the Soils and Construction – Managing Urban Stormwater manual (Blue Book).

(8) **Unexpected Finds Contingency (General)** - Should any suspect materials (identified by unusual staining, odour, discolouration or inclusions such as building rubble, asbestos, ash material, etc) be encountered during any stage of works (including earthworks, site preparation or construction works, etc), such works shall

cease immediately until a qualified environmental specialist has be contacted and conducted a thorough assessment.

In the event that contamination is identified as a result of this assessment and if remediation is required, all works shall cease in the vicinity of the contamination and Council shall be notified immediately.

Where remediation work is required, the applicant will be required to obtain consent for the remediation works.

(9) **Tree Protection During Construction Work** - All trees located in front of the site and located on adjoining properties must be protected in accordance with the standards specified in the "Australian Standard for Protection of Trees on Development Sites - AS 4970-2009."

(10) **Tree Protection Measures** - Tree protection measures contained within Arboricultural Impact Assessment Report prepared by Redgum Horticultural dated 20 April 2016 (Ref 1800) shall be in accordance with clauses 5.14, 5.15, 5.16 and 5.17 of that report.

(11) **Additional Approvals Required** - Where any works are proposed in the public road reservation, the following applications shall be made to Council, as applicable:

a) For installation or replacement of private stormwater drainage lines or utility services, including water supply, sewerage, gas, electricity, etc, an application shall be made for a Road Opening Permit and an approval under Section 138 of the *Roads Act 1993*;

b) For construction / reconstruction of Council infrastructure, including vehicular crossings, footpath, kerb and gutter, stormwater drainage, an application shall be made for a Roadworks Permit under Section 138 of the *Roads Act 1993*.

Note: Private stormwater drainage is the pipeline(s) that provide the direct connection between the development site and Council's stormwater drainage system, or street kerb and gutter.

(12) **Noise During Work** - All work shall not give rise to an 'offensive noise' as defined in the *Protection of the Environment Operations Act 1997*.

All work shall comply with the requirement of the NSW Industrial Noise Policy and the Environment Protection Authority's Environmental Noise Manual.

(13) **Fill Material** - Importation and/or placement of any fill material on the subject site, a validation report and sampling location plan for such material must be provided to and approved by the Principal Certifying Authority.

The validation report and associated sampling location plan must:

a) be prepared by a person with experience in the geotechnical aspects of earthworks;

b) be endorsed by a practising engineer with Specific Area of Practice in Subdivisional Geotechnics;

c) be prepared in accordance with;

Virgin Excavated Natural Material (VENM):

i) the Department of Land and Water Conservation publication "Site investigation for Urban Salinity"; and

ii) the Department of Environment and Conservation - Contaminated Sites Guidelines "Guidelines for the NSW Site Auditor Scheme (Second Edition) - Soil Investigation Levels for Urban Development Sites in NSW".

d) confirm that the fill material;

i) provides no unacceptable risk to human health and the environment;

ii) is free of contaminants;

iii) has had salinity characteristics identified in the report, specifically the aggressiveness of salts to concrete and steel (refer Department of Land and Water Conservation publication "Site investigation for Urban Salinity");

iv) is suitable for its intended purpose and land use; and

v) has been lawfully obtained.

Sampling of VENM for salinity of fill volumes:

e) less than 6000m3 - 3 sampling locations;

f) greater than 6000m3 - 3 sampling locations with 1 extra location for each additional 2000m3 or part thereof.

For e) and f) a minimum of 1 sample from each sampling location must be provided for assessment.

Sampling of VENM for Contamination and Salinity should be undertaken in accordance with the following table:

Classification of Fill Material	**No of Samples Per Volume**	**Volume of Fill (m^3)**
Virgin Excavated Natural Material	1 (see Note 1)	1000 or part thereof

Note 1: Where the volume of each fill classification is less than that required above, a minimum of 2 separate samples from different locations must be taken.

(14) **Site Management Plan** - The following practices are to be implemented during construction:

a) stockpiles of topsoil, sand, aggregate, spoil or other material shall be kept clear of any drainage path, easement, natural watercourse, kerb or road surface and shall have measures in place to prevent the movement of such material off site;

b) builder's operations such as brick cutting, washing tools, concreting and bricklaying shall be confined to the building allotment. All pollutants from these activities shall be contained on site and disposed of in an appropriate manner;

c) waste shall not be burnt or buried on site, nor shall wind blown rubbish be allowed to leave the site. All waste shall be disposed of at an approved waste disposal facility;

d) a waste control container shall be located on the site;

e) all building materials, plant, equipment and waste control containers shall be placed on the building site. Building materials, plant and equipment (including water closets), shall not to be placed on public property (footpaths, roadways, public reserves, etc);

f) toilet facilities shall be provided at, or in the vicinity of, the work site at the rate of 1 toilet for every 20 persons or part thereof employed at the site. Each toilet shall:

i) be a standard flushing toilet connected to a public sewer; or

ii) have an on-site effluent disposal system approved under the *Local Government Act 1993*; or

iii) be a temporary chemical closet approved under the *Local Government Act 1993*.

(15) **Removal of Waste Materials** - Where there is a need to remove any identified materials from the site that contain fill/rubbish/asbestos, the waste material shall be assessed and classified in accordance with the NSW EPA Waste Classification Guidelines (2008) (refer to: www.environment.nsw.gov.au/waste/envguidlns/index.htm)

Once assessed, the materials shall be disposed of to a licensed waste facility suitable for that particular classification of waste. Copies of tipping dockets shall be retained and supplied to Council upon request.

(16) **Compliance with BCA** - All building work shall be carried out in accordance with the requirements of the BCA.

(17) **Building Height** - A survey report prepared by a registered land surveyor confirming that the building height complies with the approved plans or as specified by the development consent, shall be provided to the PCA prior to the development proceeding beyond frame stage.

(18) **Survey Report** - The building shall be set out by a registered land surveyor. A peg out survey detailing the siting of the building in accordance with the approved plans shall be provided to the PCA prior to the pouring of concrete.

(19) **Easements** - No changes to site levels, or any form of construction shall occur within any easements that may be located on the allotment.

(20) **Air Quality** - Vehicles and equipment used on site must be maintained in good working order and be switched off when not operating. The burning of any waste material is prohibited.

(21) **Disposal of Stormwater** - Water seeping into any site excavations is not to be pumped into the stormwater system unless it complies with relevant EPA and ANZECC standards for water quality discharge.

(22) **Public Open Space Street Trees Repair or Replacement** - During any development works relating to this Consent, the applicant is responsible to ensure that any Street Trees, their tree guards, protective bollards, garden bed surrounds or root barrier installations which are disturbed, removed, or damaged must be restored or replaced at the time the damage or disturbance occurred.

Any repairs, relocations or replacements needed to the street trees, their garden bed surrounds, tree guards or root guard barriers, are to be completed with the same type, species, plant maturity and materials and the works and successful establishment of the trees completed prior to the issue of an Occupation Certificate.

(23) **Excavations and Backfilling** - All excavations and backfilling associated with this development consent shall be executed safely, and be properly guarded and protected to prevent them from being dangerous to life or property, and in accordance with the design of a suitably qualified structural engineer.

If an excavation extends below the level of the base of the footings of a building on an adjoining allotment, the person causing the excavation shall:

a) preserve and protect the building from damage;

b) if necessary, underpin and support the building in an approved manner; and

c) give at least seven (7) days' notice to the adjoining owner before excavating, of the intention to excavate.

The principal contractor, owner builder or any person who needs to excavate and undertake building work, shall contact "Dial Before You Dig" prior to works commencing, and allow a reasonable period of time for the utilities to provide locations of their underground assets.

This condition does not apply if the person having the benefit of the development consent owns the adjoining land or the owner of the adjoining land has given consent in writing to that condition not applying.

5.0 - Prior to Issue of an Occupation Certificate

The following conditions of consent shall be complied with prior to the issue of an Occupation Certificate.

(1) **Positive Covenant – OSD / On Site Retention / Water Quality Facility** - A positive covenant shall be created under Section 88E of the *Conveyancing Act 1919* burdening the owner(s) with a requirement to maintain the on-site detention, water quality facility and on-site retention/re-use facilities on the property, prior to the issue of an Occupation Certificate.

The terms of the Section 88E instrument with positive covenant shall include the following:

a) the Proprietor of the property shall be responsible for maintaining and keeping clear all pits, pipeline s, trench barriers and other structures;
b) the proprietor shall have the facilities inspected annually by a competent person;
c) the Council shall have the right to enter upon the land referred to above, at all reasonable times to inspect, construct, install, clean, repair and maintain in good working order the facilities; and
d) The registered proprietor shall indemnify the Council and any adjoining land owners against damage to their land arising from the failure of any component of the OSD and OSR, or failure to clean, maintain and repair the OSD and OSR.

The proprietor or successor shall bear all costs associated in the preparation of the subject Section 88E instrument. Proof of registration with Land and Property Information shall be provided to and approved by the PCA prior to the issue of an Occupation Certificate.

(2) **Stormwater – Plan of Management** - The registered proprietor of the land shall prepare a Plan of Management (POM) for the on-site detention facilities. The POM shall set out all design and operational parameters for the detention facilities including design levels, hydrology and hydraulics, inspection and maintenance requirements, and time intervals for such inspection and maintenance. The POM shall be provided to the PCA for approval.

(3) **Flood Management Plan** - A Certificate of Compliance prepared by a suitably qualified engineer shall be provided to the PCA stating that all aspects of the Flood Risk Management Plan have been completed and/or implemented in accordance with the approved Plan.

(4) **Flooding – Evacuation Management Plan** - A Flood Emergency Evacuation and Management Plan for the proposed development shall be prepared in accordance with Council's Flood Risk Management Policy (as amended).

(5) **Completion of Landscape Works** - All landscape works, including the removal of noxious weed species, are to be undertaken in accordance with the approved landscape plan and conditions of this Development Consent.

(6) **Works As Executed Plan** - Works As Executed Plans shall be prepared and provided in accordance with Council's Engineering Specifications.

Digital data must be in AutoCAD .dwg or .dxf format, and the data projection coordinate must be in (GDA94.MGA zone 56).

(7) **Waste Management Plan** - The PCA shall ensure that all works have been completed in accordance with the approved waste management plan referred to in this development consent.

(8) **Lighting Compliance** - Details shall be submitted to the PCA demonstrating that the external lighting complies with AS 4282 and AS 1158.

(9) **Fire Safety Certificates** - A Fire Safety Certificate shall be provided to the PCA in accordance with the requirements of the EP&A Regulation 2000.

(10) **Survey Certificate** - A registered surveyor shall prepare a Survey Certificate to certify that the location of the building in relation to the allotment boundaries complies with the approved plans or as specified by this consent. The Survey Certificate shall be provided to the satisfaction of the PCA.

(11) **Building Height** - A registered surveyor shall certify that the maximum height of the building is consistent with the height in the approved plans and this consent. The certification/verification shall be provided to the satisfaction of the PCA.

(12) **Footpath Crossing Construction** - A footpath crossing and driveway shall be constructed in accordance with this consent and the approved Construction Certificate prior to use or occupation of the development.

(13) **Services** - Certificates and/or relevant documents shall be obtained from the following service providers and provided to the PCA:

a) Energy supplier – Evidence demonstrating that satisfactory arrangements have been made with the energy supplier to service the proposed development;

b) Telecommunications – Evidence demonstrating that satisfactory arrangements have been made with a telecommunications carrier to service the proposed development; and

c) Water supplier – Evidence demonstrating that satisfactory arrangements have been made with a water supply provider to service the proposed development.

(14) **Food Premises** - The following notifications shall occur:

a) Council shall be notified that the premises is being used for the preparation, manufacture or storage of food for sale and an inspection of the completed fit out is to be conducted. A 'Food Business Registration' form can be found on Council's website; and

b) the NSW Food Authority shall be notified and a copy of the notification shall be provided to Council. Notification can be completed on the NSW Food Authority website.

(15) **Department of Education** - Compliance with any requirements of the Department of Education in relation to this development is required. In this regard, a letter from the Department of Education which details the approved number and age of children to be accommodated at the facility and any conditions of operation must be submitted to the Consent Authority (i.e. Camden Council) prior to the child care centre becoming operational.

6.0 – Ongoing Use

The following conditions of consent are operational conditions applying to the development.

(1) **Offensive Noise** - The use and occupation of the premises including all plant and equipment shall not give rise to any offensive noise within the meaning of the *Protection of the Environment Operations Act 1997* and shall comply with the NSW Industrial Noise Policy 2000 (as amended).

(2) **Maintenance of Landscaping** - Landscaping shall be maintained in accordance with the approved landscape plan.

(3) **Landscaping Maintenance Establishment Period** - Commencing from the date of practical completion, the applicant will have the responsibility to establish and maintain all hard and soft landscaping elements associated with this consent.

The 12 month maintenance and establishment period includes the applicant's responsibility for the establishment, care and repair of all landscaping elements including all street tree installations, plantings, lawn and hardscape elements including paths, walls, bins, seats, BBQs, shelters, playground equipment and soft fall treatments.

The date of practical completion is taken to mean completion of all civil works, soil preparation and treatment and initial weed control, and completion of all planting, turf installation, street tree installation and mulching.

At the completion of the 12 month landscaping maintenance and establishment period, all hard and soft landscaping elements (including any nature strip and road verge areas, street trees, street tree protective guards and bollards, etc) shall be in an undamaged, safe and functional condition and all plantings have signs of healthy and vigorous growth.

At the completion of the maintenance and establishment period, the landscaping works shall comply with the approved landscape plans.

(4) **Amplified Music** - The use of amplified music in outdoor areas of the centre is prohibited. If used indoors all windows and doors shall remain closed.

(5) **Mechanical Plant Noise Restriction** - The use and operation of all mechanical plant shall be restricted to only operate between the hours of 7.00am to 6.30pm Monday to Friday (excluding public holidays).

(6) **Windows to be Closed** - Whilst children are participating in indoor activities the windows of the building are to be closed.

(7) **Noise Levels** - Noise from all ventilation equipment, kitchen exhausts and any other plant associated with the building shall be controlled by the way of effective acoustic treatments such as acoustic barriers and silencers incorporated in the fan system. The LAeq 15minute cumulative noise level from such equipment shall not exceed the following criteria when measured at the nearest residential boundary:

- 51dB(A) - 7.00am-6.30pm.

(8) **Acoustic Compliance Report** - A compliance report shall be submitted to the PCA and Council within 3 months after occupying the premises. The report shall be prepared by an independent acoustic consultant and certify that noise levels from the use of the ventilation equipment, kitchen exhausts and any other plant associated with the building comply with the following criteria when measured at the nearest residential boundary:

- 51dB(A) - 7.00am-6.30pm.
- All noise attenuation materials and structures used for the mitigation/control of noise are compliant with the conditions of this development consent.

For any non-compliance, the acoustic compliance report must make recommendations for compliance or further attenuation of noise sources and these recommendations will be enforced by Council at the cost of the owner/occupier.

The owner / occupier must then provide a supplementary acoustic report to the PCA and Council certifying that all compliance works have been completed and that noise levels comply with the above criteria.

(9) **Commercial Waste Contract** - The applicant shall enter into a commercial contract for the collection of trade waste and recycling. A copy of this agreement shall be held on the premises at all times.

(10) **Waste Disposal** - The building owner shall ensure that there is a contract with a licensed contractor for the removal of all waste. No garbage is to be placed on public land (e.g. footpaths, roadways, plazas, reserves etc.) at any time.

(11) **Waste Collection and Deliveries** - Waste collection and deliveries are to occur wholly within the site's car park outside of the centre's peak operating hours.

(12) **Hours of Operation** - The approved development is only to be open and used within the following hours:

Day	Hours of Operation
Monday	7am-6.30pm
Tuesday	7am-6.30pm
Wednesday	7am-6.30pm
Thursday	7am-6.30pm
Friday	7am-6.30pm
Public Holidays	No operations

(13) **Occupation Certificate Required** - An Occupation Certificate shall be obtained prior to any use or occupation of the development.

(14) **Manoeuvring of Vehicles** - All vehicles shall enter and exit the site in a forward direction.

(15) **Driveways to be Maintained** - All access crossings and driveways shall be maintained in good order for the life of the development.

(16) **Parking Areas to be Kept Clear** - At all times the loading areas, car parking spaces, driveways and footpaths shall be kept clear of goods and shall not be used for storage purposes.

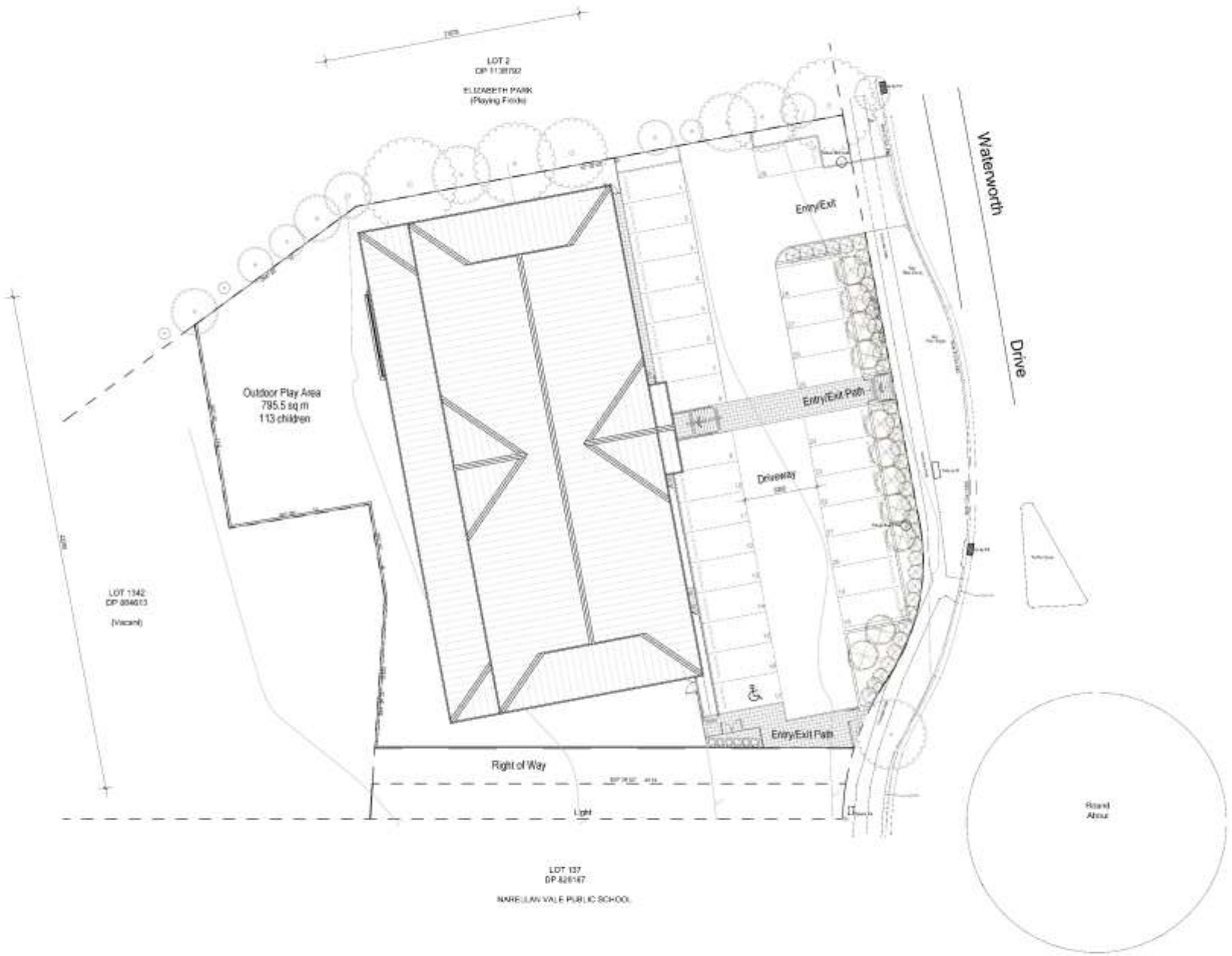
(17) **Number of Employees** - The number of people working in the approved development shall not exceed 19 at any given time.

(18) **Number of Children** - The centre is approved to cater for a maximum of 112 children. However this number shall be reduced to any lower number of children that is separately approved for the centre by the Department of Education.

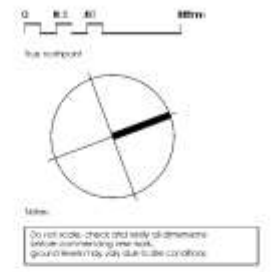
(19) **Removal of Graffiti** - The owner/manager of the site is responsible for the removal of all graffiti from the buildings and fences within 48 hours of its application.

(20) **Special Activities** - No special events or other activities/functions are approved by this development consent.

(21) **Amenity** - The business shall be conducted and customers controlled at all times so that no interference occurs to the amenity of the area, the footpath, adjoining occupations and residential or business premises.



Site Plan



C New Levels to AHD 22.06.16
B Development Application 24.07.16
A Development Application 04.05.16

architex

DEVELOPMENT APPLICATION

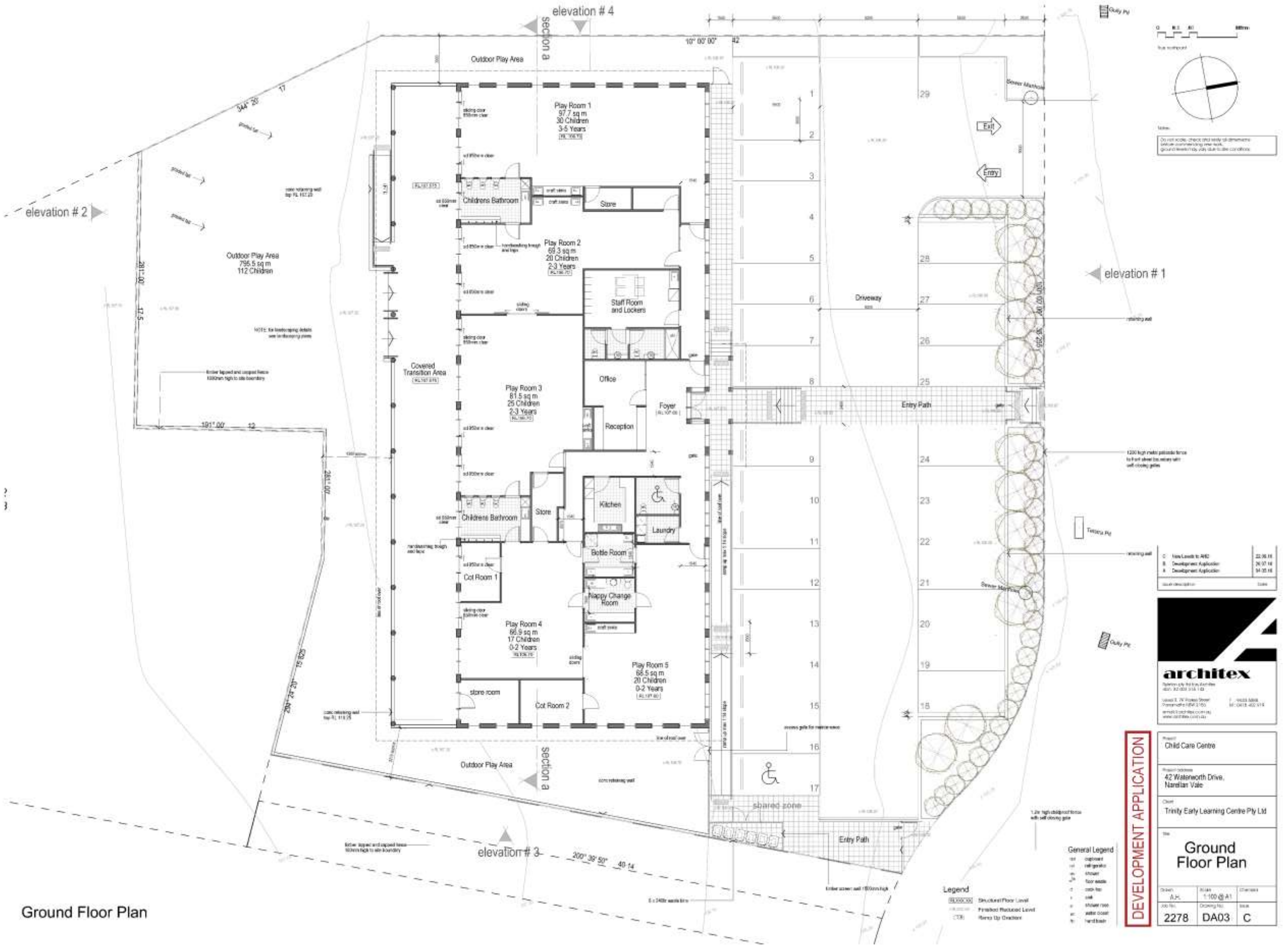
Project
Child Care Centre

Project address
42 Waterworth Drive,
Narellan Vale

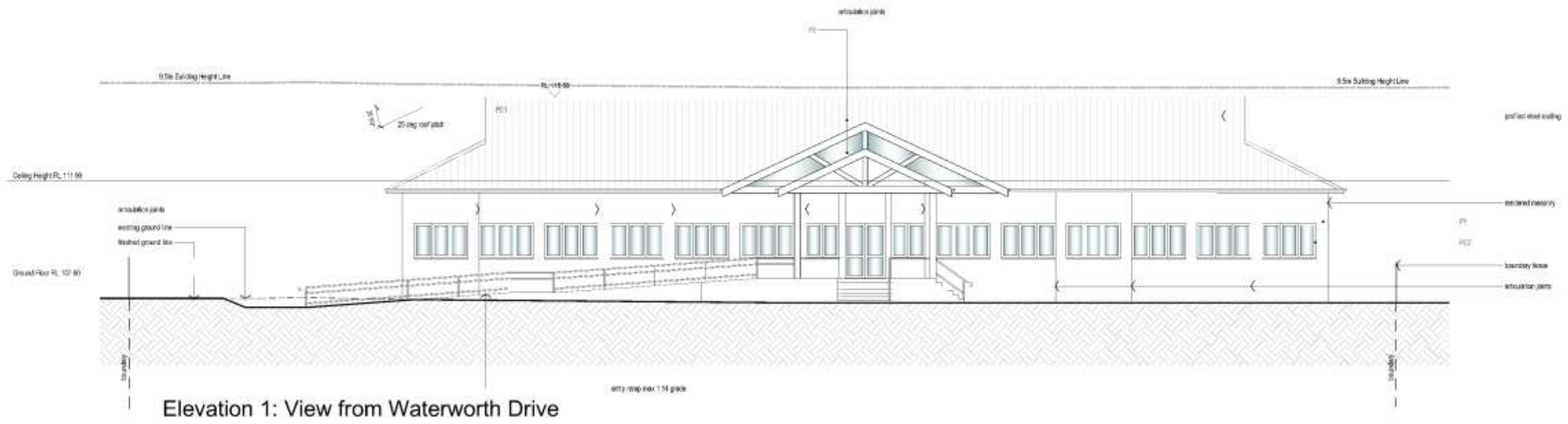
Client
Trinity Early Learning Centre Pty Ltd

Title
Site Plan

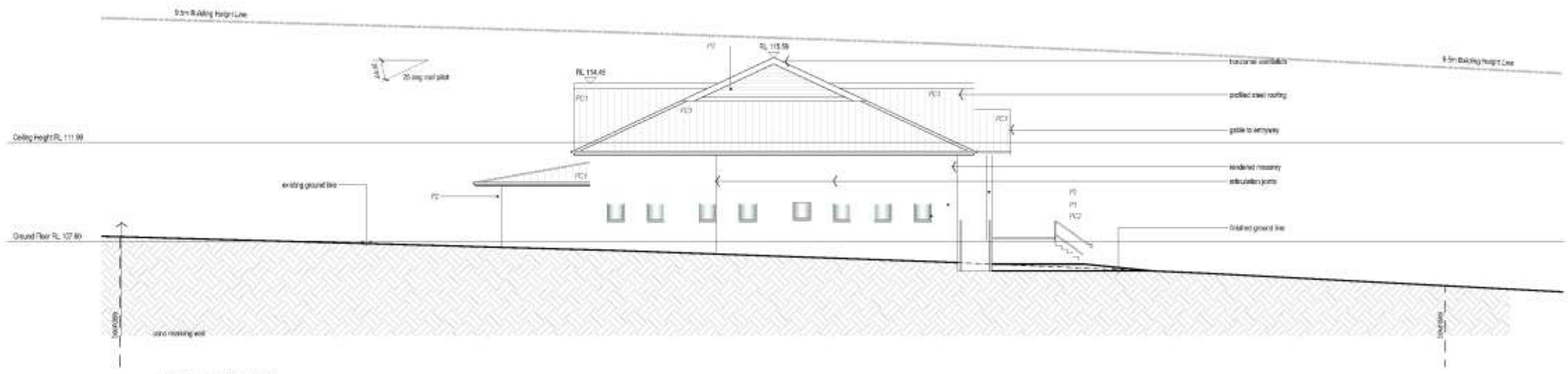
Drawn	Scale	Checked
A.H.	1:200 @ A1	
Job No.	Drawing No.	Issue
2278	DA02	C



Ground Floor Plan



Elevation 1: View from Waterworth Drive



Elevation 3

Elevations

LEGEND
EXTERNAL MATERIALS + FINISHES

P1	PAINT FINISH 1 Dulux Pale Mustard P16F5
P2	PAINT FINISH 2 Dulux Lexicon Half PF2A1
PC1	POWDERCOAT 1 Colorbond - Basalt
PC2	POWDERCOAT 2 Dulux - Pearl White

E	Roof Pitch Amended	03.11.16
D	Articulation Joints Added	01.11.16
C	New Levels to AHD	22.09.16
B	Development Application	26.07.16
A	Development Application	04.05.16

architex

DEVELOPMENT APPLICATION

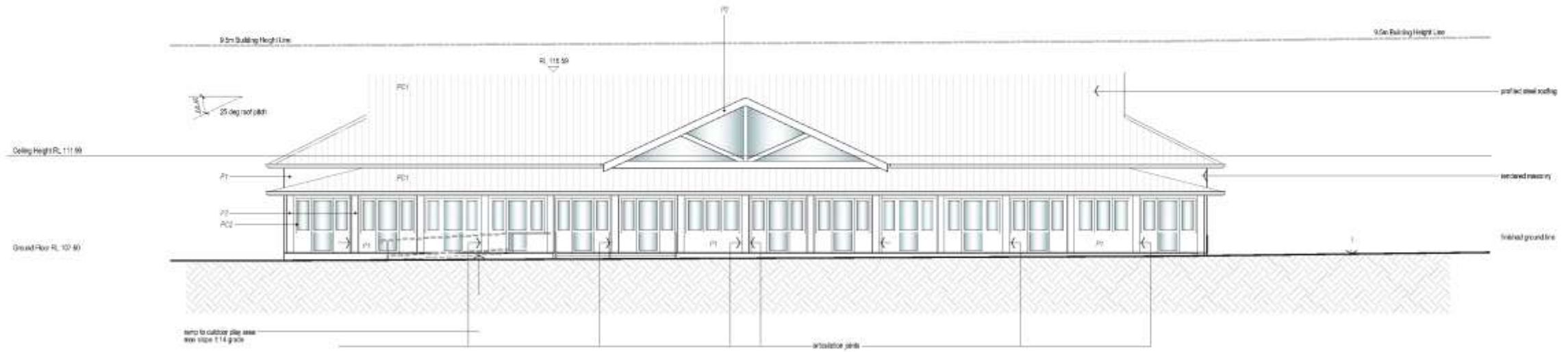
Project: Child Care Centre

Project address: 42 Waterworth Drive, Narellan Vale

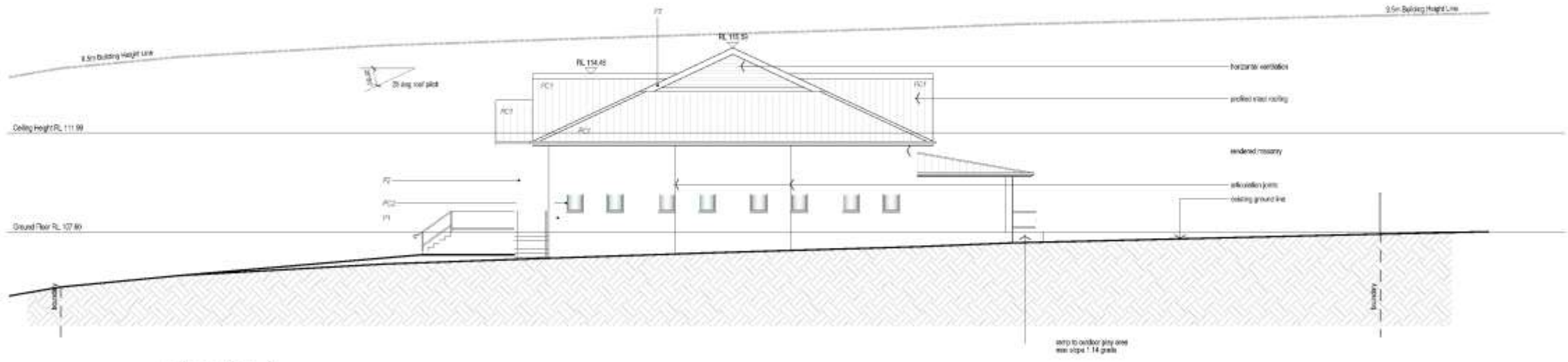
Client: Trinity Early Learning Centre Pty Ltd

Title: Elevations 1 + 3

Drawn	Scale	Checked
A.H	1:100 @ A1	
Job No.	Drawing No.	Issue
2278	DA04	E



Elevation 2



Elevation 4

Elevations

LEGEND
EXTERNAL MATERIALS + FINISHES

P1	PAINT FINISH 1 Dulux Pale Mustard PWP5
P2	PAINT FINISH 2 Dulux Lexicon Half PR2A1
PC1	POWDERCOAT 1 Colorbond - Basalt
PC2	POWDERCOAT 2 Dulux - Pearl White

Notes
Do not scale, check and verify all dimensions before commencing new work. ground levels may vary due to site conditions.

E	Roof Pitch Amended	03.11.16
D	Articulation Joints Added	01.11.16
C	New Levels to RHD	22.09.16
B	Development Application	26.07.16
A	Development Application	04.05.16

issue description — date

architex
Sydney pty ltd trad Architex
abn: 52 005 319 142
Level 3 , 76 Pirie Street Adelaide SA 5000
T: 08 8232 5844
M: 0418 822 918
email@architex.com.au
www.architex.com.au

DEVELOPMENT APPLICATION

Project: Child Care Centre
Project address: 42 Waterworth Drive, Narellan Vale
Client: Trinity Early Learning Centre Pty Ltd
Title: Elevations 2 + 4

Drawn	Scale	Checked
A.H.	1:100 @ A1	
Job No.	Drawing No.	Issue
2278	DA05	E

1.0 - General Conditions of Consent

The following conditions of consent are general conditions applying to the development.

(1) **Approved Plans and Documents** - Development shall be carried out in accordance with the following plans and documentation, and all recommendations made therein, except where amended by the conditions of this development consent:

Plan Reference/ Drawing No.	Name of Plan	Prepared by	Date
16080 SUB	Proposed Subdivision	East and West Surveyors	20 March 2016

7.0 - Prior to Issue of a Subdivision Certificate

The following conditions of consent shall be complied with prior to the issue of a Subdivision Certificate.

(1) **Section 94 Contributions – Monetary (Turner Road and Oran Park)** - A contribution pursuant to the provisions of Section 94 of the *EP&A Act 1979* for the services and amounts detailed below.

Plan Name	Contribution Type	Indexed Rate	Amount Payable
Oran Park & Turner Road	Open Space & Recreation - Land Acquisition	$15,349 per dwelling	$15.349.00
Oran Park & Turner Road	Open Space & Recreation - Works	$8,936 per dwelling	$8,936.00
Oran Park & Turner Road	Open Space & Recreation - Project Management	$197 per dwelling	$197.00
Oran Park & Turner Road	Community Facilities - Land Acquisition	$174 per dwelling	$174.00
Oran Park & Turner Road	Community Facilities - Works	$1,737 per dwelling	$1,737.00
Oran Park & Turner Road	Community Facilities - Project Management	$38 per dwelling	$38.00
Total Cash Contributions			**$26.431.00**

A copy of the Oran Park and Turner Road Precincts Section 94 Contributions Plan may be inspected at Council's Oran Park office at 70 Central Avenue, Oran Park or can be accessed on Council's website at www.camden.nsw.gov.au.

The amount of contribution payable under this condition has been calculated at the date of consent. In accordance with the provisions of the Contributions Plan, this amount shall be indexed at the time of actual payment in accordance with the applicable Index.

(2) **Requirement for a Subdivision Certificate** - The application for subdivision certificate(s) shall be made in accordance with the requirements of Clause 157 of the Environmental Planning & Assessment Regulation 2000.

(3) **Show Easements/ Restrictions on the Plan of Subdivision** - The developer shall acknowledge all existing easements and/or restrictions on the use of the land on the final plan of subdivision.

(4) **Burdened Lots to be Identified** - Any lots subsequently identified during construction of the subdivision as requiring restrictions shall also be suitably burdened.

(5) **Services** - Certificates and/or relevant documents shall be obtained from the following service providers and provided to the PCA:

a) Energy supplier – Evidence demonstrating that satisfactory arrangements have been made with the energy supplier to service the proposed development;

b) Telecommunications – Evidence demonstrating that satisfactory arrangements have been made with a telecommunications carrier to service the proposed development; and

c) Water supplier – Evidence demonstrating that satisfactory arrangements have been made with a water supply provider to service the proposed development.

A1

ROSE STREET

SKAIFE STREET

PROPOSED DRIVE WAY

PROPOSED DRIVE WAY

PROPOSED LOT 51

(351.75 m²)

PROPOSED LOT 52

(348.25 m²)

EASEMENT TO DRAIN WATER 1.5 WIDE

LOT 5267
D.P. 1174055

ONE STOREY BRICK HOUSE TILE ROOF

BRICK HOUSE UNDER CONSTRUCTION

LOT 5424
D.P. 1174055

LEGEND:

ADJ	ADJOINING BUILDING
AHD	AUSTRALIAN HEIGHT DATUM
BM	BENCH MARK
COMM	COMMUNICATION PIT
CONC	CONCRETE
D/H/S	DIAMETER/HEIGHT/SPREAD
D	DOOR
E-G	EAVE & GUTTER
FL	FLOOR LEVEL
GUTT	GUTTER
M/HOLE	MANHOLE
PP	POWER POLE
RL	REDUCED LEVEL
ROCK/BT	BOTTOM OF ROCK
ROCK/T	TOP OF ROCK
S	STEPS
SILL	WINDOW SILL
TK	TOP OF KERB
TOP	TOP OF WINDOW
U/E	UNDERSIDE OF EAVE
VC	VEHICLE CROSSING
W	WINDOW
WM	WATER METER

DIMENSIONS AND AREAS SUBJECT TO FINAL SURVEY

NO COVENANTS AND/OR RESTRICTIONS HAVE BEEN INVESTIGATED BY EAST&WEST SURVEYORS

(A) – EASEMENT TO DRAIN WATER 1.5 WIDE

GEOFFREY GALLEN
REGISTERED SURVEYOR
No 1083

EAST & WEST SURVEYORS
Ph: 0403 818 643 ABN: 76 470 937 002
PO BOX 2940 ,CARLINFORD, NSW - 2118
Email : info@eastwestsurveyors.com.au
www.east&westsurveyor.com.au

PROPOSE SUBDIVISION OF LOT 5425 IN D.P. 1198455
SKAIFE STREET, ORAN PARK

INSTRUCTING PARTY:	AS PER REQUEST	DATUM:	A.H.D.	SURVEYED BY:	SL
		SURVEY DATE:	20.03.2016	DRAWN BY:	KU
		DATE DRAWN:	23.03.2016	SCALE:	1: 100
		REFERENCE:	16080 SUB	SHEET:	1 OF 1

ATTACHMENT 1 - RECOMMENDED CONDITIONS

1.0 - General Conditions of Consent

The following conditions of consent are general conditions applying to the development.

(1) **Engineering Specifications** - The entire development shall be designed and constructed in accordance with Council's Engineering Specifications and the relevant DCP.

(2) **Remediation Works** - All works proposed as part of the remediation action plan that include remediation of landfill, excavation of landfill and screening of materials, soil segregation, groundwater extraction and treatment, landfill gas extraction and management, onsite / offsite treatment / disposal of all waste materials, asbestos identification and management, environmental controls that includes odour and noise and dust, cut and fill, backfilling, compaction, monitoring, compliance / validations, site management and security, health and safety of workers, must be undertaken on the site in accordance with the Remediation Action Plan titled *"Dart West Developments: Remediation Action Plan: 3 Elyard Street Narellan NSW, Prepared by Environmental Investigations, Report E1445 At RAP Rev 3, Dated 31 August 2016"* except as stated in any other condition of this consent.

(3) **Variation or Modification of Works** - Any variation or modification of remedial works or compliance or validation works, from that stated in the remediation action plan, other than those variations or modifications as stated in this consent, must be requested from the Consent Authority in writing and approved by the Consent Authority and a NSW DEC Accredited Site Auditor in writing prior to any such works being undertaken. Where variation or modification is considered by the Consent Authority to be major then separate development consent may be required.

(4) **Leachate Ponds** - The construction and use of leachate ponds on site is not permitted.

(5) **Earthworks** - The approved earthworks are approved to remove the existing soil stockpiles on the site and regrade the land to its previous state as shown on the plan titled "Existing Surface Levels Prior to Stockpile Placement."

(6) **Approved Plans and Documents** - Development shall be carried out generally in accordance with the following plans and documentation, and all recommendations made therein, except where amended by the conditions of this development consent:

Plan Reference/ Drawing No.	Name of Plan	Prepared by	Date
N/A	Plan of Proposed Tree Removal	Dart West Developments	N/A
N/A	Existing Surface Levels Prior to Stockpile Placement	Dart West Developments	N/A

Document Title	Prepared by	Date
Remediation Action Plan	Environmental Investigations	31 August

This is the report submitted to the held on

	Australia	2016
Interim Advice – Remedial Action Plan	Environmental Strategies	21 April 2016
Additional Information Request Response	Dart West Developments	22 April 2016

2.0 - Prior to Commencement of Works

The following conditions of consent shall be complied with prior to any works commencing on the development site.

(1) **Soil Erosion and Sediment Control** - Soil erosion and sediment controls must be implemented prior to works commencing on the site in accordance with 'Managing Urban Stormwater – Soils and Construction ('the blue book') and any Sediment and Erosion plans approved with this development consent.

Soil erosion and sediment control measures shall be maintained during construction works and shall only be removed upon completion of the project when all landscaping and disturbed surfaces have been stabilised (for example, with site turfing, paving or re-vegetation).

(2) **Public Liability Insurance** - The owner or contractor shall take out a Public Liability Insurance Policy with a minimum cover of $20 million in relation to the occupation of, and works within, public property (i.e. kerbs, gutters, footpaths, walkways, reserves, etc) for the full duration of the proposed works. Evidence of this Policy shall be provided to Council and the Certifying Authority.

(3) **Sign and Contact Details** - A sign shall be erected in a prominent position on the site stating the following:

a) that unauthorised entry to the work site is prohibited; and
b) the name of the principal contractor (or person in charge of the site) and a telephone number on which that person can be contacted at any time for business purposes and outside working hours.

The sign shall be maintained while the work is being carried out, and shall be removed upon the completion of works.

(4) **Performance Bond** - Prior to commencement of works a performance bond of $10,000 must be lodged with Camden Council in accordance with Camden Council's Engineering Construction Specifications.

Note – An administration fee is payable upon the lodgement of a bond with Council.

(5) **Additional Management and Operation Plans** - To support the remediation strategy the following plans are required to be completed and submitted to Council prior to the commencement of works:

- Demolition Waste Management Plan;
- Environmental Monitoring and Odour Control Plan;
- Emergency Response Plan;
- Bush Fire Emergency Response Plan

- Works Progress Plan;
- Quality Assurance and Quality Control Plan;
- Site Specific Project Health and Safety Plan; and
- Wastewater Management Plan.

(6) **Licenses** - It is the responsibility of the applicant / land owner / site operator to ensure that all relevant licenses are obtained from all appropriate authorities in accordance with relevant legislation requirements prior to the commencement of remediation works.

(7) **Trade Waste Agreement** - A suitable trade waste agreement between the applicant and Sydney Water is required. The agreement must incorporate Sydney Water accepting treated contamination liquid waste from the site to be drained into the sewer main.

(8) **Construction Management Plan** - A construction management plan that includes construction waste, dust, soil and sediment and traffic management (including heavy vehicles movements), prepared in accordance with Council's Engineering Design Specification, shall be prepared and submitted to Council.

(9) **Work Zone** - A work zone shall to be provided along part of the frontage of the property to facilitate heavy vehicle access and allow provision for site vehicles to park prior to accessing the site without disrupting traffic flow. This is subject to a Public Road Activity application and the approval of the Local Traffic Committee.

(10) **Shoring and Adequacy of Adjoining Property** - If the approved development involves an excavation that extends below the level of the base of the footings of a building, structure or work on adjoining land, the person having the benefit of the consent shall, at the person's own expense:

a) protect and support the adjoining building, structure or work from possible damage from the excavation; and

b) where necessary, underpin the building, structure or work to prevent any such damage.

This condition does not apply if the person having the benefit of the consent owns the adjoining land or the owner of the adjoining land has given consent in writing to that condition not applying.

A copy of the written consent must be provided to the PCA prior to the excavation commencing.

(11) **Civil Engineering Plans** - Civil engineering plans indicating drainage, roads, accessways, earthworks, pavement design, details of line-marking, traffic management, water quality and quantity facilities including stormwater detention and disposal, shall be prepared in accordance with the approved plans and Council's Engineering Design and Construction Specifications.

Note. Under the *Roads Act 1993*, only the Roads Authority can approve commencement of works within an existing road reserve.

(12) **Dilapidation Report – Council Property** - A Dilapidation Report prepared by a suitably qualified person, including a photographic survey of existing public roads, kerbs, footpaths, drainage structures, street trees and any other existing public infrastructure within the immediate area of the subject site.

(13) **Traffic Management Plan** - A Traffic Management Plan (TMP) shall be prepared in accordance with Council's Engineering Specifications and AS 1742.3.

(14) **Soil, Erosion, Sediment and Water Management** - An erosion and sediment control plan shall be prepared in accordance with Council's Engineering Specifications.

(15) **Environmental Management Plan** - An Environmental Management Plan prepared in accordance with Council's Engineering Design Specification shall be provided to the Council.

The Environmental Management Plan shall address the manner in which site operations are to be conducted and monitored to ensure that adjoining land uses and the natural environment is not unacceptably impacted upon by the proposal.

The Environment Management Plan shall include but not be necessarily limited to the following measures:

a) Measures to control noise emissions from the site;
b) Measures to suppress odours and dust emissions;
c) Soil and sediment control measures;
d) Measures to control air emissions that includes odour;
e) Measures and procedures for the removal of hazardous materials that includes waste and their disposal;
f) Establishment and maintenance of windbreaks to manage material stockpiles;
e) Any other recognised environmental impact; and
g) Community consultation.

(16) **Compliance of Remediation Work** - All remediation work must comply with the following requirements:

a) *Contaminated Land Management Act 1997*;
b) Department of Urban Affairs and Planning – Contaminated Land Planning Guidelines 1998;
c) SEPP 55 – Remediation of Land;
d) Sydney Regional Environmental Plan No. 20 Hawkesbury Nepean River (No.2 – 1997); and
e) Council's adopted policy for the Management of Contaminated Lands.

(17) **Demolition Work** - Consent is granted for the demolition of the existing slab currently existing on the property, subject to compliance with the following conditions:

a) The developer shall notify adjoining residents of demolition works seven (7) working days prior to demolition. Such notification is to be clearly written on A4 size paper giving the date demolition will commence and be placed in the

letterbox of every premises (including every residential flat or unit, if any) either side, immediately at the rear of, and directly opposite, the demolition site.

b) Prior to demolition, the applicant shall erect a sign at the front of the property with the demolisher's name, licence number, contact phone number and site address.

c) Prior to demolition, the applicant shall erect a 1.8m high temporary fence and hoarding between the work site and any public property (footpaths, roads, reserves etc). Access to the site shall be restricted to authorised persons only and the site shall be secured against unauthorised entry when work is not in progress or when the site is otherwise unoccupied.

d) Suitable erosion and sediment control measures in accordance with an approved erosion and sediment control plan shall be installed prior to the commencement of demolition works and shall be maintained at all times.

e) A Work Plan prepared by a suitably qualified person in accordance with AS 2601 'Demolition of Structures' shall be completed prior to demolition works commencing. The Work Plan shall identify hazardous materials including surfaces coated with lead paint, method of demolition, the precautions to be employed to minimise any dust nuisance and the disposal methods for hazardous materials.

f) If the property was built prior to 1987, an asbestos survey shall be carried out by a suitably qualified person prior to demolition. If asbestos is found, a WorkCover Authority licensed contractor shall remove all asbestos in accordance with the requirements of the WorkCover Authority, including notification of adjoining neighbours of asbestos removal.

g) The burning of any demolished material on site is not permitted and offenders will be prosecuted.

h) Care shall be taken during demolition to ensure that existing services on the site (i.e. sewer, electricity, gas, phone, etc.) are not damaged. Any damage caused to existing services is to be repaired by the relevant authority at the expense of the applicant.

(18) **Environmental Protection Licence** - Should any element of the approved development require an environmental protection licence this must obtained from the NSW Environment Protection Authority.

(19) **Site Fencing** - The site shall be fenced to prevent unauthorised access of persons to the site. Where there is no solid fencing to the perimeter of the site a chain wire fence with a minimum height of 1.8m is to be erected. All fencing (existing and required by this condition) is to be fitted with shade cloth fixed to the surface of each fencing panel to assist in controlling in the movement of particles from the site. The fencing and shade cloth is to be erected prior to the commencement of work on site and is to remain in good working order during the remediation work on site.

3.0 - During Works

The following conditions of consent shall be complied with during the construction phase of the development.

(1) **Unexpected Finds Contingency (Remediation)** - Should any additional contamination or hazardous materials be encountered during any stage of the remediation process, all remediation works in the vicinity of the findings shall cease and compliance with the contingency recommendations in the approved remediation action plan shall be adopted.

(2) **Soil, Erosion, Sediment and Water Management – Implementation** - All requirements of the erosion and sediment control plan and/or soil and water management plan shall be maintained at all times during the works and any measures required by the plan shall not be removed until the site has been stabilised.

(3) **Erosion and Sedimentation Control** - Soil erosion and sedimentation controls are required to be installed and maintained for the duration of the works. The controls must be undertaken in accordance with version 4 of the Soils and Construction – Managing Urban Stormwater manual (Blue Book).

(4) **Location of Stockpiles** - Stockpiles of soil shall not be located on / near any drainage lines or easements, natural watercourses or water bodies, footpath or roadway without first providing suitable protective measures adequate to protect these water bodies. All stockpiles of contaminated materials shall be suitably covered to prevent dust and odour nuisance.

(5) **Disposal of Stormwater** - Water seeping into any site excavations is not to be pumped into the stormwater system unless it complies with relevant EPA and ANZECC standards for water quality discharge.

(6) **Delivery Register** - The applicant must maintain a register of deliveries , which includes date, time, truck registration number, quantity of fill, origin of fill and type of fill delivered. This register must be made available to Council officers on request and be provided to the Council at the completion of the development.

(7) **Fill Material** - For the Importation and/or placement of fill material on the subject site, a validation report and sampling location plan for such material must be provided to and approved by the Principal Certifying Authority.

The validation report and associated sampling location plan must:

a) be prepared by a person with experience in the geotechnical aspects of earthworks;

b) be endorsed by a practising geotechnical engineer;

c) be prepared in accordance with;

Virgin Excavated Natural Material (VENM):

i) the Department of Land and Water Conservation publication "Site investigation for Urban Salinity"; and

ii) the Department of Environment and Conservation - Contaminated Sites Guidelines "Guidelines for the NSW Site Auditor Scheme (Second Edition) - Soil Investigation Levels for Urban Development Sites in NSW".

d) confirm that the fill material;

i) provides no unacceptable risk to human health and the environment;

ii) is free of contaminants;

iii) has had salinity characteristics identified in the report, specifically the aggressiveness of salts to concrete and steel (refer Department of Land and Water Conservation publication "Site investigation for Urban Salinity");

iv) is suitable for its intended purpose and land use; and

v) has been lawfully obtained.

Sampling of VENM for salinity of fill volumes:

e) less than 6000m3 - 3 sampling locations;

f) greater than 6000m3 - 3 sampling locations with 1 extra location for each additional 2000m3 or part thereof.

For e) and f) a minimum of 1 sample from each sampling location must be provided for assessment.

Sampling of VENM for Contamination and Salinity should be undertaken in accordance with the following table:

Classification of Fill Material	**No of Samples Per Volume**	**Volume of Fill (m^3)**
Virgin Excavated Natural Material	1 (see Note 1)	1000 or part thereof

Note 1: Where the volume of each fill classification is less than that required above, a minimum of 2 separate samples from different locations must be taken.

(8) **Offensive Noise, Dust, Odour and Vibration** - All work shall not give rise to offensive noise, dust, odour or vibration as defined in the *Protection of the Environment Operations Act 1997* when measured at the property boundary.

(9) **Construction Hours** - All work (including delivery of materials) shall be restricted to the hours of 7.00am to 5.00pm Monday to Saturday inclusive. Work is not to be carried out on Sundays or Public Holidays.

(10) **Traffic Management Plan Implementation** - All construction traffic management procedures and systems identified in the approved Construction Traffic Management

Plan shall be introduced and maintained during construction of the development to ensure safety and to minimise the effect on adjoining pedestrian and traffic systems.

(11) **Site Signage** - A sign shall be erected at all entrances to the site. The sign shall be constructed of durable materials, be a minimum of 1200mm x 900mm, and read as follows:

"WARNING UP TO $1,500 FINE. It is illegal to allow soil, cement slurry or other building materials to enter, drain or be pumped into the stormwater system. Camden Council (02 4654 7777) – Solution to Pollution."

The wording shall be a minimum of 120mm high and the remainder a minimum of 60mm high. The warning and fine details shall be in red bold capitals and the remaining words in dark coloured lower case letters on a white background, surrounded by a red border.

(12) **Supervision of Remediation Works** - A qualified and experienced environmental consultant who is familiar with the approved Remediation Action Plan (RAP) will be required to be onsite full time to provide full time supervision throughout the first stage of excavation and remediation works. The consultant is to ensure that such works are undertaken in accordance with the RAP and conditions of this consent. After the completion of the first stage of works, the consultant is required to attend the site a minimum of once per week when remediation is being conducted to ensure that the RAP and conditions of consent are being complied with.

(13) **Remediation Work** - All remediation work must comply with relevant requirements of the NSW WorkCover Authority, including the management of stockpiles and contaminated materials.

(14) **Removal of Waste Materials** - Where there is a need to remove any identified materials from the site that contain fill / rubbish / asbestos, this material will need to be assessed in accordance with the NSW DECC Waste Classification Guidelines (November 2014) (refer http://www.epa.nsw.gov.au/wasteregulation/classify-guidelines.htm) Once assessed, the materials will be required to be disposed to a licensed waste facility suitable for the classification of the waste.

(15) **Air Quality** - Vehicles and equipment used on site must be maintained in good working order and be switched off when not operating. The burning of any waste material is prohibited.

(16) **General Requirement** - All activities associated with the development must be carried out in an environmentally satisfactory manner as defined under Section 95 of the *Protection of the Environment Operations Act 1997*.

(17) **Monthly Environmental Monitoring and Performance Reporting** - The applicant must throughout the entire period of remediation works and, until the remediation works have been completed and the site validated, conduct regular environmental monitoring and prepare and submit to the Consent Authority on a monthly timeframe a Monthly Environmental Monitoring and Performance Report.

In addition to ensuring consent compliance, the report will allow the review of environmental performance from remediation works with respect to the potential

levels of odour and noise generation. The assessments must be undertaken by a qualified environmental consultant and be conducted when actual remediation works are at their worst. Monitoring shall be undertaken at the boundaries of the most potentially affected residents / premises located down wind of the remediation works.

The report must include as a minimum:

a) A minimum of four (4) monitoring points on each of the four boundaries is to be established;
b) Monitoring for odour and noise levels when the site is in operation shall be undertaken every morning, at midday and in the afternoon at a minimum of 2 hour intervals at established locations where sensitive receptors are located.
c) Monitoring for any findings of asbestos contamination.
d) A copy of the complaints register for the month and details of how complaints were addressed and resolved;
e) Identification of any non-compliance with the conditions of consent that includes odour and noise
f) Details of additional measures to be implemented to address any non-compliance.
g) Details relating to the excavated volumes and types of materials (in tonnes) that have been excavated, sorted as part of the remediation works and, how much waste material (in tonnes) that have been disposed off- site.
h) Details of volumes of all fill (VENM) material (in tonnes) brought onto the site.
i) A copy of the current delivery register.

The first report must be submitted to the Consent Authority within one month after the commencement of excavation works that forms part of the remediation works and every month thereafter.

(18) **Storage and Treatment of Leachate** - Where liquid leachate or groundwater is extracted from the landfill as a result of remediation works, the leachate/groundwater is not permitted to be re-used on site for any purpose. The storage and treatment of liquid leachate or groundwater must be in enclosed bladders or containers suitable for the purpose. The bladders or holding tanks must be bunded and not allow the release of odour from the stored liquid into the atmosphere.

(19) **Landfill Gas** - Where the compositional analysis of the landfill gas determines that the gas is odourous or potentially hazardous, the applicant shall ensure that appropriate controls are implemented to mitigate any odour impact or hazard.

(20) **Offensive Odour** - Where a Council Authorised Officer or an Authorised Officer (under the *Protection of the Environment Operations Act 1997*) deems that offensive odour has occurred beyond the boundary, then the carrying out of remediation works approved by this development consent must cease immediately until the offensive odour has been eliminated or is controlled to the satisfaction of the Authorised Officer.

(21) **Bunding and Containment Systems** - Where there is a potential for any stored material/s to spill and cause environmental harm, suitable bunding or alternative spill containment systems must be in place. The bunding or containment systems must be designed, engineered and constructed to be suitable for the types of material and quantities stored.

(22) **Vehicle Decontamination** - All vehicles that come in contact with contaminated materials will need to be swept down prior to exiting the site. The movement of vehicles should be policed so as reduce their contact with contaminated materials.

(23) **Telephone Complaint Line** - Consistent with the "Community Consultation Plan", the applicant/owner/site Manager must operate, for the duration of the remediation works, a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to remediation / demolition / construction works undertaken on the site. The complaint line is to be available 24hours per day seven days a week.

(24) **Notification of Complaint Line** - The Applicant / Owner / Site Manager must notify the public of the existence of a complaints phone line and number. Community notification must be via a letter box drop to all premises (including residential, commercial, industrial) located in the immediate area enclosed by Queen Street (both sides), Leicester Street, Somerset Avenue (both sides) and Camden Valley Way. In addition, a sign notifying the complaint line details must be erected in a prominent position on the front boundary of Elyard Street and must remain until the completion of remediation works. These contact details are to be available throughout the period of work.

(25) **Recording of Complaints and Register** - Consistent with the "Community Consultation Plan", the Applicant / Owner / Site Manager of the site must keep a legible record of all complaints in a register that have been received in relation to the activity of remediation and / or demolition works undertaken on the site. A record of all complaints must be kept for the duration of site remediation works and be produced to any Council Authorised Officer under *the Protection of the Environment (Operations) Act 1997*.

The record must include the following detail:

(a) The date and time of the complaint;

(b) The method by which the complaint was made;

(c) Any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;

(d) The nature of the complaint;

(e) The action/s taken by the applicant / owner / site manager in relation to the complaint, including any follow-up contact with the complainant; and

(f) If no action was taken by the applicant / owner / site Manager, the reasons why no action was taken.

(26) **Access Driveway** - The access from Elyard Street must accommodate heavy vehicles in accordance with AS 2890 and Council's Engineering Specifications. Approval of any new or modified driveway is subject to a Public Road Activity application.

(27) **Noise During Work** - All work shall not give rise to an 'offensive noise' as defined in the *Protection of the Environment (Operations) Act 1997*.

All work shall comply with the requirement of the NSW Industrial Noise Policy and the Environment Protection Authority's Environmental Noise Manual.

(28) **Public Nuisance** - All work shall not give rise to noise, dust, odour or vibration that causes a nuisance to the public (that includes residents) as defined under the *Local Government Act 1993*.

(29) **Noxious Weeds Management** - The applicant must fully and continuously suppress and destroy, by appropriate means, any noxious or environmentally invasive weed infestations that occur during or after works. New infestations must be reported to Council.

Pursuant to the *Noxious Weeds Act 1993*, the applicant must at all times ensure that any machinery, vehicles or other equipment entering or leaving the site are clean and free from any noxious weed material.

(30) **Environmental Protection Licence** - Should any element of the approved development require an environmental protection licence this must obtained from the NSW Environment Protection Authority.

(31) **Stop Work in Windy Conditions** - All excavation, processing and stockpiling works must cease in windy conditions (being wind speeds in the vicinity of all excavation, processing and stockpiling works of 36km/hr or more in accordance with the Blue Book). Wind speeds must be constantly monitored around all excavation, processing and stockpiling work to facilitate compliance with this condition.

(32) **Abestos Testing** - All off site laboratory testing for any suspected or identified asbestos findings must be completed within 24 hours.

(33) **Truck Movements** - Truck movements to and from the site must reach the site from Camden Valley Way via Somerset Avenue and Elyard Street. Trucks leaving the site must reach Camden Valley Way via Elyard Street and Somerset Avenue.

Truck and dog movements are limited to a maximum of 5 per hour up to a maximum of 25 per day. However should this need to increase as a result of any unexpected finds or other unplanned occurrence Council must be notified in writing.

(34) **No Work During the 2016 Christmas/New Year School Holidays** - No works are permitted during the 2016 Christmas/New Year School Holidays.

4.0 – Following Completion of Works

The following conditions of consent shall be complied with following completion of the works.

(1) **Long Term Management Plan** - Any proposed or final long term management plan relating to the remediation or monitoring or management of the site must be provided to the Consent Authority for review and written approval prior to the plan being included into any Site Audit Statement applicable to the land.

(2) **Validation Report** - A validation report prepared by a suitably qualified person shall be provided to the PCA within 60 days of completion of the remediation works which demonstrates:

a) compliance with objectives of the approved RAP;

b) that the remediation acceptance criteria (in the approved RAP) has been fully complied with;

c) that all remediation works comply with the contaminated lands planning guidelines, *Contaminated Lands Management Act 1997* and SEPP 55;

and includes:

d) Works-As-Executed Plan(s) that identify the extent of the remediation works undertaken (that includes any encapsulation work) prepared by a registered surveyor;

e) a "notice of completion of remediation work" as required under Clause 18 of SEPP 55; and

f) a statement confirming that the site following remediation of contamination is suitable for the intended use.

(3) **Site Audit Statement (SAS)** – An EPA accredited Site Auditor will be required to provide a Site Audit Statement (SAS) in accordance with the contaminated lands planning guidelines, Contaminated Lands Management Act 1997, SEPP 55, and Council's Contaminated Lands Policy confirming that the land is suitable for the intended use. The SAS shall be provided to the consent authority 60 days following the completion of remediation works.

DART WEST DEVELOPMENTS

REVISED REMEDIATION ACTION PLAN
3 ELYARD STREET, NARELLAN, NSW

Report E1445 AT_RAP_Rev 3
31 August 2016

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REPORT DISTRIBUTION

Revised Remediation Action Plan
3 Elyard Street, Narellan, NSW

EI Report No.: E1445 AT_RAP Rev 3
Date: 31 August 2016

Copies		Recipient
1	Soft Copy (PDF – Secured, issued by email)	Dart West Developments PO Box 228, Narellan, NSW, 2567
1	Soft Copy (PDF)	Mr Rod Harwood, NSW EPA Accredited Site Auditor. Environmental Strategies Pty Ltd
	Original (Saved to Digital Archives)	Environmental Investigations Suite 6.01, 55 Miller Street PYRMONT NSW 2009

Author	Approval
for **MALCOM DALE** Snr Principal / Contaminated Land	**ERIC GERGES** Senior Environmental Engineer

Revision	Details	Date	Amended By
Rev 0	Original	19 October 2015	Malcolm Dale
Rev 1	Client comments	12 November 2015	Malcolm Dale / G Brickle
Rev 2	Updated with Auditor Comments	24 December 2015	Malcolm Dale
Rev 3	Response to Council Comments	31 Aug 2016	Nik Kontos

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TABLES

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FIGURES (IN TEXT)

FIGURES (end of text)

APPENDICES

EXECUTIVE SUMMARY

Dart West Developments engaged Environmental Investigations Australia Pty Ltd (EI) to prepare a Revised Remediation Action Plan (RAP) for soils and groundwater impacted by contaminants at 3 Elyard Street, Narellan, NSW, ('the site'). The client proposes the rehabilitation of the former landfill at the site to allow the future construction of commercial and residential properties suitable for the Camden Council zoning. Any proposed development would be subject to a separate development application once the site is considered suitable by a NSW EPA accredited site auditor.

The main objective of the RAP is to excavate the former landfill to render the site soils, soil vapour and groundwater suitable for future beneficial land use. This RAP will guide site remediation, validation and additional investigation work by:

- Providing details on how to carry out remediation works in a safe and environmentally friendly manner, while minimising impacts; and
- Providing a sampling and quality plan (SAQP) to be used for site validation.

Previous investigations undertaken indicate that the former brick pit was filled with construction waste (bricks, bitumen, steel, concrete, timber, etc.) and various unknowns (plastic, minor putrescible material and potentially asbestos). Part of the site also contain the demolished brickworks and waste bricks. The water table in the former quarry varies between 1.4m to 3.9m below the surface from the seepage and rainfall infiltration. Landfill gas (methane and carbon dioxide) has been identified in parts of the landfill and the immediately surrounding land that presents a risk to potential development of the site. The adopted remedial strategy for the impacted fill materials considered most appropriate for the current scenario is excavate, reprocess and reuse suitable geotechnical materials (bricks, concrete, soil and rock) and treat, dispose or recycle unsuitable materials (metal, asbestos, timber waste, plastic and organic waste). The following works are required to remediate the former quarry and landfill:

- Planning approvals under the Environmental Planning and Assessment Act;
- Site establishment including environmental and soil and water controls;
- Dewatering of landfill materials, treatment, reuse and/or disposal to approved location
- Excavation of former landfill/quarry, segregation of waste, treatment, classification and reuse of suitable materials or disposal or recycling of materials that are not suitable for backfilling in accordance with NSW EPA guidelines; and
- Validation sampling of the site works including landfill gas.
- Following completion of the remediation works, a Validation Report will be prepared in accordance with the OEH (2011) Guidelines for Consultants Reporting on Contaminated Sites stating that the results of remediation and site validation assessment meet the criteria for suitable beneficial land use.
- Sign off of the site works by the NSW EPA site auditor.

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IMPORTANT TELEPHONE NUMBERS

Role /Service	Name / Service Provider	Contact Number
Project Site Manager:	TBA	
Principal Contractor	TBA	
Council	Camden	
Hospital:	Campbelltown Hospital	4634 3000
Police, Fire, Ambulance:		000
Telstra		13 22 00
Electrical:		131 388
Water	Sydney Water	132 092
Gas	AGL	131 909

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1. INTRODUCTION

1.1 BACKGROUND

Dart West Developments at the request of Diblar Pty Limited , Jimbalia Pty Limited, Greenfields Development Corporation Limited, and D Vitocco Constructions Pty Limited, engaged Environmental Investigations Australia Pty Ltd (EI) to prepare a Revised Remediation Action Plan(RAP) for soils and groundwater impacted by contaminants at 3 Elyard Street, Narellan, NSW(('the site').

The site is located in the Narellan Township, within the Local Government Area of Camden City Council (Council) (see **Figure 1** at rear of text) and comprises one lot with an area of approximately 3.45 hectares (see **Figure 2 2)**.

The site is currently unoccupied and was more recently occupied by a steel yard and a hardware store. A landfill is located at the southern end of the property and the majority of the surface has been concreted for its previous uses for the storage of steel products.

Based on the previous site investigations comprising title searches, and review of historical aerial photographs, the land was likely to have been used for farming purposes until 1946 and then used quarrying activities between 1957 and 1980, and the land filling activities are thought to have been undertaken in the 1980s. The purpose of the RAP is to address identified contamination issues to allow redevelopment of the site.

This revision supersedes earlier RAP documents prepared for the site including:

- Environmental & Earth Sciences (EES) 2006, Remediation Action Plan for Elyard Garden Residential Development 1 Elyard Street Narellan NSW(Ref No. 105082_RAP for Diblar Jimbalia Pty Ltd dated May 2006, and;
- by DLA Environmental (2011) Remediation Action Plan, 1 Elyard Street Narellan NSW(prepared for Elyard Gardens PO Box 368 Narellan 2567 Ref: DL2664 dated July 2011

The RAP has incorporated available data from the many site investigations (see **Appendix A and Appendix B**) and addresses feedback received from the Camden Council, and the Site Auditor.

1.2 PROPOSED DEVELOPMENT

It is understood that the northern part of the site is zoned B2 "Local Centre" and southern part is zoned R3 for medium density residential development. The site remediation would be undertaken to allow some commercial development along Elyard Street with the remainder being residential. No development applications have been submitted to Council but initial discussions indicate that multistorey commercial and residential buildings with possible basements need to be considered in formulating this RAP.

It is envisaged that once remediation is nearing completion, a detailed development application would be submitted through the normal environmental planning process.

1.3 REGULATORY FRAMEWORK

The following regulatory framework and guidelines were considered during the preparation of the RAP:

- *Contaminated Land Management Act* (1997);
- Camden Council (2008) Management of Contaminated Lands Policy 3.12 and Development Control Plan PART C: Residential Subdivision, C12. 17 Contamination.
- *Protection of the Environment Operations Act* (1997) and associated Regulations including UPSS Regulations (2014) and Waste Regulations (2014).
- State Environmental Planning Policy No 55 (SEPP 55) — *Remediation of Land*, under the *Environmental Planning and Assessment Act* (1979);
- Sydney Regional Environmental Plan No 20 – Hawkesbury Nepean River (SREP No.20, No 2 1997);

- *Work Health and Safety Act* (2011) and associated Regulations and codes of practice.
- ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality;
- DECCW(2010) Vapour Intrusion: Technical Practice Note;
- DECCW(2009) Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (now 2014);
- DEC (2007) Guidelines for the Assessment and Management of Groundwater Contamination;
- DEC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition;
- EPA (1995) Sampling Design Guidelines;
- EPA (2012) Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases (the 'Ground Gas Guidelines');
- EPA (2014) Technical Note: Investigation of Service Station Sites;
- EPA (2014) Best Practice Note: Landfarming;
- EPA (2014) Waste Classification Guidelines Part 1: Classifying Waste
- EPA (2015) Guidelines on the Duty to Report Contamination under the *Contaminated Land Management Act* 1997
- EPA (2015) Technical Note: Light Non Aqueous Phase Liquid Assessment and Remediation
- NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure 1999 – Amendment 2013; and
- OEH (2011) Guidelines for Consultants Reporting on Contaminated Sites.

1.4 OBJECTIVES

The objectives of the RAP, in accordance with those given in NSW EPA, SEPP 55 guidelines and Council's contaminated land policy and with consideration of any site specific issues, are:

- Set remediation goals that meet the conditions of the consent so that the proposed redevelopment would be suitable for residential and commercial use, and would pose no unacceptable risk to human health or the environment;
- Evaluate the range of remediation options available to address the existing site contamination issues, and thereby reduce risks to acceptable levels;
- Document the preferred remediation techniques and procedures;
- Establish various environmental safeguards required to complete the remediation work in a safe and environmentally acceptable manner;
- Identify the necessary approvals and licences required by regulatory authorities in order to enable the remediation works to proceed;
- Document a remediation strategy that would address on site issues affecting future migration of contamination to and from the site.

1.5 SCOPE OF WORKS

The scope of work completed for the preparation of the RAP included:

- Review and assessment of the available data relevant to the remediation of the site and provided by the investigation reports conducted at the site and by other consultants on the adjoining land;
- Consultation with Camden Council, and the site developer;
- Consultation with the Site Auditor;

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- Review and assessment of the latest technical literature on remediation technologies relevant to the site and relevant case studies;
- Selected groundwater/leachate sampling within the landfill;
- Technical assessment of alternate remediation technologies;
- Conceptual engineering design and project planning; and
- Documentation of the preferred remediation strategy and plans in the RAP.

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2. SITE DESCRIPTION

2.1 PROPERTY IDENTIFICATION AND LOCATION

The site identification details and associated information are presented in **Table 2 1**, while the site locality is shown in **Figure 1** (at rear of text).

Table 2 1 Site Identification, Location and Zoning

Attribute	Description
Street Address	3 Elyard Street, Narellan, NSW
Location Description	The site is surrounded by commercial, residential and open space areas. These include the Narellan shopping centre to the north, a council park and equipment yard to the west and residential properties to the south and east. Elyard St. forms the northern boundary of the site.
Site Area	3.45 hectares (former quarry footprint approximately 1.1 hectares)
Site Owner	Dibblar Pty Limited , Jimbalia Pty Limited, Greenfields Development Corporation Limited , D Vitocco Constructions Pty Limited As tenants in common in equal shares.
Lot and Deposited Plan (DP)	Lot 6 in DP812672
State Survey Marks	Permanent Survey Mark PM85612 located approximately 315 m WSW from NE corner of site Permanent State Survey Mark PM46438 located approximately 187 m from east corner of site
Local Government Authority (LGA)	Camden Council
Current Zoning	B2 'Local Centre' (northern part of site) and R3 – Medium Density Residential southern part of site under Camden LEP 2010 Land Zoning Map Sheet LZN_012 (see **Figure 2 1**).

At the time of the earlier assessments, the site comprises two distinct halves. The northern half was predominantly level and covered in concrete that were a combination of yard areas and building slabs associated with the former use as a Steel Yard and Hardware Store. The former buildings have now been demolished. Discrete and localised stockpiles of demolition rubble (bricks, concrete, asphalt, steel and wood etc.) were present in this half of the site.

The southern half of the site is unsurfaced and is occupied by locally vegetated stockpiles of soil materials, which are up to approximately 10m high in places and comprise imported natural excavated materials that may be used to construct a clay cap across the former landfilled portion of the site. (See **Figure 2** at rear of text).

The site is situated within an area of mixed use and current uses on surrounding land and sensitive receptors are described in **Table 2 2**.

Figure 2 1 **Local zoning around site (Camden LEP, 2010)**

Table 2 2 **Local Land Use**

Direction	Land Use	Sensitive Receptors
North West	Elyard Street and Narellan Shopping Centre, Zoning B2	Retail use across Elyard St, Cross Creek
South West	Camden Council and Library, Play Ground, Cross Creek, Residential across Queen Street	Public recreation and Cross Creek, Residential beyond.
North East	Commercial (Medical suites) and Residential	Residential properties immediately beyond the eastern site boundary
South East	Parkland and residential dwellings off Leicester Street	Public Recreation Area & Residential

The closest sensitive environmental receptors include the following:

- Cross Creek located approximately 150m west and northwest and down gradient of the site.

2.2 SITE HISTORY

Based on the available information (sources documented in **Section 3.1**), the history of the site can be summarised as follows:

- Pre 1946 – Farming purposes;
- 1947 to 1956 – Goods storage by Clinton Distributions;
- 1957 to 1980 Quarrying / brick pit within the centre of the site, an inclined access road was noted on the north western face;
- The 1976 aerial photograph indicated the quarry was ¾ filled with water. A former creek was located approximately 120m northwest of the site running north south and former drainage channels were noted running between the site and the creek. A former dam (approximately 25m x 25m) was present 60m northwest of the site.
- 1982 – Metropolitan Waste Disposal Authority granted a certificate of registration for disposal of non putrescible and demolition solid waste (including asbestos waste). No records of the quarry dimensions were available.
- 1984 – Aerial photograph indicated the western side of the quarry was infilled and vegetated suggesting this side of the landfill was the first to be completed. The southern side of the landfill was infilled by 1984 but not yet vegetated and part of the eastern side appeared freshly laid.
- 1994 – Aerial photograph indicated the quarry was completely infilled. No hardstand was present at the site.

Following completion of the landfilling, the site was covered with a clay capping material (reportedly between 1990 and 1994). A Steel Yard and Hardware Store with associated concrete hard standing was then constructed on the northern half of the site (reportedly prior to 1998).

The site was acquired by the current owners in 2004.

2.3 LOCAL SETTINGS

The local setting including local ground topography and soil landscape is summarised in **Table 2 3**.

Table 2 3 Local Setting

Attribute	Description (source)
Topography	The site has an overall slope from the south east to the north west. Due to quarrying activities, the site is benched with the natural ground surface still existing along the south eastern boundary at an elevation of approximately 103m AHD. In a north westerly direction, the ground level rapidly drops away as it reaches the quarry face (in the approximate mid point of the site) at an elevation of approximately 92m AHD. Along Elyard Street the hardstand level slopes from approximately 93.5m AHD in the north east corner down to approximately 90m AHD in the north west corner. The general topographic gradient from south east to north west continues across Elyard Street, where ground level dips steeply between one to several metres below the site level.
Soil Landscape	The 1:100,000 scale Wollongong – Port Hacking Soil Landscape Series Sheet (9029 – 9129) indicates that residual soils of the Blacktown Landscape are present beneath the site which consists of shallow to moderately deep (<1 metre) hard setting, mottled texture contrast soils. Colour ranges from red to brown grading to yellow podzolic soils on the lower slopes and in the drainage lines.
Site Drainage	A stormwater drainage system consisting of subsurface pipes and surface grates exists in the northern half of the site, draining to Elyard Street. Stormwater drainage in the southern half of the site is expected to be via surface run off or direct infiltration into unsealed local depressions.

Attribute	Description (source)
Sewer/Other services	The nearest sewer lines run along the NE boundary in the northern corner and there is a boundary connection on the SW boundary toward the NW corner. There is a low risk of other utility cables on site but old services may be encountered during site works.

2.4 Local Geology & Subsurface Conditions

The 1:100,000 scale Wollongong – Port Hacking Geological Series Sheet (9029 – 9129) indicates that the residual soils are underlain by Bringelly Shale of the Wianamatta Group, which consist of shale, carbonaceous claystone, laminate and coal in parts.

A Section 149 Certificate states that the site is within a proclaimed Mine Subsidence District and may be affected by surface development controls to prevent damage from old, current or future coal mining.

The subsurface conditions encountered during the various investigation are divided into 4 subsections and comprised:

- **Pavements**: bitumen and concrete pavement (mostly in Area C & D) underlain by a sub base layer of fine crushed rock. The depth of pavements ranged from 0.2 metres to 0.4 metres (GDK, 2007). Estimated volume of concrete is 1,700m^3 (assuming average 0.15m thick pavement)
- **Fill**: silty clay, medium to high plasticity, orange to red and grey, moist and stiff. Encountered across the property outside the Quarry area (particularly Areas A & C and some on Area B). Area C had a large percentage of bricks (some of which appeared to be stacked) and other concrete slabs and may have resulted from the brickworks decommissioning or demolition (CES, Feb 2010). Capping material in Areas A and part B have been stockpiled for future remediation works.
- **Landfill material**: building demolition materials, including timber, brick, concrete, steel and pipe, silt and some clay, grey and dark grey in colour, poorly compacted and saturated. Free water was present throughout the test pits to within about 2.0 metres of the surface (GKD, 2007).
- **Residual soils**: silty clays and shale materials; grey brown and orange to red and grey in colour, moist to wet and firm.
- **Bedrock**: shale, highly weathered to slightly weathered, grey, dry to moist and very stiff to hard. Encountered around the perimeter of the Quarry and beneath the landfill in the developed area of the subject property.

The observed stratigraphy of shallow fill, landfill material and overlying the residual soil and weathered bedrock profile is summarised in **Table 2 4.**

Table 2 4 Summary of Inferred Subsurface Conditions

Area[1] (m^2)	Material	More Recent Boreholes	Depth Fill (mBGL)	Estimated Volume (m^3)	Comments
A (8,600)	Imported capping	GWM05 107, GWM11, L5, L6, P3, P4 P5	0.2 – 8.2+	20,500	Stockpiled above southern edge of quarry and extending into Area B (J Wyndham Prince Survey, 2011)
B (11,000)	Landfill in former quarry	F1 F4, GWM08 110, GWM12 113, MW8 4, MW5, MW10, P2, P6	>11m (to approx. RL 82 mAHD	95,800[2] 123,000[3]	EIWSP (2012) cross sections indicate quarry floor at RL 82 84 mAHD. Some of this volume is capping material.
C (7,600)	Brickworks fill	GWM01, L1 2, MW2, MW84,	0.4 – 4.6	19,000[4]	May contain some landfill material closer to area B. Other concrete slabs also encountered in

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Area[1] (m²)	Material	More Recent Boreholes	Depth Fill (mBGL)	Estimated Volume (m³)	Comments
		MW84D, MW5 5D, MW8, P1			excavations (CES, 2010). Including concrete pavements
D (7,700)	Residual soils & Shallow bedrock	GW102 104, L3AVB, L4, MW21	0.25 – 1.35	4,000[4]	Including concrete pavements
GW	Groundwater		Approx. RL 90.5 m in landfill (2013)	17MI[5] 23MI[5]	Not including possible extension into Area C.

Notes:
1 Area estimated from six maps (http://maps.six.nsw.gov.au/), see **Figure 3 1**
2 EES, 2004 ESA
3 Using 82mAHD as quarry base, average surface RL and estimated area
4 Estimated using average depth in test pits and boreholes
5 Based on 8.5m saturated thickness, 0.25 porosity over Area B, does not include Area C water volume

2.5 LOCAL HYDROGEOLOGY

Three groundwater types were identified beneath the site:

- a perched water table intercepted within fill material at the north western site corner;
- leachate contained within the landfill cell; and
- a regional aquifer which is confined by an aquitard at a depth of approximately 80 mAHD (approximately five metres below the estimated depth of the landfill cell).

Leachate within the landfill cell contained concentrations of toluene and phenols exceeding the site criteria (EES, 2006). EES considered that the leachate was potentially migrating from the landfill and impacting the surrounding aquifer in the immediate vicinity of the landfill. These impacts based on the site testing were, however, considered to minimal.

At the Narellan site, groundwater depth would also be influenced by the landfilled area, underlying services and the various cutting and filling. The local hydrogeology is summarised in **Table 2 5.**

Table 2 5 Local Hydrogeology

Attribute	Description (source)	Influence on Remediation
Depth to Groundwater	0.8 – 9.3 m, average 2.9 mBGL (deeper groundwater at rear of site in areas A and the southern part of B.	Depth to water in landfill between 2 and 3m depending on rainfall and infiltration. (also see volume calculations in Table 2 4)
Aquifer Types	Perched water, water within landfill material and deeper water within shale bedding planes and discontinuities	Some seepage may enter excavation during site works.
Nearest Surface Water Feature	Cross Creek 150 m west & NW of site	
Hydraulic Gradient (i)	0.005 – 0.02 (EIWSP, Aug 2012)	

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Attribute	Description (source)	Influence on Remediation
Groundwater Salinity	Analytical results indicate a total dissolved solids in deeper groundwater up gradient of the landfill to be 1,800mg/L (MW21) and higher (other deep wells). The groundwater is therefore considered unsuitable for the majority of beneficial uses. High salinity is typical of the Bringelly Shale Aquifer. As such, aquatic ecosystems are the only beneficial use considered.	May require sampling to assess whether can be pumped to storm water or sewer
Hydraulic conductivity	44 m/d landfill (EIWSP, Aug 2012), 3.4×10^{-2} m/d shales (PPK, 2000)	Dewatering of landfill required to allow excavation of solid landfill materials.

The localised groundwater flow direction is toward the north west and depicted in **Figure 2 2**. The groundwater flow direction reflects the general topographic slope.

Figure 2 2 Inferred shallow groundwater contours 2012

Contours in mAHD (Source: EIWSP, Aug 2012)

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2.6 Background Soil and Groundwater Quality

No specific sampling of background soil and groundwater quality has been undertaken at the site, however, samples from the surficial shale soils shows low level concentrations of heavy metals. Background groundwater quality would be considered to be in the up gradient wells from the landfill including BH32, GWM06 and GWM07 near the southern boundary of the property. Background water quality is likely to be saline with salinity from 5,000 50,000 mg/L (McNally, 2004), low dissolved metals and low ammonia.

2.7 Local Groundwater Use and Groundwater Bore Records

No groundwater is used in the immediate area for domestic or industrial purposes. Groundwater within the fractured bedrock and surficial seepage at the site would migrate toward and provide environmental flow into Cross Creek. It is noted that the area is located in a highly urbanised environment and no sensitive ecosystems are located in the immediate area.

A search of registered groundwater bores by EI on the 15 October 2015 through the NSW Department of Primary Industries database (Ref. http://allwaterdata.water.nsw.gov.au/water.stm), identified no registered bores within a 500 m radius of the site (see **Figure 2 3**), except those on site. Six monitoring wells are within approximately 1 km radius of the site, with one well to the north east, and five wells to the north west across Cross Creek in the former Ampol service station at Narellan. EI considers that these wells are not hydraulically connected to the site or are receptors from the site.

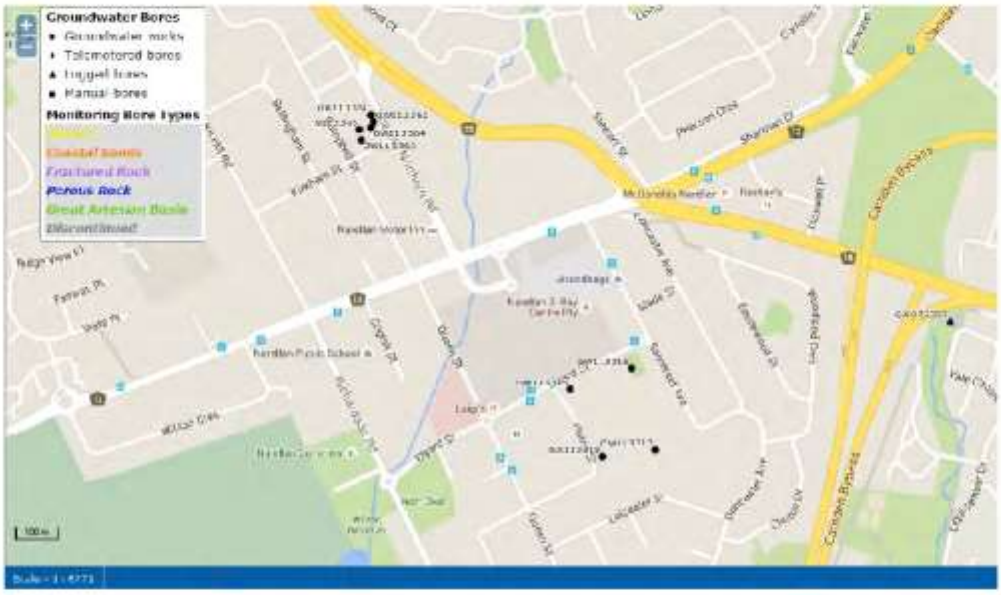

Figure 2 3 Registered bore locations (DPI Water)

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3. SITE CHARACTERISATION

3.1 PREVIOUS INVESTIGATIONS

Previous investigations undertaken at the site since 2003 include:

- SMEC, 2003. 1 Elyard Street, Narellan Preliminary Environmental Investigation Final Report. Reference 31342.033;
- Environmental and Earth Sciences (EES), 2004. Detailed Site Assessment of 1 Elyard Street, Narellan, New South Wales. Report No. 104080;
- EES, 2006. Remediation Action Plan for Elyard Garden Residential Development, 1 Elyard Street, Narellan, NSW. Report No 105082_RAP;
- Emerson Associates, July 2011, Elyard Street Joint Venture, No 1 Elyard Street, Narellan, NSW, Groundwater Report. Reference 1111/JE/110706/C;
- DLA Environmental, July 2011. Remediation Action Plan, 1 Elyard Street, Narellan, NSW. Reference DL2664;
- Environmental Investigations, EI (31st January 2012) Former Landfill 1 Elyard Street, Narellan, NSW, Gas And Groundwater Monitoring Investigation. Report No E1445.1 GW.

Other documents considered include:

- Environ (2005) Interim Opinion letter No. 1 1 Elyard Street. Narellan, dated 21 April 2005;
- Environ (2006) Interim Opinion Letter No. 2 Review of Remediation Action Plan 1 Elyard Street, Narellan.19 May 2006 Ref: 31 0368;
- Environmental Strategies (2011) 11089 L01 Interim Advice 1- Review of Remediation Strategy.docx 1 Elyard Street, Narellan, NSW Interim Advice Number 1 – Review of Remediation Strategy (Ref: 11089 L01 Interim Advice 1- Review of Remediation Strategy.docx, dated 4 October 2011);
- Environmental Strategies (2011) 1 Elyard Street, Narellan, NSW Interim Advice Number 2 – Review of Preliminary Long Term Management Plan (Ref: 11089 L01 Interim Advice 2, dated 5 December 2011), and;
- Environmental Strategies (2012) 1 Elyard Street, Narellan, NSW Interim Advice Number 3 – Review of Gas and Groundwater Monitoring (Ref: 11089 L03 Interim Advice 3, dated 8 February 2012).

3.2 EXTENT OF INVESTIGATIONS

To date, the following, test pit, boreholes, monitoring wells and soil vapour points have been installed.

Table 3 1 Summary of Intrusive Investigations

Type (number)	ID	Depths (min/max) (m)	Date	Source
Testpits (5) Boreholes (8) Monitoring Wells (3)	TP1 – TP5 H8 – H15 TP2, TP4, TP5	4.5/6.8 0.13/0.34	Mar – Apr 2003	SMEC, 2003
Surface Samples (7) Boreholes (33) Monitoring Wells (8)	SS1 – SS7 BH1 – BH33 BH6, 7, 9, 11, 30, 31, 32 & 33	0.2 0.5/23.5 2.45/23.5	Jul – Oct 2004	EES, 2004
Testpits (9)	CTP1 – CTP9	1.7/4.6	Jan 2010	CES, 2010
Monitoring Wells (13)	GWM01 – GWM13	3.24/6.05	Sep/Oct 2011	EIA, 2011

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Type (number)	ID	Depths (min/max) (m)	Date	Source
Monitoring Wells (20)	F1 – F4 L1 – L6 P1 – P6 BH5D, BH34S, BH34D, GWM08D	6/11.8 4.2/18/2 10/18.1 15/18	May – Jun 2012	EIAWSP, 2012
Test pits (3)	TP1201 – TP1203	2/3	Jun 2012	EIAWSP, 2012

The extent of the investigation data is shown in **Figure 3 1** and **Figure 3 2.**

3.3 SUMMARY OF RESULTS

3.3.1 Soils

The available soils contamination data from the various reports is summarised in **Table 3 2.**

Table 3 2 Summary of Soil Analytical Results

No. primary samples	Analyte	Min. Conc. (mg/kg)	Max. Conc. (mg/kg)	Sample locations exceeding investigation levels
Hydrocarbons				
23	TPH C_6–C_9	<2	<25	None
23	TPH C_{10} C_{36}	ND	11,300	BH7_1.8 2 (10,000mg/kg TPH C_{15} C_{28})
14	Benzene	<0.5	<0.5	None
14	Toluene	<0.5	<0.5	None
14	Ethyl benzene	<0.5	<0.5	None
14	Total xylenes	<1.0	<1.5	None
28	PAHs	ND	11.5	None
28	Benzo(a)pyrene	<0.1	1.1	None
OCPs				
3	OCPs	ND	ND	None
Heavy Metal				
36	Arsenic	3	19	None
36	Cadmium	<0.5	5	None
36	Chromium (Total)	5	34	None
36	Copper	7.5	94	None
36	Lead	7	50	None
36	Mercury	0.02	<0.1	None
36	Nickel	2.5	41	None
36	Zinc	18	140	None

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3.3.2 Groundwater/Leachate

The groundwater/leachate water quality data from the various reports is summarised in **Table 3 3**.

Table 3 3 Summary of Water Quality Analytical Results

No. Primary samples	Analyte	Min. Conc. (mg/L)	Max. Conc. (mg/L)	Sample locations exceeding investigation levels
Hydrocarbons				
19	TPH C_6–C_9	<0.01	<0.01	none
19	TPH C_{10} C_{36}	<0.25	<0.39	none
19	Benzene	<0.001	<0.001	none
19	Toluene	<0.001	<0.001	none
19	Ethyl benzene	<0.001	<0.001	none
19	Total xylenes	<0.003	<0.003	none
19	Naphthalene	<0.001	0.004	none
Heavy Metal (filtered)				
12	Arsenic	<0.001	0.009	none
12	Cadmium	<0.0001	0.0001	none
12	Chromium (Total)	<0.001	0.003	none
12	Copper	<0.001	0.004	MW5S
12	Lead	<0.001	<0.001	none
12	Mercury	<0.0005	<0.0005	none
12	Nickel	<0.001	0.026	GWM08D, MW5S
12	Zinc	<0.001	0.065	BH32, GWM08D
PAHs/Phenols				
12	Total PAHs	<0.001	0.004	none
12	Phenols	<50	<50	none
Others				
12	Ammonia	0.04	74	BH32, BH34, BH7, F3, GWM08, MW2, MW4, MW5D
4	Ammonia	7.6	110	MW4, GWM13, GWM08, GWM09 in Dec 2015 sampling.
12	Nitrite	<0.005	5.1	
12	TDS	790	11,000	
4	Conductivity mS/cm	11.6	17.6	Screened in Shale, highest in BH34D downgradient. Lowest in BH32 upgradient
10	Conductivity mS/cm	1.3	8.9	Screened in Fill (mean 3.7 excluding 8.9 mS/cm which may be in shale)
4	BOD5	16	70	Recent sampling in MW4, GWM08, GWM09 & GWM13 (average 34 mg/L)

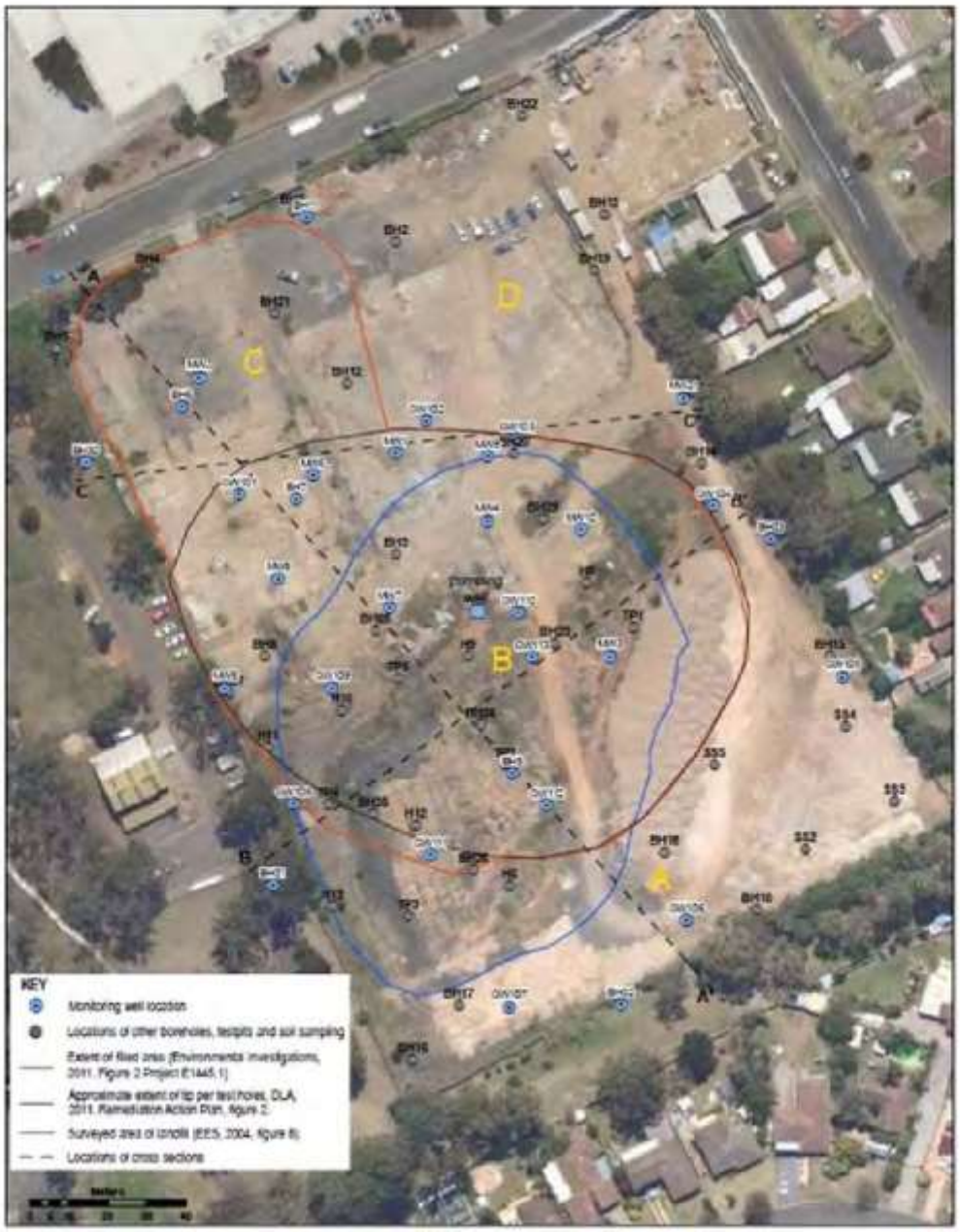

Figure 3 1 **Sample locations and extent of landfill areas**

(Source: EIAMSP, Jan 2012, Figure 2)

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Figure 3 2 Other Sampling Locations (EIA/WSP, 2013, Figure 5)

Recent sampling of selected groundwater wells (MW4, GW108, GW109 & GW113) was undertaken on the 8 December 2015 to assess the landfill leachate quality against the Sydney Water Acceptance Standards 2015 16. The results are presented in **Appendix B**. Most results were below the Sydney Water standards except Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).

3.4 GROUND GAS MONITORING

Ground gas was monitored between January 2012 and May 2013. The monitoring identified potential ground gas risk in accordance with the EPA 2012 Ground Gas Guidelines.

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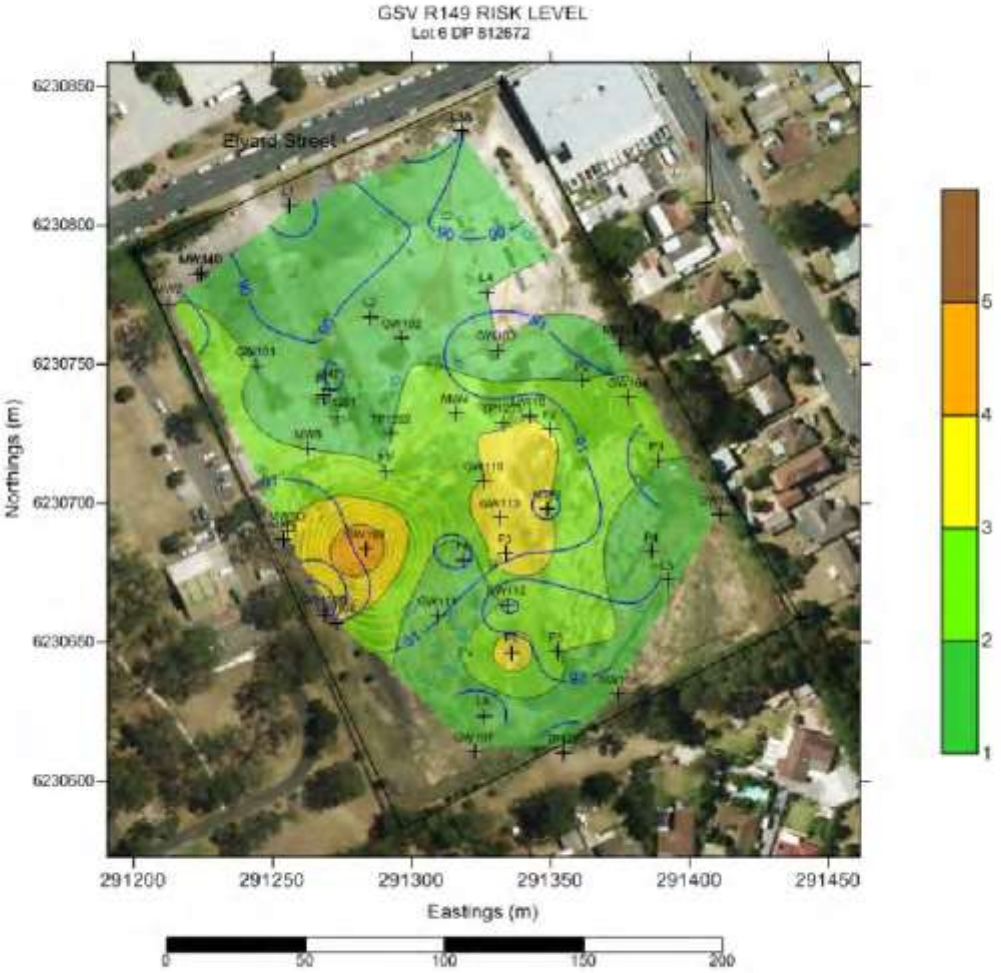

Figure 3 3 GSV risk levels identified in boreholes (EI/WSP, 2013)

3.5 INVESTIGATION DATA QUALITY

The overall investigation data quality (2003 – 2013) has been assessed by the seven step data quality objective (DQO) process to determine the data suitability in accordance with NSW EPA guidelines and is summarised in **Table 3 4**.

Table 3 4 Summary of Report Data Quality Objectives

DQO Steps (DEC, 2006)	Details	Conformance with DQOs
1. State the Problem	The site is to be developed for future beneficial land use. Contamination was identified in the soils, soil gas and groundwater that may impact on future development.	**Yes** A conceptual site model was developed showing linkages.
2. Identify the Goal of the Study (Identify the decisions)	Has the likelihood and/or extent of soil, groundwater and vapour contamination been identified from the previous investigations. Identify contamination which may be occurring at the site and non compliance with environmental regulations Recommend additional investigations and/or remediation works.	**Yes/partial** The studies have been undertaken for various purposes identified in Table xx. The overall sampling for soil gas was undertaken over 12 months to assess variability. Recommendations were provided.
3. Identify Information Inputs (to decision)	The use of proper investigation techniques. Development of a conceptual site contamination model The use of appropriate site assessment criteria and compared results as measured against these criteria	**Generally** Due to the age of the investigations some investigation methods have improved. The site assessment criteria use has also been updated (NEPM, 2013, EPA, 2012 & others)
4. Define the Boundaries of the Study	Lateral, Vertical and Temporal Sampling works undertaken in accordance with guidelines made or approved by the NSW EPA.	**Yes** The site boundary has been consistent during the works. Temporal data has also been collected.
5. Develop the Analytic Approach (or decision rule)	The decision rules for the soil and groundwater data is that they essentially comply with the NSW EPA contaminated land guidelines and by the Data Quality Indicators (DQI).	**Generally consistent**
6. Specify Performance or Acceptance Criteria (or limits on decision errors)	Laboratory test results to be measured against EPA approved criteria The site would be deemed not contaminated if soil, groundwater and soil vapour concentrations were within background levels, QA/QC data demonstrate acceptable reliability and representativeness of results to meet regulatory criteria.	**Generally** Due to the age of the investigations some investigation and analytical methods have improved.
7. Develop the Detailed Plan for Obtaining Data (Optimise the design for obtaining data)	Identify the most resource effective sampling and analysis design for general data that are expected to satisfy the DQOs. This may involve the use of field screening tests and use of biased sampling.	**Yes** Additional information has been collected based on data gaps identified in the previous investigations.

In summary EI consider that the overall data from the previous site investigations is useable (complete), comparable, representative and accurate to allow the development of a comprehensive remediation action plan.

Further it is noted the Auditor considered that there was sufficient analytical data to assist him with review of conservative control measures for potential development and to engage with the appropriate statutory authorities (ES, Ref: 11089 L03 Interim Advice No 3 dated 8 February 2012).

3.6 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) was derived for the site, assessing potential linkages between contamination sources, migration pathways and receptors and aid with site characterisation and is summarised below. The general subsurface conditions are given in Section

3.6.1 Hydrogeological model

The overall hydrogeological conceptual site model comprises:

- A shallow groundwater bearing zone is present in fill materials, shallow residual soils and the weathered top of shale bedrock. The shallow groundwater is unconfined to semi confined and represents a continuous, connected system. The groundwater gradient generally follows the topographic gradient from south east to north west. Groundwater levels across the site range from shallower than 1 mBGL in some portions of the hardstand area, to deeper than 5 mBGL in the elevated portions of the site.

  Some of the groundwater particularly in Area C (Table 2 4) is likely to be impacted by seepage from the landfill area and from contact with some organics in this area with the highest concentration of ammonia detected in MW84 (71 mg/L) and MW2 (74 mg/L) on the downgradient side of Area C.

- A deeper groundwater body exists in the Bringelly Shale bedrock, likely associated with discrete fracture zones at various depths within the rock profile, generally deeper than 10 mBGL. The Bringelly Shale is typically a low permeable aquiclude with groundwater movement isolated to discrete fracture zones and bedding planes with little or no vertical connectivity and limited horizontal connectivity. The deeper groundwater appears to be interconnected across the site. Considering the standing water levels of the deep groundwater to reach the shallow water system, both zones are presumed to be a continuous systems, but with limited connectivity due to the low permeability shale.

  The deeper wells appear to have the elevated filtered heavy metal concentrations (MW6, BH32 and GWM08D) and are the more saline with conductivities ranging from 11.6 – 17.6 mS/cm. Ammonium in the deeper and shallow wells in shale was generally <5 mg/L.

- The landfill material is thought to be more permeable than its surrounding natural formations and, as such, represents a water bearing zone. Groundwater in the landfill (also referred to as leachate in this report) is saturated and is continuous with the shallow groundwater outside the landfill area. The groundwater is potentially also in direct contact with the deeper groundwater. Currently the southern portion of the landfill is covered with stockpiled clay soil, while the northern portion extends under the concrete hardstand.

  The groundwater in the landfill material is likely to have elevated nutrients, ammonia and biological oxygen demand 16 – 70 mg/L in sampling undertaken in December 2015 in wells MW4, GWM08, GWM09 and GWM13).

In portions of the site the shallow groundwater level is higher than the hydraulic head of the deeper groundwater, creating a potential for downward migration of potential contaminants from shallow groundwater. The hydraulic head difference between the shallow and deep groundwater zones was recorded to be between 0.6m and 1.2m by EES in 2004, with the lowest head difference in the southern landfill area increasing to the north west and down hydraulic gradient i.e. an increased potential for migration of leachate from the shallow groundwater into the deeper shale away from the landfill area.

Historically, downward migration rates would have been augmented by direct infiltration into the open pit, causing the shallow hydraulic head in the quarried area to rise (further) above the hydraulic head of the deeper shale and surrounding shallow groundwater bodies. This potentially induced a radial flow away from the landfill.

In the north west portion of the site a backfilled former quarry access road is located with identified depths to at least 2.5 metres. Landfill materials were encountered in portions of the backfilled volume, are considered to be associated with a separate shallow waste pit and not part of the main landfill.

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A pumping test carried out on a 4.9 m deep pumping well indicated the landfill material had a transmissivity of 220 m²/d and an equivalent hydraulic conductivity of 44 m/d (based on 5 m saturated thickness). The well was pumped at 185 L/m. Calculations based on an estimated porosity of 0.25 and a saturated thickness of 8.5 m indicates there is potentially 17 – 23 ML of water in the main landfill area (not including Area C see Table 2 1).

3.6.2 Contamination Sources Requiring Remediation

The primary contamination source is the existing landfill material placed in the former brick quarry. The landfill material while mostly construction waste also contains organic matter which is generating:

- Landfill gas; and
- Leachate resulting from the contact with surface water and groundwater infiltration.

The landfill material may contain potentially hazardous materials such as asbestos sheeting and drums, engine blocks and other containers filled with petroleum hydrocarbons or other unknown chemicals of concern.

3.6.3 Chemicals of Concern

The landfill is a potential source of landfill gases (including methane, sulfides, carbon dioxide and carbon monoxide) and also leachate. In addition to landfill gas and leachate the fill materials placed in the landfill may contain chemicals of concern. The following lists the most likely chemicals of concern based on the former land use.

Landfill gasses:

- Methane (CH_4);
- Hydrogen sulfide (H_2S);
- Carbon monoxide (CO); and
- Carbon dioxide (CO_2).

Landfill leachate:

- Organics (petroleum hydrocarbons, benzene, toluene ethyl benzene xylene (BTEX), methane and phenols);
- Inorganic (heavy metals, nutrients ($N0_3$, NH_4 and PO_4) as well as COD/BOD;

Soil contamination:

- Organics (petroleum hydrocarbons, BTEX, PAHs)
- Inorganic (heavy metals and asbestos)

To date some of these chemical of concern have not been detected at unacceptable levels on this site. However the chemicals remain as "potential chemicals of concern" as they are commonly found within land filled areas and may be encountered in isolated instances during future site works.

3.6.4 Potential receptors

During and post remediation works the following human and environmental receptors are considered in **Table 3 5**. The up dated Conceptual Site Model given in **Figure 3 4**.

Table 3 5 Potential Receptors

Receptor	Media/exposure route	Risk
Workers during remediation	Soil / Groundwater Dermal / Inhalation/Ingestion	Medium / High for impacted fill removal particularly in the area of landfilling contamination. To be managed by CEMP (including vapour monitoring) and site specific safety plan
Trench maintenance workers	Soil / Groundwater Inhalation	Low post remediation
Buried services (particularly sewer and stormwater)	Infiltration and dissolution	Medium to High in area of contamination. Low post remediation
Surrounding Residents and worker	Soil / Groundwater Inhalation	Medium to High during site remedial works. To be managed by CEMP, vapour monitoring and site specific safety plan Low post remediation.
Residential occupants	Soil/Groundwater / Inhalation Ground gas/odour	Low (post remediation)
Groundwater	Soil / Contact / Dissolution	Low to Medium due to low permeability of shales (including migration off site). Low post remediation.

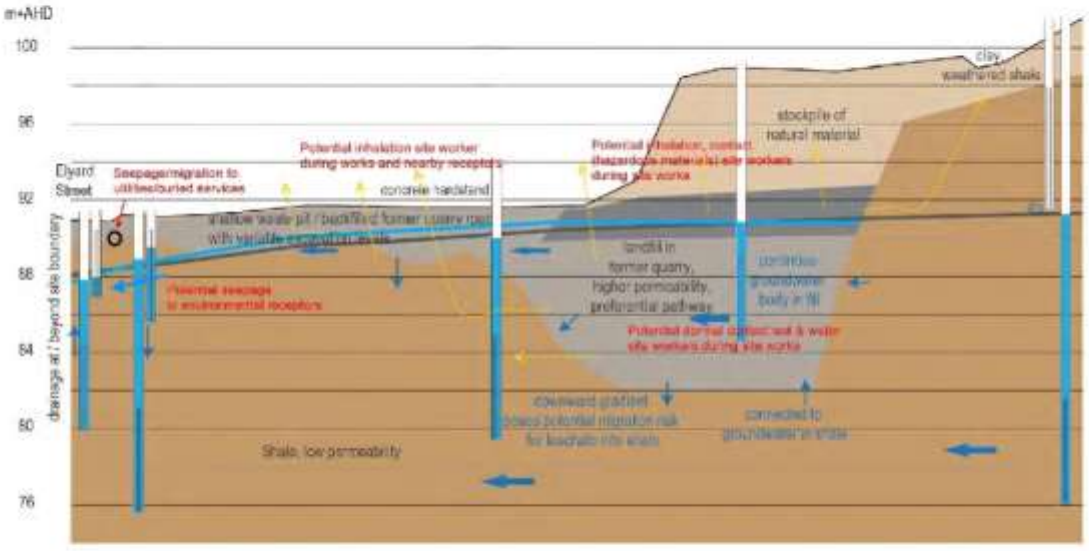


Figure 3 4 Conceptual Site Model

3.7 AESTHETICS

Based on the current information, some impacted odorous waste and saturated material would be removed during site works.

While some aesthetic issues (odour, sharps, & general rubble) may be present during site works, these would be removed during the remediation process and are not considered to have an impact on the site.

3.8 WEATHER DATA

Narellan has a sub tropical climate with high late summer rainfall. The summary of the site weather is provided in **Table 2 1**. The data is from Camden Airport AWS (Site number 068192 Latitude: 34.04 °S, Longitude: 150.69 °E, Elevation: 74 m).

Table 3 6 Climate data (Camden Airport, www.bom.gov.au, rounded)

Statistic Element	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean max temp (°C)	29.5	28.5	26.8	23.8	20.6	17.7	17.3	19.1	22	24.2	26.2	28.4	23.7
Mean minimum temperature (°C)	16.8	16.8	14.8	11	7	4.5	2.9	3.9	6.8	9.9	12.9	15.2	10.2
Mean rainfall (mm)	77.8	98.9	88.1	70.5	55.8	60.6	36.8	41.7	38.8	62.1	77.3	57	763.8
Highest rainfall (mm)	264	422	344	338	309	304	143	276	148	243	167	163	1261
Lowest rainfall (mm)	0	12.8	0	2.3	0.8	2	0.2	0.6	1.6	0.3	8.8	0	446.7
Highest daily rainfall (mm)	125.2	156	99.4	108	89.4	135	83	142.6	61.4	109.2	66.4	70.4	156
Mean days of rain	10.2	11	10	9.6	8.7	8.8	8.1	7.7	8	9.7	11	9.2	112
Max wind gust speed (km/h)	91	102	109	68	74	80	87	96	109	83	102	106	109
Mean 9am relative humidity (%)	72	78	77	77	81	82	81	73	66	64	69	68	74
Mean 9am wind speed (km/h)	6.5	5.5	6	6.3	5.4	5.9	5.8	7.9	9	9.3	8	7.9	7
Mean 3pm relative humidity (%)	49	52	52	52	52	53	50	43	44	47	50	46	49
Mean 3pm wind speed (km/h)	17.2	15.5	15	13.8	12.5	13.9	14.6	16.8	18.1	17.7	17.7	18.5	15.9

3.9 RISKS, HAZARDS AND MITIGATION

Specific risks associated with excavating the landfill material, any potential contaminated soils, and exposure to landfill gas, soil vapours and groundwater include:

- Health and safety risks to workers; (physical and chemical, see Table 3 7)
- Potential hazardous wastes (particularly asbestos, batteries, buried drums)
- Odours and dust from excavation of landfill material or pumping/treatment of groundwater; and
- Odours and dust from processing of landfill materials and treating groundwater.

The main potential hazards and mitigation measures for excavation of the former landfill are further outlined in **Table 3 7**.

Table 3 7 Potential Hazards and Mitigation Measures

Potential hazards	Potential Issues	Mitigation Measures (eliminate, isolate, procedure, PPE)	Risk Rating (H, M, L)	Stage
Hazardous Waste and Special Waste Management	Discovery of lead acid batteries or compressed gases (e.g., tanks), waste oil drums or other unknown substances and Asbestos Containing Material (ACM)	• Use expected finds protocol • Any unknowns should be treated as unexpected finds. • Safety and Environmental Training/induction of Staff • Establishment of hazardous/prohibited waste storage area	H	Preliminaries and during operations
Excavation Works	Impact or damage to underground services	• All ground disturbance activity must be conducted in accordance with industry best practice • If unknown utilities or infrastructure are encountered stop the work activity and contact Project Manager.	M	Site Contractor
	Potential for explosive or toxic atmosphere, particularly during removal of landfill material and groundwater	• During excavation activities continually monitor for explosive atmospheres with a Combustible Gas Detector. • Record LEL readings at pre determined time intervals. This is to be agreed by Environmental Consultant and Site Contractor prior to works commencing on site. • Works must cease if LEL readings exceed action levels specified in the WHS plan (Chemical Hazard Action Levels), and can only recommence after a gas test has been completed of the site, and the site has been re cleared for explosive gases. • No ignition sources to be used within defined work area (mobile phones, cigarettes, etc.) • Keep fire extinguishers (2 x 9 kg) within easy reach of personnel (i.e. within 10 m of the work area and outside of the field vehicle).	M H	Site Contractor
	Exposure to contaminants	• Use of PID to monitor chemical concentrations in operator breathing zone during excavation works. Action to be set based on NIOSH levels. • If monitoring alarm sounds, stop work, move upwind and contact PM for further advice. • Respirators only to be used if user is correctly fit tested and appropriate filters are available.	M	Site Contractor

Potential hazards	Potential Issues	Mitigation Measures (eliminate, isolate, procedure, PPE)	Risk Rating (H, M, L)	Stage
		• Use a half face respirator (with appropriate organic filter) if PID action level is reached. • Ensure appropriate PPE is used (e.g. nitrile gloves, respirator, etc.). • Unnecessary contact with contaminated substances or materials is to be avoided.		
Excavation works (continued)	Asbestos impacted soils	• A licenced contractor shall be prepare an asbestos management plan (AMP) prior to the excavation of asbestos impacted soils • The AMP shall detail methods for preventing the migration of asbestos impacted soils and dusts. • Asbestos soils to be managed in accordance with WorkCover/EPA requirements (Ref. NSW WorkCover Publication Cat No. WC01253, March 2014). • Conduct asbestos air monitoring as described in this RAP, which will be detailed in the AMP prepared by licensed asbestos removal contractor. Specific measures will be employed to prevent mobilisation of airborne asbestos fibres during excavation and loading of asbestos impacted soils onto waste transport vehicles.	L	Site Contractor
	Burial due to collapse	• Entry into an excavation or trench should not be made unless absolutely necessary. • All excavation or trench to be undertaken to Worksafe Excavation Code of Practice (July 2014). • Site personnel entering an excavation greater than 1.0 m deep need a spotter and a safe means of access/egress defined. • Near vertical excavation/test pit walls should be treated as unstable irrespective of their apparent stability. Excavations/test pits shall be viewed from the corner of the excavation or the ends of the excavation.	L	Site Contractor
Soil Sampling	Exposure to contaminants in soil (contaminated land)	• Use PID/LEL to monitor air quality in operator breathing zone. • Ensure appropriate PPE is used (e.g. nitrile gloves, respirator, etc.) • Eating, drinking, smoking, and chewing gum are strictly prohibited during field work involving potential exposure to hazardous substances. • Use of half face respirator (with an appropriate organic filter) if PID action is reached.	L	Site Contractor/Environmental Consultant

Potential hazards	Potential Issues	Mitigation Measures (eliminate, isolate, procedure, PPE)	Risk Rating (H, M, L)	Stage
		• Unnecessary contact with contaminated substances or materials is to be avoided. • Personnel should thoroughly wash their hands and face following field activities before eating, drinking or smoking.		
Groundwater management	Pumping of landfill leachate	Groundwater shall be analysed for pH and any substances (in composite samples) detailed in Sydney Waters acceptance standards (SW\839 06/15) and ANZECC (2000) or as appropriate, to determine suitability for discharge to the stormwater/sewer system. • Water should be pumped to holding ponds or storage tanks prior to disposal to stormwater or sewer. • Prior water treatment may be required for the analytical results to comply with the relevant EPA and ANZECC standards for water quality for stormwater discharge or Sydney Water trade waste license requirements prior to disposal to sewer. • Should the groundwater not meet the required quality standards for discharge to either stormwater or sewer, it must be returned to the respective excavations or require further treatment.	L	Site Contractor/Environmental Consultant
	Generation of waste water from groundwater seepage in excavations	Groundwater shall be analysed for pH and any contaminants of concern identified during the preliminary or detailed site investigation, to determine suitability for discharge to the stormwater/sewer system. • Prior water treatment may be required for the analytical results to comply with the relevant EPA and ANZECC standards for water quality for stormwater discharge or Sydney Water trade waste license requirements prior to disposal to sewer. Should the groundwater not meet the required quality standards for discharge to either stormwater or sewer, it must be removed from the respective excavations with the use of licensed liquid waste contractors.	L M	Site Contractor/Environmental Consultant
Surface water and sediment management	Sediment migration and erosion due to ponding, flooding and excessive runoff	Appropriate measures shall be taken to ensure that potentially contaminated water does not leave the site. Such measures may include: • construction of diversion channels and linear drainage sumps with catch pits in the remediation area to divert stormwater;	L	Project Manager

Potential hazards	Potential Issues	Mitigation Measures (eliminate, isolate, procedure, PPE)	Risk Rating (H, M, L)	Stage
		• provision of sediment traps, including geo textiles or hay bales; and • only discharging water that meets the appropriate effluent discharge consent condition under the Protection of the Environmental Operations Act. Onsite surface water shall be managed in accordance with Camden Council's Design Specifications and relevant codes of practice. The design should allow for surface water flows and groundwater seepage.		
Remediation / excavation works involving vehicle movement, earthworks, stockpile management and materials handling	Generation of dust and air pollution from excavation activities and through wind erosion, including: chemical vapours, odours and airborne, solid particulate matter	• The local weather conditions particularly wind speed and direction will be considered during all site works; • Periodic atmospheric monitoring will be completed in the vicinity of the works using a photo ionisation detector (PID) and LEL to detect the presence of organic chemicals; • Appropriate action levels for the PID readings (refer to the HSEP) will be developed to protect site personnel; • If odorous material is encountered during excavation works and the site supervisor believes that the odour may impact on neighbouring properties, work shall stop until the HSE representative is contacted and appropriate engineering controls are implemented; • If elevated PID readings or odorous material is encountered it will be stored in a separate stockpile, if necessary it may be covered with a plastic sheet (tarpaulin) to minimise the odour emission; and • The presence and movement of dust will be monitored during any works that disturb earth (in situ or already excavated). If the level of dust becomes excessive or if dust begins to migrate off site, dust generating work will cease until dust suppression equipment (water spray) is utilised or dust generating conditions abate. Dust suppression measures should be appropriate for the specific works and should aim to prevent dust from leaving the site. These may include: • use of water carts or dust suppression sprays, • provision of screens, and • work restrictions during windy periods.	M	Site Contractor, Contractor

Potential hazards	Potential Issues	Mitigation Measures (eliminate, isolate, procedure, PPE)	Risk Rating (H, M, L)	Stage
		If dust is being generated from excavated soil stockpiles, the stockpiles may be covered with plastic sheeting (tarpaulin).		
Vehicle movement, earthworks, handling and transport of spoil and fill	Dust generated from earthworks, materials handling and wheel dust	• Cover all loads of excavated material and other erodible materials that are transported to or from the work site. • Avoid or restrict dust generating activities during windy periods.	L	Site Contractor
Management of stockpiles, exposed areas and general site	Wind erosion of exposed surfaces and stockpiles	• Keep areas adjacent to the work sites, including roadways, free of construction soil or dust. • Monitor all work sites, general work areas, stockpiles and skip bins for dust generation and water down or cover affected areas. • Minimise soil and vegetation disturbance, in order to minimise erosion.	L	Site Contractor
Undertaking construction works within built up area	Public complaints regarding odours / dust	Sign to identify the site manager's number. The contact number is to be available 24hrs a day/7 days a week to receive comments and complaints, including emergencies.	L	Site Contractor

4. REMEDIATION GOALS AND CRITERIA

4.1 REMEDIATION GOALS

The remediation goals for this RAP, are consistent with NSW EPA, SEPP 55 guidelines and Council's contaminated land policy, and include:

- Meeting the conditions of the planning consent and to render the site suitable for the proposed land uses;
- Demonstrating that the proposed remediation strategy for the site is environmentally justifiable practical and technically feasible;
- Adopting clean up criteria appropriate for the future use of the site to mitigate possible impacts to human health and the environment;
- Mitigating possible off site migration of contaminants (including migrations in existing utilities such as the sewer, stormwater and other subsurface pipes or service trenches);
- Consideration of Council concerns outlined in a letter regarding request for further information in 7 September 2011;
- Consideration of to the principles of ecologically sustainable development in line with Section 9 of the Contaminated Land Management Act 1997;
- Minimising waste generation under the Waste Avoidance and Resource Recovery Act 2001; and
- To remediate all contamination at the site so there are no unacceptable risks to off site receptors;
- To remediate the site to a condition where any residual contamination does not require long term management using an EMP; and
- Demonstrating that the plans for site management of remediation work consider work health and safety, environmental management, community relations and site contingencies.

4.2 SITE REMEDIATION CRITERIA

As the site is to be remediated to allow potential redeveloped for the site zoning (B2 and R3) which allows for commercial and residential development (with possible basements), Schedule 1 of the NEPM (2013) is considered as remediation criteria. As the site is a former landfill, the NSW EPA ground gas guidelines (EPA, 2012) are also considered. The main criteria are referenced below and provided in **Appendix D**:

- Vapour Intrusion Health Screening Level D (HSL D) for commercial/industrial land uses including premises such as shops, offices, factories and industrial sites;
- Soil contaminants – Health based Investigation Level B for residential properties with minimal soil access. Where the NEPM is silent on volatile organic contamination the US EPA Regional Screening Levels (Region 9) dated June 2015.

The selected soil remediation acceptance criteria correspond to EPA endorsed generic Investigation Levels and represent conservative concentrations protective of human health and the environment (**Appendix D**). In general the HIL B will be used for all areas of the site with reference made to the environmental investigation levels as appropriate, i.e. in garden or landscaped areas. EILs are not considered at this stage as no development plans are available. These criteria have been adopted as the default Remediation Criteria, however, site contingencies outlined in **Section 7 9** includes a provision for developing site specific risk based criteria during the remediation work should these be better in achieving the remediation goals.

Conformance with the remediation criteria will be deemed to have been attained when soil validation samples collected from similar lithology and depth show contaminant concentrations that are below the specified criteria, or, as a minimum, the 95% upper confidence limit (UCL) mean concentration values of each contaminant (volatile and non volatile) in the remediated area (i.e. across the excavated surface) is below the respective criteria.

4.3 GROUNDWATER

In selecting appropriate groundwater investigation remediation criteria, EI considered the following factors:

- The site nearest environmental receptor is Cross Creek approximately 150 m to the west flows into the downgradient Narellan Creek and the Nepean River; and
- The site is serviced by an articulated (town) water supply and there are no licensed potable water supply bores within 500 m of the site

Therefore for groundwater assessment purposes, the adopted remediation criteria are referred to as the Groundwater Investigation Levels (GILs) and are sourced from the documents listed in **Table 4 1**.

Table 4 1 Groundwater Remediation Criteria Source documents

Media	Adopted Guidelines	Rationale
Groundwater	NEPM, 2013 GILs for fresh Waters	**Groundwater Investigation Levels (GILs) for Fresh Water** NEPM 2013 provides GILs for typical, slightly moderately disturbed, fresh waters, which are based on the ANZECC & ARMCANZ 2000 Trigger Values (TVs) for the 95% level of protection of fresh water aquatic ecosystems. The 99% level will be applied for bio accumulative contaminants (i.e. cadmium and mercury). Where no reliable criterion is given, EI will assess the results against the lower reliability criterion given in chapter 8.3.2 of *ANZECC/ ARMCANZ (2000)*.
	NEPM, 2013 Groundwater HSLs for Vapour Intrusion	**Health based Screening Levels (HSLs)** Given the residential nature of the surrounding area and the potential for impacted groundwater to migrate off site, the NEPM 2013 groundwater HSLs for vapour intrusion were used to assess for potential human health impacts from residual vapours resulting from petroleum, BTEX and naphthalene impacts. The *HSL A* and *HIL B* thresholds for low and medium density residential sites were applied for groundwater sampled.
	NHMRC 2011 GILs for Recreational contact	**Down gradient non potable water users** NHMRC (2011) suggest that environmental quality standards for chemicals in recreational waters should be based on the assumption that recreational water makes a 10% contribution to daily 2 litre average intake. This provides for a simple screening approach in which a substance occurring in recreational water should be at a concentration of less than 10 times the drinking water criteria.

Where low reliability numbers are considered for the groundwater, EI may also consider risk based criteria during the remediation work should these be better in achieving the remediation goals.

4.4 GROUND GASES

Using the characteristic gas situation described in the EPA (2012) Ground Gas Guidelines and the nature of the existing buildings or proposed development for the site, an appropriate guidance value was obtained from **Table 4 2**.

Table 4 2 Guidance values for gas protection

Characteristic gas situation (CS)	Required gas protection guidance value				
	Low density residential	Medium–high density residential (strata title)	Public buildings, schools, hospitals, shopping centres	Standard commercial buildings (offices, etc.)	Large commercial (warehousing) and industrial buildings
1	0	0	0	0	0
2	3	3	3	2	1 (a)
3	4	3	3	2	2
4	6 (b)	5 (b)	5	4	3
5	6 (b)	6 (b)	6 (c)	5	4
6	6 (b)	6 (b)	6 (c)	6	6

Notes:
a) If maximum measured methane concentration exceeds 20%, increase to CS3.
b) Residential development not recommended at CS4 and above without pathway intervention and high level of management.
c) Consideration of evacuation issues and social risks required.

4.5 Impacted Fill, Soils and Rock intended for Off Site Disposal

Prior to being removed from the site, excavated soils must be classified in accordance with the EPA (2014) Waste Classification Guidelines (the 'Waste Guidelines'). Under these guidelines, soils (including fill) may be classified into the following groups: General Solid Waste, Restricted Solid Waste or Hazardous Waste, subject to laboratory test results for total and leachable contaminant levels, the later involving the Toxicity Characteristics Leaching Procedure (TCLP). The total and TCLP results for each parameter will then be interpreted against the respective EPA (2014) thresholds in order to classify the waste. Soils containing asbestos may also be classified as Special Waste (Asbestos Waste), assuming no other contaminant is present at such a level as to render the material Restricted Solid Waste or Hazardous Waste.

Protocols for addressing asbestos or other potentially hazardous materials are outlined in **Sections 6.5** and **7.4**.

5. REMEDIATION TECHNOLOGY

5.1 REGULATORY OVERVIEW & REMEDIATION PROCESS OPTIMISATION

In order to attain an environmental outcome, the NEPM guidelines (Volume 1 Section 16) indicates when assessing contamination, the preferred hierarchy for site remediation options and/or management should be considered including:

- on site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and
- off site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or,

if the above are not practicable,

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

or,

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

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

Other considerations, as outlined under NSW EPA (2007), in relation to measures for the mitigation of groundwater contamination may include, but are not limited to:

- notifying of the affected property (under the CLM Act, 1997) and the downgradient receptors;
- containment of the plume;
- active or passive clean up of contaminated groundwater (this may include the concept of Clean up to the extent practicable or CUTEP) which may include ongoing monitoring of groundwater, and/or contingency plans and management plans to mitigate risks; and
- legislative control through restricting groundwater use in and down gradient of the contaminant plume.

A number of remediation options were reviewed (see **Appendix E**) for the site to examine the suitability of each method for the purpose of making the site suitable for the intended land use(s). This review included consideration of surrounding land uses, the geological and hydrogeological limitations at the site, as well as the following issues:

- Development requirements (residential, open space and commercial)
- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to material and infrastructure limitations;
- Remedial timetable;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

Due to the nature/size of the project consideration of the need for an environmental protection licence may also be required which needs to consider Schedule 1 of the Protection of the Environment Operations Act (1997) particularly but not limited to clauses:

- 15 Contaminated soil treatment
- 15A Contaminated groundwater treatment
- 16 Crushing, grinding or separating;
- 48 Transportation of trackable waste

5.2 TECHNOLOGY REVIEW

A number of soil and groundwater remediation technologies were also reviewed as part of the remedial options review process, using the following primary information sources:

- US EPA CLU IN website (https://clu in.org/remediation/); and
- Recent experience with landfills in the Sydney Metropolitan area (including site auditor review and sign off).

Discussion on the various remediation technology options is provided in **Appendix E**. Each of the available remediation technologies except ones that are not commonly used in Australia (like in situ thermal or steam injection) are summarised and ranked in terms of their suitability for treatment of soils, landfill reclamation and groundwater are summarised in **Table 5 1**. The ranking process is further discussed in **Section E1.3** in **Appendix E**.

Table 5 1 Remediation Technology Matrix

Technology	Matrix	Asbestos	Score	Heavy metals	Score	TPH	Score	VOC	Score	Landfill Gas	Score	Long Term Monitoring	Score	EMP	Score	Individual Scores	Overall Ranking	Preferred Option
Bioventing	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
	Ground gas	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Yes	1	Possible	2	13		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14	40	No
Enhanced	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
Bioremediation	Ground Gas	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Yes	1	Yes	1	12	39	No
Capping and	Soil	Yes	3	Yes	3	Yes	3	Yes	3	Yes	3	Yes	1	No	3	19		Possible
Containment	Ground Gas	Yes	3	Yes	3	No	1	No	1	Yes	3	Yes	1	No	3	15		Possible
	Groundwater	N/A	0	No	1	No	1	No	1	No	1	Yes	1	No	3	8	42	Possible
Chemical	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
Oxidation	Ground Gas	N/A	0	Yes	3	Yes	3	Yes	3	Yes	3	Possible	2	Yes	1	15		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Yes	1	Yes	1	12	40	No
Excavation	Soil	Yes	3	Yes	3	Yes	3	Yes	3	Yes	3	N/A	0	No	3	18		Yes
Reuse & Disposal	Ground Gas	Yes	3	Yes	3	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	19		Yes
	Groundwater	N/A	0	Possible	2	Possible	2	Possible	2	Possible	2	Possible	2	Possible	2	12	49	Yes
Land Farming	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
	Ground Gas	N/A	0	No	1	Possible	2	Possible	2	Possible	2	N/A	0	Possible	2	9		No
	Groundwater	N/A	0	No	1	No	1	No	1	No	1	N/A	0	No	3	7	29	No
Air Sparging	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
	Ground Gas	N/A	0	No	1	No	1	No	1	Yes	3	Possible	2	Possible	2	10		No

Technology	Matrix	Asbestos	Score	Heavy metals	Score	TPH	Score	VOC	Score	Landfill Gas	Score	Long Term Monitoring	Score	EMP	Score	Individual Scores	Overall Ranking	Preferred Option
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14	37	No
Reactive Barrier	Soil	N/A	0	N/A	0	Yes	3	Yes	3	Yes	3	No	3	No	3	15		No
Wall	Ground Gas	N/A	0	N/A	0	No	1	No	1	No	1	Yes	1	Yes	1	5		No
	Groundwater	N/A	0	Yes	3	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14	34	No
Pump and Treat	Soil	N/A	0	No	1	No	1	No	1	No	1	N/A	0	No	3	5		No
	Ground Gas	N/A	0	Possible	2	Yes	3	Yes	3	Yes	3	Yes	1	Possible	2	14		No
	Groundwater	N/A	0	Yes	3	Yes	3	Yes	3	Yes	3	Yes	1	Possible	2	15	34	No

Score1 Scores are provided for each technology and their suitability for each contaminant group and their long term monitoring requirements and need for EMP.
See Section E1.3 in Appendix E for further details on scoring and ranking.

5.3 PREFERRED REMEDIATION TECHNOLOGY

The various remediation options reviewed in **Appendix E** are summarised in the form of a technology matrix to assess their suitability for the various subsurface materials at the site, the primary objectives of the remediation works program and their ability to improve the downgradient water quality. The ranking of the remedial options in **Table 5 1** identifies the following options as being suitable to remediate the Narellan site:

- Groundwater recovery and treatment, and
- Excavation and waste segregation for:

  On site reuse of suitable, non hazardous materials; and

  Off site disposal of un suitable or hazardous materials.

The remedial options review (**Appendix E** and **Table 5 1**) classed the landfarming method as not being preferred for site remediation, due to the potential for emissions of volatile hydrocarbons and associated odour impacts on the surrounding environment during the site works. It is acknowledged in NSWEPA (2014) *Best Practice Note: Landfarming*, however, that where fill materials contain low concentrations of volatile compounds and biological degradation (bio remediation) is the main mechanism for the remediation process, landfarming in this case would be a more environmentally sustainable remedial strategy, which minimises waste and maximises the amount of material that can be recycled and reused.

As such the preferred remediation strategy is a combination of excavation, waste segregation and bio remedial landfarming for on site reuse, or off site disposal of spoil in accordance with the NSWEPA (2014) waste classification guidelines.

In summary, the preferred remediation technologies can be combined to provide a preferred remediation strategy, which may include the following technologies:

- Dewatering of the landfill area to allow excavation of the landfill material;
- Bio remediation and removal of potential primary sources of contamination within the landfill material, which may include, but not be limited to, hazardous materials, organic materials (timber, putrescible waste), and foreign objects (car bodies, tanks, drums etc.);
- Recycling of suitable materials including metal (as above) and timber products (such as wood chips) for off site use;
- Dispose of contaminated fill, or unsuitable soil, rock or material mentioned above exceeding the RAP criteria to landfill; and
- Treatment of contaminated groundwater (which may accumulate in excavations) using a packaged water treatment plant typically used in Sydney for excavated sites. The treated GW may be reused on site or disposed either to stormwater or sewer under licence.

5.4 SITE PREPARATION AND LICENCES / APPROVALS

SEPP 55 (1998) – *Remediation of Land*, details when a consent is required for remediation works. Under SEPP 55, proposed remediation work is considered Category 1 work where there is the potential for significant environmental impact and therefore requires development consent. Remediation work which is considered to be Category 2 works does not require consent.

In Camden, Category 2 remediation works are not applicable as the requirements of the Sydney Regional Environmental Plan – Hawkesbury Nepean River (No.20 1997) supersedes SEPP 55. Part 3 Clause 11 subclause (4) requires consent for any remediation works.

ORD05

Attachment 2

The process for council to consider Category 1 remediation works is outlined in Figure 4 of the Camden Council Contaminated Land Management Policy 3.12 dated February 2008. General regulatory approvals may also be required but are limited to:

- Council conditions of consent (yet to be determined);
- WorkCover notification of any demolition of slabs and asbestos removal work; and
- License from DPI Water/Council/Sydney Water for groundwater extraction/treatment/disposal/trade waste (if required).

6. REMEDIATION METHODOLOGY

6.1 OVERVIEW OF REMEDIATION

Following approvals and site establishment; the main site remediation works would include but not be limited to:

Stage 1 works:

- Installation of suitable groundwater recovery wells/trenches in landfill material;
- Construction of groundwater storage ponds/tanks/bladders and associated treatment systems for disposal (to stormwater or sewer) or for on site use for dust management;
- Construction of stormwater diversion drains to divert any "clean" stormwater around the proposed landfill excavation (see **Figure 3**);
- Construction of waste segregation, crushing and storage areas (including hazardous material storage); and
- Establishment of environmental controls (air, water, dust, odour etc.).

Stage 2 works:

- Excavation and removal of landfill material including segregation of the material to be removed from site or reused on site;
- Ongoing groundwater recovery and treatment;
- Verification of the impacted groundwater plume within the shale bedrock; and
- Assessment of the potential vapour risks posed to previously identified receptors.

Stage 3 works (ongoing throughout operations):

- Segregation, crushing, waste classification and suitability assessment for material to be re used on site;
- Bio remedial landfarming of fill impacted with organic compounds of low volatile content;
- Stockpiling and placement of suitable material into landfill void; and
- Geotechnical testing for compaction control.

Stage 4 works (ongoing throughout operations):

- Validation sampling to confirm that all the contamination has been removed to allow the development of the site for residential purposes; and
- The date of completion of the remediation work is when the Site Auditor has completed the review of a draft validation report and has issued a statement that the Site Auditor has received all necessary data required to prepare a **Section A** Site Audit Statement.

6.2 PRELIMINARIES

The remediation of the contamination identified at the Camden site requires preparation of the appropriate CEMP, staging or project plan, community engagement plan and an appropriate site specific work health and safety plan in order that all necessary approvals and licences are obtained from the regulatory authorities to enable the remediation work proceed.

Establishment of environmental controls, site access and security and implementation of community engagement plan is require prior to commencement. A project plan should also be developed to outline engineering design for excavation support (if required), water treatment requirements and design, staging of excavation works, stockpiling, loading and traffic requirements and stabilisation works.

As part of the preliminary tasks a remediation workshop was undertaken with the appointed contractor to further develop any remedial measures, excavation plans and environmental management requirements.

Also prior to commencing work the site contractor is to prepare a staging or project plan that outlines the basic stages of the remediation works. The staging plan should include but not limited to:

- Staging of areas to be excavated;
- Areas designated for stockpiling, amenities, soil and groundwater treatment;
- Truck movement to allow loading to mitigate impact to the surrounding residents and council infrastructure, and
- Proposed environmental mitigation measures.

6.3 LEACHATE/GROUNDWATER RECOVERY & TREATMENT

Preliminary calculations indicate there is potentially 17 – 23 ML of water in the landfill that will require dewatering prior to and during excavation. This water would be pumped from a single or multiple recovery wells or sumps in the main landfill (see Figure 3). During a pump test, pumping rates of 185 L/m (approx. 266 kL/d) was achieved from one 4.9 m deep well.

Conventional landfill leachate/groundwater treatments can be classified into three major groups:

a) leachate pumping: recycling and combined treatment with domestic sewage,

b) biodegradation: aerobic and anaerobic processes and

c) chemical and physical methods: chemical oxidation, adsorption, chemical precipitation, coagulation/flocculation, sedimentation/flotation and air stripping.

To deal with the large volume of water to be pumped/recovered from the landfill matrix, it is envisaged that a number of processes would be required to allow the following re use or disposal option including:

- Recycling of the water for environmental controls;
- Pumping of the stormwater to the stormwater system via the Council street stormwater system, or
- Disposal to sewer with a Trade Waste Licence from Sydney Water. In the local area any wastewater appears to flow to the West Camden Wastewater Treatment Plant (WWTP) which includes Tertiary treatment (with additional Phosphorus removal and disinfection) and is re used at the Agricultural Institute or discharged via Matahill Creek to the Nepean River

Sydney Water considers applications to discharge groundwater during a site remediation on a site specific basis where:

- There is evidence the groundwater was previously contaminated by man made sources;
- The groundwater is treated to meet Sydney Waters' acceptance standards;
- It is pumped to sewer through an approved flow measurement device
- An approved rainfall cut off device is installed to delay discharge during and immediately after a rainfall event, and;
- A plan is provided outlining the anticipated time frame of the remediation.

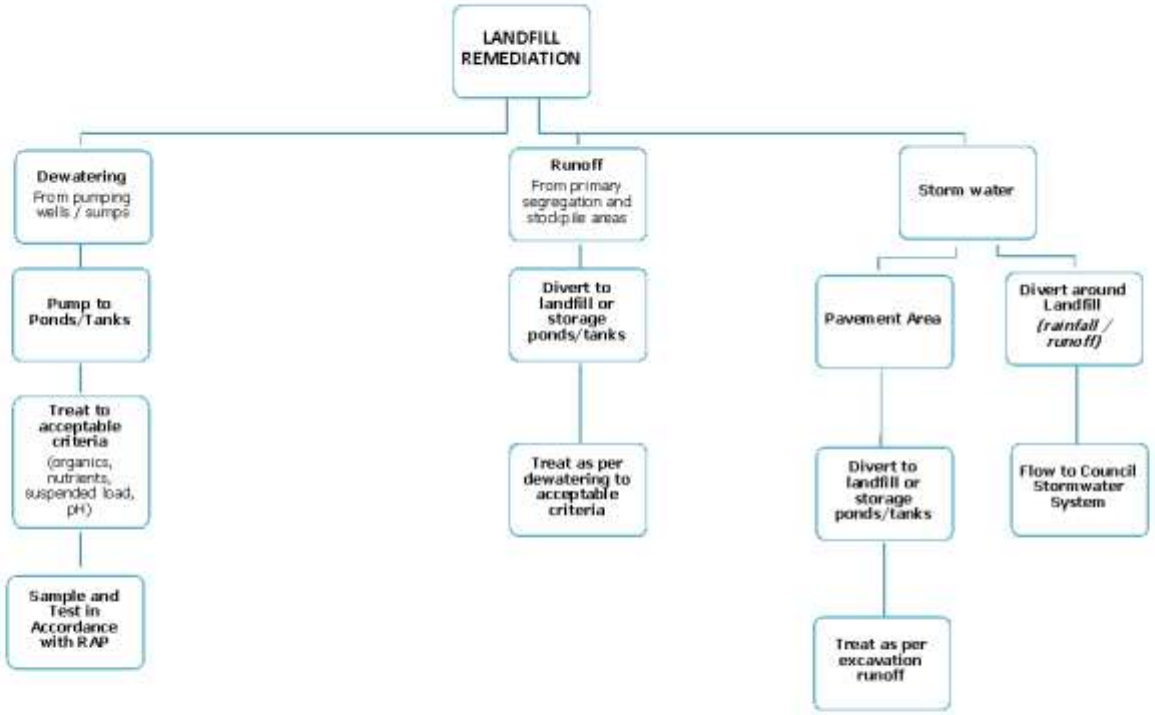
Sydney Water do not permit groundwater and surface water collected during excavation and construction to be discharged to the system. These media must treated and discharged to the site stormwater drainage system.

It is envisaged that the groundwater residing within the former quarry would be managed and treated as follows:

- Pumping to a series of treatment/storage ponds (or bladders) and/or readily available off the shelf containerised water treatment systems to adjust/treat pH, ammonia load, odour, and BOD_5
- Settlement/filtration to manage sediment or suspended solids load, and
- Pumping of batch treated water for recycling (e.g. dust control) or off site disposal.

The actual storage and treatment system will depend on the further sampling of the groundwater to obtain basic water quality parameters (pH, Biological Oxygen Demand (BOD_5), Nutrient load (Total Nitrogen, TKN, Ammonia, Nitrate, Nitrite, etc.), Total Dissolved Solids (TDS), Suspended Solids, Sulfate, Temperature and quantity.

Preliminary dewatering and treatment flow path is shown in **Figure 6 1** and preliminary location of pumping wells, storage ponds and treatment areas are shown on **Figure 3** (at end of text).



Notes:
All liquid waste disposal to NSW EPA Waste Classification Guidelines (2014) and the POEO (Waste) Regulations (2014) to licenced facility (treatment plant)
All works to EPA, Sydney Water and Camden Council guidelines and control plans
Validation sampling in accordance with this RAP and assessed against NEPM (2013), Sydney Water Trade Waste or ANZECC Water Quality guidelines

Figure 6 1 Landfill Excavation Strategy (Water)

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6.4 LANDFILL EXCAVATION, CLASSIFICATION & VALIDATION

Excavation is considered to be the option that best meets the remediation objective as it would result in the whole site being suitable for the intended land use without ongoing liabilities or restrictions. The method is to excavate all the fill material and screen for suitability to remain onsite. Under this scenario, material which is not suitable due to contamination issues or contains hazardous materials would be further managed and disposed off site in an appropriate manner.

Any geotechnically unsuitable material (such as timber or organic matter) would either be disposed offsite or reused on the surface in landscaped areas following suitable processing (chipping or composting). Materials that are suitable for on site reuse, and which is geotechnically suitable, would be reinstated into the brick pit with appropriate compaction.

The following subsections provide further detail on the landfill remedial works would be undertaken and illustrated in **Figure 6 2** which provides a flow chart for the overall process.

Following removal of the site capping material for classification and re use, excavations of the underlying landfill and any other impacted soils is required to the base of the former quarry. This work should be undertaken in a staged manner across the site with:

- Area 1 in the eastern area of the landfill, and
- Area 2 in the remaining part of the landfill.

All materials would be selectively excavated and tracked from cradle to grave as required by the waste guidelines. Stockpiled location, size, and environmental control measures are described in Section 6.5 and 7.3. Material can be classified for either retention on site if contaminant levels are below the NEPM Residential or Commercial criteria or off site disposal in accordance with the waste guidelines. Any stockpiled material should be sampled in accordance with NEPM (2013) Schedule B2 guideline and NSW EPA waste guidelines and exemptions for ENM and VENM.

6.4.1 Excavation and Pre screening

An excavator would remove the contents of the landfill and either directly load the material to a grizzly to separate the divide the material into less than or greater than 75 mm size or remove larger items (such as car bodies) or hazardous material for separate stockpiling for recycling or disposal. This preliminary separation process would be aided by a site spotter as required.

A front end loader then load the excavated materials onto a conveyor or wheeled hauler/truck to be further processed or placed in manageable stockpiles or specific waste bins (for bulky items, such as, car bodies, whitegoods and lengths of steel cable). The various materials and expected finds are outlined in **Table 6 1**.

Table 6 1 General Landfill Materials Following Pre Screening

Large materials >75mm	• Concrete, rubble, bricks, boulders • Rubbish (including steel and other metals, plastic, glass etc.) • Organic material (wood, green waste etc.)
Soils/Gravel <75mm	• Soil, clay, fines <20mm, ash • Fine gravel 5 20mm • Gravel 20 75mm • Building materials (gyprock, broken bricks, etc.) • Rubbish (glass, metal, organics)
Other Expected Finds	• Car bodies, tyres and engine blocks, • Wire ropes and possible conveyor belt • Tanks & drums • Whitegoods • Hazardous materials (asbestos, liquid in containers)

6.4.2 Material Processing

The landfill material would then be processed into suitable or unsuitable materials for reuse in the landfill/quarry void or disposed of off site.

It is envisaged that the landfill material separation (or Screening) would involve a trommel (i.e., a revolving cylindrical sieve) or vibrating screens separate soil (including the cover material) from solid waste in the excavated material. The size and type of screen used depends on the end use of the recovered material. The size of the screen would be typically, a 75 mm screen is used for separation. Smaller mesh screen may also be used to remove small pieces of metal, plastic, glass, and paper. Trommel screens are more effective than vibrating screens for basic landfill reclamation. Vibrating screens, however, are smaller, easier to set up, and more mobile.

The general processing is outlined in the flow chart in **Figure 6 2** and include:

Concrete/Rubble,

- Crush <75 mm
- Stockpile in designated area
- Re use in quarry void

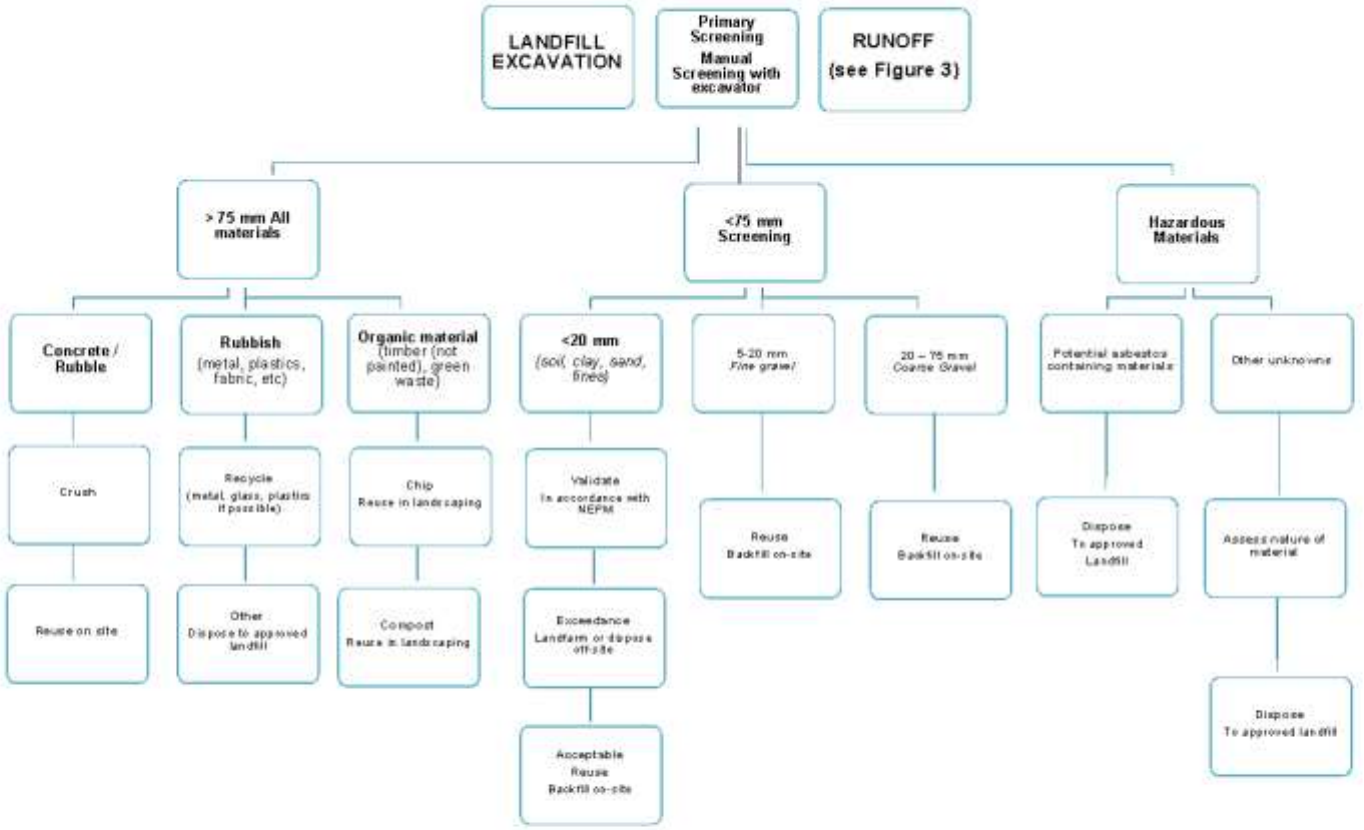
Rubbish,

- Remove larger steel and other metals objects for recycling
- Separate plastics/fabric for disposal
- Tyres for disposal or recycling
- Painted timber to be segregated for disposal

Organic Matter,

- Timber (not painted) for chipping and re use in landscaping,
- Organic matter composted and re use in landscaping.

The processed materials would be stockpiled prior to placement back into the landfill/quarry void. The stockpiling of the various materials is further discussed in **Section 6.5**.



Notes:
All waste disposal to NSW EPA Waste Classification Guidelines (2014) and the POEO (Waste) Regulations (2014) to landfills that are licensed to accept the type of waste
All works to Workcover guidelines and codes of practice
validation sampling in accordance with this RAP and assessed against NEPM (2013) criteria

Figure 6 2 Landfill Excavation Strategy (Solids/Soils)

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6.4.3 Environmental Monitoring & Odour Control

Environmental monitoring (including air quality assessment) would be conducted to demonstrate that workers at the site and members of the general public are being protected from odour, fugitive emissions, dust, noise, vibrations, groundwater, treated groundwater disposal during the remediation work. Any monitoring would be outlined in the Environmental Management Plan to be prepared by the site contractor.

All open excavations and treated soils would be monitored during the remediation works with a photoionisation detector (PID), to ensure ambient air concentrations of volatile organic compounds are within acceptable safe work limits. The proposed remediation and validation works has the potential to pose health risks to workers in the immediate vicinity of any contaminated soils. Mitigation measures, including monitoring of ambient air conditions for volatile organic compounds, would be necessary to minimise the potential impacts. The remediation works could also generate dust impacts for nearby residents.

The boundary air quality monitoring program would be prepared by the relevant contractor in accordance with the RAP. As a minimum, two hourly monitoring will be maintained at selected monitoring points to address potential sensitive receptors such as the nearby residents. A minimum of four monitoring points on the four boundaries would be established and monitoring would also be carried out during the staged excavation. Action levels and specific control measures would be described in the site EMP and may include, but will not be limited to the following:

- Establishment of monitoring points
- use of vapour masks or respirators for works in some areas of the site
- wetting down the excavated material with the use of water sprays
- covering of all contaminated material loaded onto trucks for off site disposal
- reduce the volume of soils excavated, and
- use of odour suppressant sprays, particularly at locations where contaminated soil is excavated / disturbed.

The environmental monitoring would continue during all stages of excavation.

6.5 Stockpiling, Processing & Segregation

6.5.1 Material Processing

Solid materials would be excavated and be visually assessed by a trained spotter for visible bonded asbestos and other potentially hazardous materials (such as unknown drums, unexpected staining or odours). Asbestos has not been identified at the site to date, however it is commonly present in uncontrolled landfill materials. Any asbestos containing materials or potential hazardous substances are to be quarantined in the appropriate bunded or contained area for subsequent classification and off site disposal.

All stockpiling is to be undertaken on concrete hardstands and have appropriate drainage measures to collect any likely water from the excavated material.

Once visible asbestos/hazardous materials has been removed from the excavated material, they would be processed to remove other larger foreign objects such as timber, car bodies, engine block etc. through visual inspection or screening though a grid. Materials that have been cleared of visible asbestos containing materials (and randomly tested for non visible asbestos) would be screened based on size. The size fraction greater than 75mm will be further screened or manually separated into geotechnically suitable bricks, soil, rubble and concrete, and putrescible waste.

The rubble will be crushed and reused as backfill material while the putrescible waste will be separated into general rubbish (for offsite disposal), and timber (for chipping and reuse in landscaping).

The less than 75mm fraction will also be further screened and crushed according to size and would be reused as backfill. Soil fractions will require validation testing to confirm that it is suitable for onsite reuse. The sampling rate and methodology for validation of screened soil is provided in Section 6.0

Soil material that fails the site criteria would be further classified for waste disposal before being transported to landfill.

Due to the scale of earth works required and the space necessary for sorting and storing materials it is likely that a staged approach would be necessary. A possible site layout for the works is presented in **Figure 3** (at end of text).

6.5.2 Hazardous Materials Removal

All hazardous materials identified during the excavation process are to be removed from the site by a licensed and competent contractor in accordance with regulatory requirements, and disposed at suitably licensed landfills. The transportation and management of asbestos waste must be carried out in accordance with Part 7 of the Protection of the Environment Operations (Waste) Regulation 2014 (Waste Regulation 2014), which includes:

- Appropriate packaging, sealing, covering and/or wetting of the waste, as is required for the form of the asbestos contamination (i.e. bonded asbestos, friable asbestos or asbestos contaminated soil);
- Reporting on transportation of asbestos waste by the transporter to the NSWEPA as required under Part 7, Section 79 of the Waste Regulation 2014; and
- Disposal to an appropriately licensed (i.e. lawful) premises, with proper advice to the occupier of the premises, while incorporating measures for the prevention of dust generation, in accordance with Part 7, Section 80 of the Waste Regulation 2014.

At the conclusion of the landfill/hazardous materials removal a competent environmental consultant must inspects the site and certify that all hazardous materials have been removed.

As ACM may in the landfill to be excavated, air monitoring for asbestos fibres should be conducted during any removal of asbestos in soil remediation works. As the landfill material is still likely to be saturated, any asbestos fibres are unlikely to become airborne, so any monitoring should only be undertaken during asbestos processes that may generate dust (also see environmental management).

All asbestos fibre air monitoring must be conducted in accordance with the Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres [NOHSC: 3003 (2005)] and analysed by a NATA accredited laboratory. The criteria and actions that will apply to this project are summarised in **Table 6 2**.

Table 6 2 Summary of asbestos in soil control measures

Control Level (fibres/mL)	Control / Action
< 0.01	• No Action. Continue with existing control measures
≥0.01	• Asbestos Consultant to notify Site Controller and provide results as soon as practicable. • Site Controller to notify Licensed Asbestos Removal Contractor. • Asbestos Consultant & Site Controller to review current control measures and improve, where applicable. This may include improved work practices, use of further control measures (e.g. plastic screening or wet wiping techniques) or changing the work methodology.

Control Level (fibres/mL)	Control / Action
≥0.02	• Asbestos Consultant to notify Site Controller and provide results as soon as practicable. • Asbestos Consultant to advise Licensed Asbestos Removal Contractor to stop work immediately. • Asbestos Consultant to conduct investigations to establish cause of problem. • Asbestos Consultant to advise Licensed Asbestos Removal Contractor on necessary works to rectify problem. • Asbestos air monitoring to be continued by Asbestos Consultant. • Contractors will be allowed to return to works area after results are <0.01 fibres/mL.

6.6 Demolition of Concrete Pavement

Following landfill excavation and processing all associated driveways and concrete pads are to be removed and crushed to be recycled on site or used as filling within the former quarry void. The concrete removal and reuse/disposal works should include:

- institution of environmental controls and monitoring locations;
- segregation and stockpiling and crushing of concrete;
- recycling of reusable materials;
- site monitoring to ensure no asbestos is identified in pavement material (e.g. as formwork);
- removal and disposal of hazardous material (if identified);

The removal of the various concrete slabs and pavements may identify potential contamination or unexpected finds (**Section 7.4**) not previously encountered. The treatment of this contamination is discussed in the contingency planning.

Following demolition, processing and crushing, the material could be reused on site following appropriate testing or removed to an approved facility for disposal or reuse.

6.7 Remediation Tasks & Timeframe

6.7.1 Preliminary Schedule

The proposed remediation works, further characterisation (e.g. asbestos) validation sampling tasks a reporting and indicative timeframes are summarised in **Table 6 3.**

Table 6 3 Remediation and validation tasks with approximate timeframes

Remediation Phases	Tasks	Validation	Schedule (approx. only)
Approval of DA for site preparation and remediation			To Be Confirmed (TBC)
Preliminaries & Site Establishment	Preparation of WHS and Environmental management plans Preparation of staging plan for the remediation works Signage, fencing etc.		TBC
Unexpected find remediation	Reassess need for further remediation	Dependent on unexpected find as per RAP	TBC

Remediation Phases	Tasks	Validation	Schedule (approx. only)
Excavation of landfill material	Waste classification Determine need for soil treatment if concentration high Unexpected finds	Waste classification Disposal dockets Auditor inspection	TBC
Excavation of cover material	Excavation of onsite stockpiled soils	Visual inspection for unexpected finds	TBC
Bio remedial landfarming of organic impacted soils	Bio remedial landfarming in designated area	In accordance with RAP	TBC
Concrete pavement removal	Noise, dust odour monitoring Unexpected finds inspections (including auditor)	In accordance with RAP	TBC
Monitoring/vapour assessment/risk assessment (if required)	Post remediation vapour/ground gas tests to assess effectiveness of treatment to mitigate offsite migration.	Closure against acceptance criteria, or clean up to extent practicable (if required).	TBC
Reporting	Post validation reporting on remedial works and validation sampling.	Documenting above works, sampling and analytical results, to be issued to NSW EPA site auditor to enable preparation of Schedule A Site Audit Statement and Report	TBC

6.7.2 Remediation Hold points

Specific hold points in the remediation work are required that may specific sampling and analysis, decision regarding further assessment or remediation and approvals required by the condition of consent and the site auditor are outlined in **Table 6 4.** These hold points are designed to minimise remediation risks and identify the outcome/criteria that need to be met for the hold point to be removed.

Table 6 4 Remediation hold points

Remediation Phases	Tasks	Hold point	Requirement
Preliminaries & Site Establishment	Preparation of WHS and Environmental management plans and	Submission of plans for approval	Site auditor to approve EMPs etc.
Excavation of Fill/Surficial Soils	Waste classification (stockpiles) Determine need for soil treatment Failure of the landfill material into the excavation void	Geotechnical assessment Waste classification Treatment system set up Auditor inspection	Expert advice Depending on results, laboratory turnaround time and inspections

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Attachment 2

Remediation Phases	Tasks	Hold point	Requirement
Final quarry/landfill surface	Assessing suitability for backfill Validation sampling	Sampling and inspections	Approval by Site Auditor
Concrete pavement removal	Noise, dust odour monitoring Unexpected finds inspections (including auditor)	Monitoring in accordance with WHS Plan and operational EMP	
Post excavation vapour/ground gas assessment/risk assessment	Post remediation vapour/ground gas tests to assess effectiveness of treatment to mitigate offsite migration.	Vapour testing and results.	Approval by Site Auditor
Reporting	Post validation reporting on remedial works and validation sampling.	Report preparation and submission	Auditor sign off

7. SITE MANAGEMENT PLAN

7.1 RESPONSIBILITIES AND CONTACTS

The overall responsibilities and capabilities for the remediation are outlined in **Table 7 1.**

Table 7 1 Site Management Responsibilities

Responsible Party	Details/Contacts	Minimum Capability & Responsible for:
Principal Contractor (PC)	TBA	Overall management of the site remedial activities. Has all appropriate WorkCover and associated licences. Preferably accredited for the AS/NZS 14001:2004 Environmental management systems;
Property Owner (including client/owner representative)	Dibblar Pty Limited , Jimbalia Pty Limited, Greenfields Development Corporation Limited , D Vitocco Constructions Pty Limited	Management of the site and associated remedial activities, particularly with respect to policy and operational procedures.
Environmental Management Coordinator (EMC)	TBA	• ensure that the site remediation works are carried out in an environmentally responsible manner; • liaise between the appointed Environmental Consultant and Council providing regular updates and informing of any problems encountered; • ensure that all environmental protection measures are in place and are functioning correctly during site remediation works; and • report any environmental issues to owner.
Earthworks or Remediation Contractor	TBA	Licenced by WorkCover for the appropriate works stages (including asbestos removal, demolition, tank removal and disposal, and waste transportation. • ensure that all operations are carried out as identified in the RAP, as directed by the project manager or environmental consultant • preparation of daily field records (including truck movements and waste disposal) to be kept by site foreman/superintendent • induct all employees, subcontractors and authorised visitors on procedures with respect to site works, WHS and environmental management procedures; • report any environmental issues; • maintain site induction, site visitor and complaint registers; • fugitive emissions and dust leaving the confines of the site must be suitably controlled and minimised; • water containing any suspended matter or contaminants must not leave the site in a manner which could pollute the environment, and must be minimised and suitably controlled;

Responsible Party	Details/Contacts	Minimum Capability & Responsible for:
Earthworks or Remediation Contractor (continued)	TBA	• vehicles shall be cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas; and • noise and vibration levels at the site boundaries must comply with the legislative requirements.
Environmental Consultant	TBA	Member of the Australian Contaminated Land Consultants Association • daily supervision of remediation in early stages of work to ensure that all operations are carried out as identified in the RAP (demolition and remediation); • preparation of daily field records • undertaken waste classification and validation sampling • advise should scenario arise deviating from the RAP • prepare report on potential • prepare remediation and validation report for submission to auditor.
Site Auditor	Mr Rod Harwood (Environmental Strategies)	Accredited by the NSW EPA • Reviewing proposed remediation strategies and ensuring remediation is technically feasible, environmentally justifiable and consistent with relevant legislation and guidelines; • review actions taken demolition, earthworks or remediation contractor; • Inspect unexpected finds and final excavation surface prior to covering • ensure all works have complied with the RAP and remedial procedures deem the site suitable for the intended land use. • Prepare site audit statement and report to confirm site is suitable for residential development.

7.2 SITE AUDITOR INSPECTIONS

Inspections of the site by the Site Auditor at key milestones during the remediation works must also by conducted to:

- Enable the auditor to view the overall excavation process and any unexpected finds;
- Enable the Site Auditor to observe the implementation of the environmental management measures and validation sampling; and
- Inform the Site Audit Statement, which is required to be issued following completion of the excavations works to ensure that the site is considered suitable for the site zoning.

7.3 MATERIALS HANDLING AND MANAGEMENT

Table 7 2 summarises the measures that should be implemented in respect of materials handling during excavation and remediation works at the site.

Table 7 2 Materials handling and management requirements

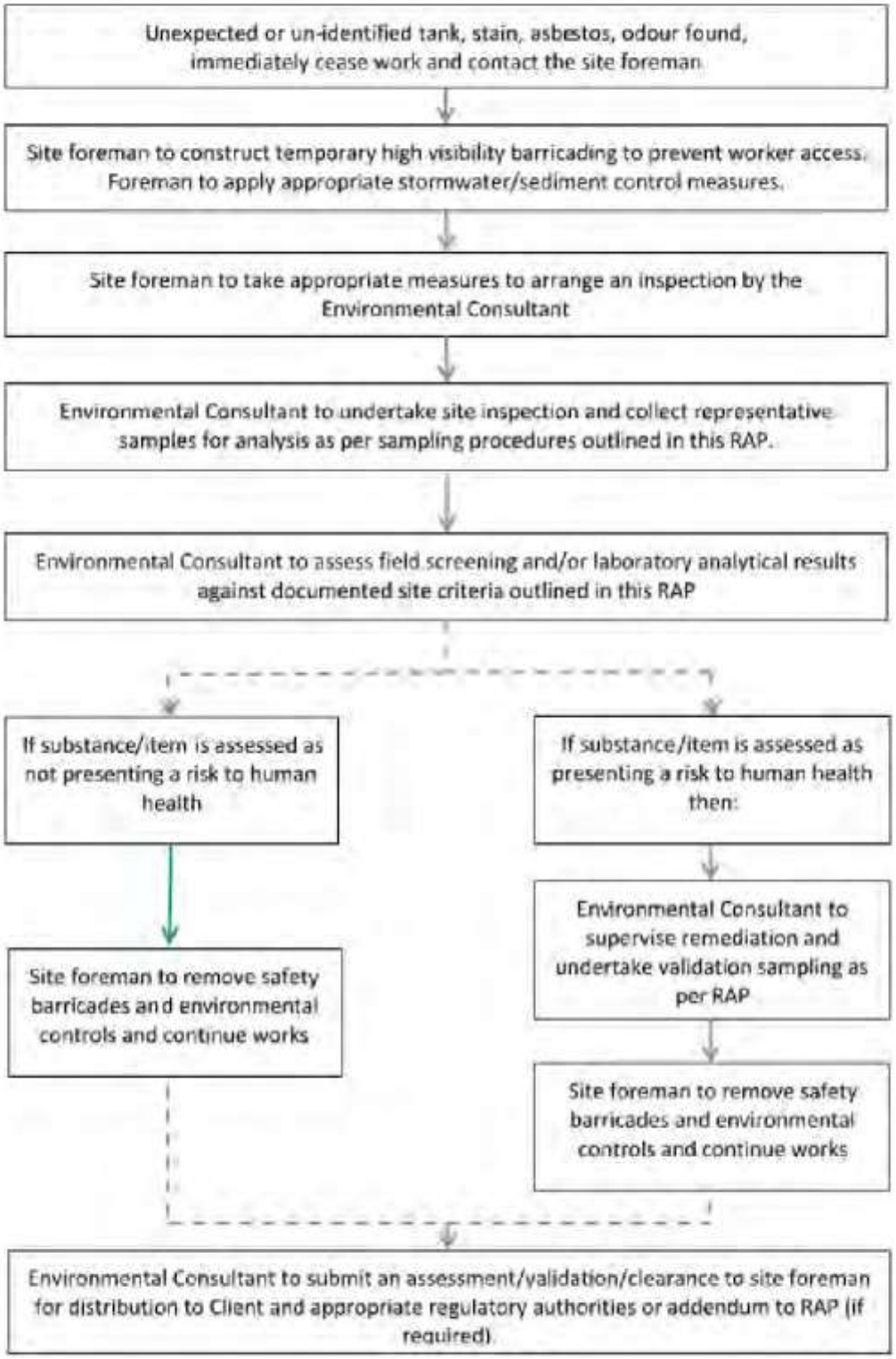
Item	Description/ Requirements
Earthworks contractors	Excavation of fill materials should be completed by a suitably qualified contractor to ensure: • All site staff are aware of the environmental and health and safety requirements to be adhered to; • There is no discernible release of dust into the atmosphere as a consequence of the works; • There is no discernible release of contaminated soil into any waterway as a consequence of the works; and • There are no pollution incidents, health impacts or complaints.
Stockpiling of materials	All stockpiles will be maintained as follows: • Stockpiles must be located on sealed surfaces such as sealed concrete, asphalt, or high density polyethylene; • Should stockpiles be placed on bare soils, these soils should be placed on yet to be remediated areas. Contaminated materials should only be stockpiled in locations that do not pose any environmental risk (e.g. hardstand areas); • Excavated soils should be stored in an orderly and safe condition (≤2m height); • Stockpiles should be battered with sloped angles to prevent collapse; • Stockpiles should be covered or lightly conditioned by sprinkler to prevent dust blow; • Should the stockpile remain in situ for over 24 hours, silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion (runoff); and • Stockpiles will be strategically located to mitigate environmental impacts while facilitating material handling requirements.
Stockpile locations	The location of the stockpiles will be selected to fit with the expected stages of the project. Stockpiles will be located in accordance with the following general requirements: • stockpiles will only be placed at approved locations • stockpiles will be strategically located to mitigate environmental impacts while facilitating material handling requirements • Contaminated materials will only be stockpiled in non remediated areas of the site or at locations that do not pose any risk of environmental impairment of the stockpile area or surrounding areas (e.g. hardstand areas).
Loading of material	Loading of stockpiles / materials will be as follows: • Transport of contaminated material off the site is to be via a clearly distinguished haul route. • Measures shall be implemented to ensure no contaminated material is spilled onto public roadways or tracked off site on vehicle wheels. Such measures should include the use of a wheel washing/cleaning facility, placed before the egress point on the site, and should be able to handle all vehicles and plant operating on site. • Residue from the cleaning facility should be collected, and either dewatered on site in a contained bunded area or disposed as a slurry to an approved facility. Such residue will be deemed contaminated unless proven otherwise.
Transport of materials (off site)	Prior to being assigned to an appropriate waste disposal facility, all waste fill/soils should be classified in accordance with the NSW EPA (2014) Waste Classification Guidelines. If prior immobilisation treatment of the waste soils is required, disposal consent will be obtained from the NSW EPA prior to spoil transport. • All trucks transporting soils from the site are to be covered with tarpaulins (or equivalent). • All haulage routes for trucks transporting soil, materials, equipment and machinery shall comply with all road traffic rules, minimise noise, vibration and odour to adjacent premises, utilise state roads and minimise use of local road. • All deliveries of soil, materials equipment or machinery should be completed during the approved hours of remediation and exit the site in a forward direction.

Item	Description/ Requirements
	• Removal of waste materials from the site shall only be carried out by a recognised contractor holding the appropriate EPA NSW licenses, consents and approvals. • Waste must be transported less than 150 km from the source (POEO, Waste, 2014) and landfills are required to be licensed for the category of waste they are scheduled to receive.
Material tracking (off site)	Materials excavated from the site should be tracked from the time of their excavation until their disposal ("cradle to grave"). Tracking of the excavated materials should be completed by recording the following: • Origin of material; • Material type; • Approximate volume; and • Truck registration number. Disposal locations will be determined by the remediation contractor. Disposal location, waste disposal documentation (weighbridge dockets) and the above listed information should be provided to the remediation consultant for reporting purposes.
Material visual inspection prior to validation sampling.	Following the completion of remedial works as specified within this RAP, the following applies: • A suitably qualified environmental scientist should undertake a visual inspection of the work area. If visual observations indicate contamination, the earthworks contractors should rectify any issues arising from the inspection (i.e. further excavation or 'chasing out' until soils show no evidence of contamination based on visual inspection and/or odours); and • Following satisfactory completion of the visual inspection, validation sampling of soils should be completed. Validation sampling is discussed in **Section 8**. Only following satisfactory validation, will remedial works be deemed as completed.

7.4 UNEXPECTED FINDS PROTOCOL

While there are many expected finds that will be identified during the landfill excavation, there is the potential for unexpected objects or situations to be encountered. This may include strange odours, unusual staining or colour of soils/material, non aqueous phase liquids (fuels or solvents) and the potential biological hazards (e.g. buried carcasses). Should unexpected finds be encountered during site works, the following hierarchical approach should be adopted (see **Table 7 3**). The site auditor must also be notified without delay of all unexpected finds.

Table 7 3 Unexpected Finds Protocol



7.5 MANAGEMENT PLANS

All work should be undertaken with due regard to the minimisation of environmental effects and to meet all statutory environmental and safety requirements (**Section 7.5**). An Environmental Management Plan (EMP) should be developed for the site works by the site contractor/builder which should also take into account any Council DA conditions and guidance including but not limited to:

- Council Conditions of Consent;
- Camden Council Development Control Plan;
- Guideline for the Preparation Of Environmental Management Plans, DIPNR 2004, and
- Managing Urban Stormwater, Soils and Construction, Volume 1: 4th edition (March 2004) – often referred to as the 'blue book'.

The overall site management related to the remedial works is presented in **Table 7 4**.

Table 7 4 Site Management Measures

Category	Measure
Asbestos Management	Appropriate measures shall be taken to ensure that demolition works are completed in accordance with WorkCover Standards and Codes of Practice. Any asbestos identified within building materials should be managed in accordance with WorkCover Codes of Practice and Australian Standards, and should be detailed within the EMP.
Site Stormwater Management and Control	Appropriate measures shall be taken to ensure that potentially contaminated water does not leave the site. Such measures should include, but not be limited to: • Diversion and isolation of any stormwater from the landfill/quarry areas; • Provision of sediment traps including geotextiles or hay bales; and • Discharge of any water to drains and water bodies must meet the appropriate effluent discharge consent condition under the *Protection of the Environmental Operations Act*.
Soil Management	Appropriate measures shall be taken to ensure soils are excavated using a methodology appropriate to reduce nuisance dust and odours from leaving the boundary, and are disposed of in accordance with the NSW Government *Protection of the Environment Operations (Waste) Regulation* (2014).
Dust and Odour	Control of dust and odour during the course of the remediation works shall be maintained by the contractor to ensure no nuisance dust or odours are received at the site boundary. Air quality monitoring (odour and dust) is required on the site boundaries with residential and child care premises comprising: • PID/LEL monitoring to ensure the level of volatile organics is below 5ppm; • Explosive atmospheres above 5% • Provision of dust sedimentation monitors to ensure no dust is detected at the boundaries; and • Asbestos monitoring in accordance with **Table 6 2**.
Noise and Vibration	Noise and vibration will be restricted to reasonable levels. All plant and machinery used on site will be noise muffled to ensure that noise emissions do not breach statutory levels as defined within the Camden DCP (2011).
Hours of Operation	Working hours will be restricted to those specified by Council, which is loosely defined as being 7am to 7pm weekdays and 7am to 5pm Saturdays; no Sunday work permitted. All remediation work shall be conducted in accordance with the standard hours of operation outlined in Camden Council DCP 2011. These hours may differ from DA conditions, and DA conditions specified for the site must be adhered to.

Category	Measure
Incident Management and Community Relations	While various environmental management and occupational safety plans will be developed to protect human health and the environment, incidents may occur which pose a risk to the various stakeholders. To mitigate these risks and ensure that a suitable response is carried out quickly, a response plan to any incident that may occur on site should be prepared and various responsibilities assigned. The site health and safety plan and environmental management plan should document these procedures and responsibilities and incident contact numbers should be maintained in an on site register. All other relevant emergency contact numbers such as Police, Fire Brigade, and Hospital should be listed in the Health and Safety Plan and posted on site for easy access.

7.6 Contingency Management

Contingency plans for anticipated problems that may arise on site during the course of the site preparation works comprising demolition and remediation are presented below in **Table 7 5**.

Table 7 5 Contingency Management

Anticipated Problems	Corrective Actions
Chemical/ fuel spill	Stop work, notify above site project manager. Use accessible soil or appropriate absorbent material on site to absorb the spill (if practicable). Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Excessive Dust	Use water sprays to suppress the dust or stop site activities generating the dust until it abates.
Excessive Noise	Identify the source, isolate the source if possible, modify the actions of the source or erect temporary noise barriers if required.
Excessive Odours/Vapours	Stage works to minimise odours/vapours. If excessive organic odours/vapours are being generated, stop works and monitor ambient air across site for organic vapours with a PID and odours at site boundaries. Implement control measures including respirators for on site workers, use of odour suppressants, wetting down of excavated material.
Excessive rainfall	Ensure sediment and surface water controls are operating correctly. If possible divert surface water away from active work areas or excavations.
Water in excavations	Collect samples and assess against relevant NSW EPA *Waste Classification Guidelines (2014)* assessment criteria, to enable disposal options to be formulated.
Leaking machinery or equipment	Stop the identified leak (if possible). Clean up the spill with absorbent material. Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Failure of erosion or sedimentation control measures	Stop work, repair failed control measure.
Unearthing unexpected materials, fill or waste	Stop activities, contact the site project manager. Prepare a management plan to address the issue.
Identification of cultural or building heritage items	Stop work and notify site project manager. Prepare action or conservation plan as required.
Equipment failures	Ensure that spare equipment is on hand at site, or that the failed equipment can be serviced by site personnel or a local contractor.
Complaint Management	Notify Client, Project Managers and Environmental Consultant (if required) following complaint. Report complaint as per management procedures. Implement control measures to address reason of complaint (if possible). Notify complainant of results of remedial actions.

7.7 REMEDIAL CONTINGENCIES

At this stage it is anticipated that the proposed remedial technologies should be effective in dealing with the contamination present, however remedial contingencies may be required should the scenarios detailed in **Table 7 6** arise.

Table 7 6 Remedial Contingencies

Scenario	Remedial Contingencies/Actions Required
Highly contaminated soils, or non aqueous phase liquids not identified during previous investigation are encountered, particularly at site boundaries.	Work to be suspended until the Environmental Consultant can further assess impacted soils/ materials and associated risks.
Impacted material identified in quarry below depth of previous investigations.	Additional assessment may be required to assess depth of impact and migration pathways.
Residual material remains on site in unexcavated soils and rock that may present a potential vapour risk to receptors.	The adoption of conservative Investigation Levels as the remediation criteria may cause the remediation work to not meet remediation goals. As a contingency a site specific risk assessment would be undertaken that provides more optimal criteria to mitigate any potential risk to human and environmental health.
Filled tanks or drums are encountered at the site.	Systems to be removed and the excavations appropriately validated and backfilled by experienced contractor. Tank removal works reported by appropriate environmental consultant in accordance with NSW EPA guidelines.
Large volume of asbestos wastes are encountered.	Work to be suspended and asbestos work removed by a suitably qualified contactor, in accordance with WorkCover regulations.
Residual soil impacts remain on site	Review/assess potential vapour hazard If there is a vapour risk additional remedial measures may be required including installation of a vapour barrier or passive or active vapour extraction system. Assess risk to human health and the environment including risk based clean up criteria.
Groundwater/leachate has migrated off site or there are increases in concentration due to increased infiltration.	Review contaminant increase and analytes. Review active remediation alternatives (if necessary). Ensure down gradient monitoring is undertaken. Carry out fate and transport modelling (if required), develop alternative risk based criteria and assess the need for further action. Should the risk assessment identify potential impacts to the downgradient receptors, alternative remedial measures may to be considered including source removal, natural attenuation and bioremediation.
Changes in proposed future land uses at the site.	Review of the remediation works completed for the site.

7.8 WORK HEALTH AND SAFETY PLAN

As required by the NSW Work Health and Safety Act 2011 and associated Regulations, a Work Health and Safety (WHS) Plan should be prepared by the Principal Contractor to manage the health and safety of site workers and nearby residents, and address such issues as site security, exclusion zones, excavation safety, vibration, noise, odour and dust levels. The plan should address the risks during the remediation works and cover site specific requirements associated with the contaminants present within the site soils and groundwater.

The site officer responsible for implementing health and safety procedures should induct all site personnel so that they are aware of and comply with, the requirements of this document. It is the contractor's responsibility, with assistance from client/owner(s) of the site to ensure that all other permits, approvals, consents or licences are current. The following hazards and mitigation measures relevant to the remedial works are presented in **Section 7.2**, with a brief summary in **Table 7 7**.

Table 7 7 Remedial Hazards

Anticipated Problems	Corrective Actions
Chemical Hazards	Contaminated sites have chemical compounds substances or materials that may present a risk to human health and the environment. Chemicals of concern and associated risks are as detailed within the Conceptual Site Model, within **Section 4.** The site specific WHS plan should set out controls to mitigate any potential risks.
Physical Hazards	The following hazards are associated with conditions that may be created during site works: • Explosive atmospheres; • Confined spaces (during quarry excavation) • Heat exposure; • Buried services; • Noise, vibration and dust; • Electrical equipment; and • The operation of heavy plant equipment.
Personal Protective Equipment and Monitoring	Personnel should, wherever possible, avoid direct contact with potentially contaminated material. Workers are to ensure that surface waters or groundwater is not ingested or swallowed and that direct skin contact with soil and water is avoided. Standard PPE as specified for the contractor will be sufficient for the prescribed remedial works.

7.9 COMMUNITY ENGAGEMENT

In accordance with the NEPM (2013) a "Community Consultation Plan" should be developed to provide the local community with the appropriate resources to manage environmental and amenity impacts through the remediation/development process. The plan should include however not be limited to the following:

- Site notice boards
- periodic newsletters mailed or emailed to neighbours, concerned residents and business operators;

The site notice board and newsletter should include as a minimum the following information:

- approved hours of work;
- contact person for the site i.e. the site/project manager and their contact phone, fax, mobile numbers and email address and a 24 hour contact phone number for any complaints
- the responsible managing company (if any) and its address
- the site activities and time frames;

A formal complaint management system should be developed to respond to all complaints in a timely manner and advise complainants of outcomes and establish protocols for resolving differences.

Prior to conducting any remediation works on the site, this community consultation/engagement plan would provide details to the surrounding residents and sensitive receptors within 100 m of the site boundary and along Elyard St, in the form of a newsletter/letter drop at least 30 days in advance and include:

- indicate that excavation and remediation work is to be carried out at the site
- state the time and date the work is to commence
- indicate that works are being conducted in accordance with the consent and to minimise any risk of site contamination impacting off site receptors,
- Indicate all site remediation works are being reviewed by a NSW EPA accredited site auditor to ensure the site is suitable for the proposed land use; and
- provide the contact information and processes required for registering any complaints.

8. VALIDATION PLAN

The remediation of the impacted fill material and excavation of the former landfill would be validated in accordance with the NSW EPA guidelines will be deemed acceptable based on the achievement of the following two validation objectives:

1. ***Landfill Excavations*** – Validation of all remedial excavation areas where contaminated/landfilled soils have been removed, and that contaminant concentrations are within the *Remediation Criteria* (Section 4).
2. ***Groundwater/Leachate*** – Monitoring of groundwater so that contaminant concentrations are within the *environmental criteria or Trade waste* (Section 4) or does not present at risk to human health (including vapour intrusion/ground gas) and the environment to the extent practicable.
3. ***Ground gas*** – Validation of the post landfill surface and surrounding lands to ensure that the gas screening value is suitable for potential site zoning (B2 and R3).
4. ***Backfill Materials*** – Validation of the on site capping material and any imported fill materials used for the backfilling of remediated areas would be required to verify their suitability for the proposed land use zoning.

8.1 SOIL SAMPLING METHODOLOGY

The soil and groundwater sampling and handling of the collected samples is proposed in **Table 8 1**.

Table 8 1 Soil Sample Collection and Handling

Action	Description
Sample Collection (soils)	Soil validation sampling will be directly from the material brought to the surface by the backhoe/excavator bucket. Sampling data shall be recorded to comply with routine chain of custody requirements. Regular headspace PID & LEL screening of soils (including daily PID & LEL calibration) being excavated.
Underneath concrete slabs)	50 m grid (surface and depth) • Analysed for TPH, BTEX, selected PAHs, heavy metals, asbestos & selected pesticides
Asbestos sampling	Detailed visual assessment of landfill materials and exposed quarry surfaces. Test pitting or other methodology in accordance Table 7 in Schedule B2 of the NEPM (2013) if asbestos identified under concrete slabs.
During excavation	Routine sampling of the excavated soils and landfill material to assess suitability for on site reuse and the impact from the known and unknown contaminant sources, including daily headspace field screening for any VOCs/landfill gases. Visual inspection of fill soils for any asbestos containing materials.
Final excavated surface (in quarry)	20 m grid (and selected wall samples) • TPH, BTEX, selected PAHs, heavy metals, asbestos
Final land surface following rehabilitation	50 m grid (approximately 15 samples) • TPH, BTEX, selected PAHs, heavy metals, asbestos)
Land farm and Stockpiled Material	Any soil material stockpiled on site for land farming should be sampled at a rate of one per 100 m^3 and/or stockpile guidelines in Schedule B2 of the NEPM (2013). Land farmed material suitable for re use may be tested at a higher frequency depending on the re use locations (i.e. use as surface soils). Stockpiled soil material considered geotechnically suitable for reuse will be tested at a rate of one per 100 m^3 for recycling or reuse.

Action	Description
On site Cap Material	Approximately 20,500 m³ of material is stockpiled on site. The material would be visually assessed and tested at a rate of 1 per 1000 m³ to ensure that it is suitable for backfilling into the quarry void.
Imported Fill Material	If material is required to be sourced from off site to reinstate the sites, it should be certified suitable for the intended use. If the material is not Virgin Natural Excavated Material (VENM) or if no suitable certification can be supplied by the source then the material should be sampled at a rate of one per 100 m³.
Laboratory Quality Assurance and Quality Control	The contract laboratory will conduct in house QA/QC procedures involving the routine analysis of: • Reagent blanks; • Spike recoveries; • Laboratory duplicates; • Calibration standards and blanks; • QC statistical data; and • Control standards and recovery plots.
Achievement of Data Quality Objectives	Based on the analysis of quality control samples (i.e. duplicates/replicates and in house laboratory QA/QC procedures), the following data quality objectives are required to be achieved: • conformance with specified holding times; • accuracy of spiked samples will be in the range of 70 130%; and • field and laboratory duplicates and replicates samples will have a precision average of +/ 30% relative percent difference (RPD). An assessment of the overall data quality should be presented in the final validation report, in accordance with the DEC (2006) *Guidelines for the NSW Site Auditor Scheme*.

The overall soil validation protocols are provided below:

- Material buried in the landfill to satisfy appropriate land use criteria with minimal access to soil
- Material exposed at the surface (top 0.5 m) to satisfy appropriate land use criteria and have no detectable asbestos, odour or other aesthetic issues.
- Should the waste classification exceed Restricted Solid Waste further treatment (including immobilisation) may be required to allow the material to be disposed of to a licenced landfill.

8.2 VAPOUR INTRUSION/GROUND GAS

The following sampling program is proposed to assess the potential vapour/ground gas risk to future land development following remediation but particularly where residual contamination/organic material or landfill waste may remain on the site in the former quarry area.

Soil vapour/ground gas samples will be measured from broadly spaced bores constructed into the surficial soils across the site to assess the sub surface conditions after excavation and backfilling of the quarry. Vapour/ground gas sampling would be undertaken with methods similar to the landfill gas monitoring that was undertaken between January 2012 and May 2013.

A summary of the proposed ground gas validation sampling strategy is presented in **Table 8 2**.

Table 8 2 Vapour/ground gas assessment

Area	Method
Outside former landfill/quarry (Areas A, part C & D)	Shallow (0.5 – 1m) bores on a 50 m grid basis (min 12 bores). Bores to be sampled monthly for three months following site rehabilitation.
Over former landfill/quarry and part C where some landfill waste was identified	Shallow (0.5 – 1m) bores on a 20 m grid basis (min 25 bores). Bores to be sampled monthly for three months following site rehabilitation.
Contingency for deeper ground gas	Minimum three bores drilled to 10m near former GSV hotspots GWM09, GWM13 and P6
Method	Ground Gas monitoring will be conducted at monthly intervals for 3 months following site rehabilitation. One sampling episode will be undertaken 1 week after a period of extended rainfall. • Monitoring will be conducted using a GF430 infra red gas analyser (or similar) and interface probe. The GF430 will be calibrated to detect methane (%LEL and %v/v), carbon dioxide (%v/v), oxygen (%v/v), carbon monoxide (ppm), hydrogen sulphide (ppm), atmospheric pressure (mb) and flow (l/hr). An interface probe will be used to monitor for groundwater depth and base of hole (if required). • A trained and experience environmental consultant will conduct the monitoring in accordance with EPA guidelines to provide appropriate quality assurance. • Calibration certificates will be provided for each visit to provide quality control of the results.
Analysis	Any identified screening levels above recommended criteria may require further monitoring to confirm or not the presence of landfill gas and assessment of various mitigation or management measures.

The proposed soil vapour validation works would be completed in accordance with guidance detailed in NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure 1999 (2013 Amendment), as well as the NSW EPA Vapour Intrusion: Technical Practice Note (September 2010) and EPA (2012) Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases.

8.3 GROUNDWATER/LEACHATE

Following the excavation works, seepage into the filled void will eventually return the groundwater table to stabilised water levels. No validation sampling of the groundwater is proposed, however the groundwater/leachate would be monitored during the dewatering and treatment process prior to disposal. The routine monitoring results would be presented in the proposed validation report. The groundwater/leachate sampling is outlined in **Table 8 3**.

Table 8 3 Groundwater/Leachate Sample Collection and Handling

Action	Description
Groundwater/leachate water quality	Groundwater/leachate would be sampled on a regular basis (rate yet to be determined), to assess the inflow and outflow water quality (including physical and chemical parameters). The analyte suite would be selected depending on whether the water is pumped to sewer or stormwater. Treated water may also be used on site for environmental controls. This water may be tested for basic water quality parameters.

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Action	Description
Methods	Analysis would be undertaken in accordance with Sydney Water approved analytical methods or similar. http://www.sydneywater.com.au/SW/your business/managing trade wastewater/industrial trade wastewater/index.htm
Flow	A flow meter would be provide on the boundary to assess the volume of water pumped to the sewer or stormwater in accordance with Sydney Water or Camden Council requirements.

The validation aims to confirm that remedial objectives and remedial endpoints or targets in the RAP have been met. For groundwater sampling, the monitoring may need to demonstrate, where applicable, that:

- concentrations of the contaminants do not pose an unacceptable risk to human health (including vapour/ground gas risk) or the environment.

8.4 Validation Reporting

All remediation activities, fieldwork and validation sampling, chemical analysis, discussions, conclusions and recommendations will be documented in a validation report for the site. The validation report will be prepared in general accordance with requirements of the NSW EPA (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme*.

This report shall be submitted to the NSW EPA site auditor at the completion of the remediation works program. No building construction other than the necessary excavation works (including retaining structures) should commence until the remediation and validation report has reviewed by the auditor and Site Audit Statement and a Site Audit Report has been issued. The goal of the remediation and validation works is to enable the site auditor to prepare a 'Section A' site audit statement with no EMP required for sign off.

8.5 Data Quality Objectives

All remediation works and validation sampling would be done in accordance with the USEPA (2006) *Data Quality Assessment* and the DEC (2006) *Guidelines for the NSW Site Auditor Scheme*. The process of Data Quality Objectives (DQO) is to be used by the EI to determine the appropriate level of data quality needed for the specific data requirements of the project. The DQO process that shall be applied for this RAP and validation works is documented in **Table 8 4.**

Table 8 4 Summary of Project Data Quality Objectives

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Deviations from DQOs
1. State the Problem Summarise the contamination problem that will require new environmental data, and identify the resources available to resolve the problem; develop a conceptual site model	Give a concise description of the problem Develop a conceptual model of the environmental hazard to be investigated. Identify resources available.	The site is zoned for Local Centre (B2) and Medium density residential (R3). The CSM is presented in **Section 3** The site is to be remediated to enable the above land use. No development plans have been prepared for the site.	.
2. Identify the Goal of the Study (Identify the decisions) Identify the decisions that need to be made on the contamination problem and the new environmental data required to make them	Identify principal study question(s). Consider alternative outcomes or actions that may result from answering the question(s). For decision problems, develop decision statement(s), organise multiple decisions. For estimation problems, state what needs to be estimated and key assumptions.	*Remedial works:* Remedial works and validation sampling are required to confirm that the site will be suitable for the intended zoning following remedial works The sampling strategy will be designed to such that there is a 95% chance of detecting a hotspot with a minimum diameter of approximately 24 m.	.
3. Identify Information Inputs (Identify inputs to decision) Identify the information needed to support any decision and specify which inputs require new environmental measurements	Identify types and sources of information needed to resolve decisions or produce estimates. Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process. Select appropriate sampling and analysis methods for generating the information.	The main inputs to the remedial works include: • Former investigation reports including longer term monitoring over 12 months • Subsequent soil validation and / or additional investigation analytical data; • Installation of additional monitoring bores for ground gas monitoring; • The guidelines referenced in this RAP.	
4. Define the Boundaries of the Study	Define the target land use and receptors of interest and its relevant spatial boundaries.	Lateral – the boundaries of the site; Vertical – from the existing ground level down to the base of the former quarry.	.

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Deviations from DQOs
Specify the spatial and temporal aspects of the environmental media that the data must represent to support decision	Define what constitutes a sampling unit. Specify temporal boundaries and other practical constraints associated with sample/data collection. Specify the smallest unit on which decisions or estimates will be made.	Temporal –Validation sampling will be representative of the day the samples are collected. Ground gas sampling would be undertaken for 3 months after site rehabilitation. Regulatory – All validation works will be undertaken with guidelines made or approved by the NSW EPA under the CLM ACT 1997.	
5. Develop the Analytic Approach (Develop a decision rule) To define the parameter of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing from alternative actions	Specify appropriate land use parameters for making decisions or estimates. For decision problems, choose a workable Action Level and generate an "If then else" decision rule which involves it. For estimation problems, specify the methodology and the estimation procedure.	**The decision rules for the soil remediation will be**: The maximum concentration and the 95% UCL average of the arithmetic mean contaminant concentration shall be compared to the relevant Tier 1 screening criteria. However, where there is sufficient data available, and it is appropriate for the exposure being evaluated, the arithmetic mean (or geometric mean in cases where the data is log normally distributed) should also be compared to the relevant Tier 1 investigation or screening level. The implications of localised elevated values (hotspots) should also be considered. The results should also meet the following criteria: • the standard deviation of the results should be less than 50% of the relevant investigation or screening level, and • no single value should exceed 250% of the relevant investigation or screening level. • Decision criteria for QA/QC measures are defined by the Data Quality Indicators (DQI).	
		The decision rules for the groundwater remediation In accordance with guidance provided by the NSW EPA or others such as the US EPA (1992) Methods for evaluating the attainment of clean up standards Volume 2: Groundwater. The following process is used for the calculation of the mean of the results from individual monitoring wells and use the standard error of the mean to construct the one sided confidence interval: • Calculate the sample mean; • Calculate the standard error of the sample mean; • Calculate the 95% upper endpoint of the one sided confidence interval;	

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Deviations from DQOs
		• The 95% upper endpoint confidence interval = sample mean + (1.65 x standard error); and If the 95% upper endpoint confidence interval is below the remediation criteria, EI will conclude that the remediation goal has been achieved; otherwise EI will conclude that either additional remediation is required, or remedial goals have been achieved. **The decision rules for Vapour Soil remediation.** Due to the many variables that affect vapour measurement's; such as fluctuating source meteorological conditions, varying building use or conditions, and where remedial work is undertaken, EI will consider the soil vapour/ground gas remediation goals will be met when soil gas values are below the relevant risk ranking (EPA, 2012).	
6. Specify Performance or Acceptance Criteria (Specify limits on decision errors) Specify the decision maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data	For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors. For estimation problems, specify acceptable limits on estimation uncertainty.	Specific limits for this project will be accordance guidance made/ or approved by the NSW EPA, appropriate indicators of data quality and standard procedures for field sampling and handling. This should include the following points to quantify tolerable limits: A decision can be made based on a probability that 95% Upper Confidence Limits (UCL) of the data will satisfy the given site criteria. Therefore a limit on the decision error will be 5% that a conclusive statement may be incorrect. A decision can be made based on the probability that a contamination hotspot of a certain circular diameter will be detected with 95% confidence using a selected density of systematic data points. The decision error will be limited to a probability of 5% that a contamination hotspot may not be detected.	
7. Develop the Detailed Plan for Obtaining Data (Optimise the design for obtaining data) Identify the most resource effective sampling and analysis design for general data that are expected to satisfy the DQOs	Compile all data and outputs generated in Steps 1 to 6. Use this information to identify alternative sampling designs that fit your intended use	Written instructions will be issued to guide field personnel in the required fieldwork activities. Unexpected finds or additional sampling may require further assessment of the remediation process. Ground gas risk in excess of residential land use may require further assessment and or mitigation measures.	

DQO Steps (NSW DEC, 2006)	US EPA (2006) (modified)	Details	Deviations from DQOs
	Select and document a design that will yield data to best achieve your data quality.		

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Attachment 2

8.6 AUDITOR LIAISON AND SIGN OFF

The validation strategy for the site has been designed to be flexible and involve continuous liaison with the Site Auditor. The process of liaison is designed to enable the Auditor to keep a continuous check on each phase of works, including results and quality control for the proposed remediation program.

9. CONCLUSIONS

Based on the information available, this Revised RAP has been prepared to undertake remediation at 3 Elyard Street, Narellan, NSW. It is envisaged that these site will be remediated in stages which will require the development of appropriate sampling and analysis, hazardous materials, environmental management, followed by demolition of the concrete slabs in order that the site be remediated to allow future development in accordance with the site zoning. The following stages are therefore considered to achieve the overall objective of the remediation:

- Review and approval of the RAP by the Site Auditor to allow commencement of the site works;
- Approval of the RAP and associated application by Camden Council and other agencies (and associated development consent conditions);
- Selection of a suitably qualified and licensed excavation contractor;
- Preliminaries including approvals;
- Implementation of the remedial measures identified in the RAP;
- Validation sampling in accordance to the approved RAP; and
- Validation reporting

In summary, Environmental Investigations considers that the site can be made suitable for the land zonings following the implementation of this RAP.

10. STATEMENT OF LIMITATIONS

This RAP has been prepared with reference to the relevant EPA guidelines. It is based on reviews of previous environmental site investigation reports, most of which included specific searches through relevant, historical databases and numerical data. It was assumed that the historical records were complete at the time of preparing the investigative reports. Although land use may not be have been specified, some of the conclusions drawn were also based on interpretations of the anecdotal and visual information that were made available during the course of these investigations.

This RAP also relies upon data, measurements and/or results taken at, or under, the particular times and conditions specified in the corresponding report. For example, numerical data presented in the reports were the result of discrete and specific sampling methodologies used in accordance with best industry practices and standards. Due to the site specific nature of soil sampling from point locations, however, it is considered likely that all variations in subsurface conditions across a site cannot be fully defined, no matter how comprehensive the field investigation program.

No warranties are made as to the information provided in this RAP. All strategies, conclusions and recommendations made in this RAP are of the professional opinions of EI personnel involved with the project and while normal checking of the accuracy of information has been conducted, any circumstances outside the scope of this RAP or which were not made known to EI personnel and which may impact on those opinions are not the responsibility of EI.

This report, its associated documentation and the information herein have been prepared solely for the use of Dibblar Pty Limited, Jimbalia Pty Limited, Greenfields Development Corporation Limited, and D Vitocco Constructions Pty Limited, their directly appointed consultants and the appointed NSWEPA Site Auditor (Mr Rod Harwood). No responsibility is accepted for the use of any part of this RAP in any other context or for any other purpose or by other third parties. Any ensuing liability resulting from use of the report by third parties cannot be transferred to EI. This RAP does not purport to provide legal advice.

This report remains the property of EI subject to payment of all fees due for this RAP. The report shall not be reproduced except in full and with prior written permission by EI.

11. REFERENCES

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Attachment 2

12. ABBREVIATIONS

AHD	Australian Height Datum
ASS	Acid sulfate soils
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BGL	Below Ground Level
BH	Borehole
BTEX	Benzene, Toluene, Ethyl benzene, Xylene
DEC	Department of Environment and Conservation, NSW
DECC	Department of Environment and Climate Change, NSW(formerly DEC)
DP	Deposited Plan
EPA	Environment Protection Authority
F1	TPH C6 – C10 less the sum of BTEX concentrations
F2	TPH >C10 – C16 less the concentration of naphthalene
GIL	Groundwater Investigation Level
GME	Groundwater monitoring event
GSV	Gas screening value
HIL	Health based Investigation Level
HSL	Health based Screening Level
mAHD	Metres relative to Australian Height Datum
mBGL	Metres below ground level
mg/m^3	Milligrams per cubic metre
mg/L	Milligrams per litre
µg/L	Micrograms per litre
MW	Monitoring well
OEH	Office of Environment and Heritage, NSW(formerly DEC, DECC, DECCW)
PAHs	Polycyclic Aromatic Hydrocarbons
PID	Photoionization detector
ppbv	Parts per billion by volume
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance / Quality Control
RAP	Remediation Action Plan
TCLP	Toxicity Characteristics Leaching Procedure
TPHs	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds (including Chlorinated Solvent)

FIGURES

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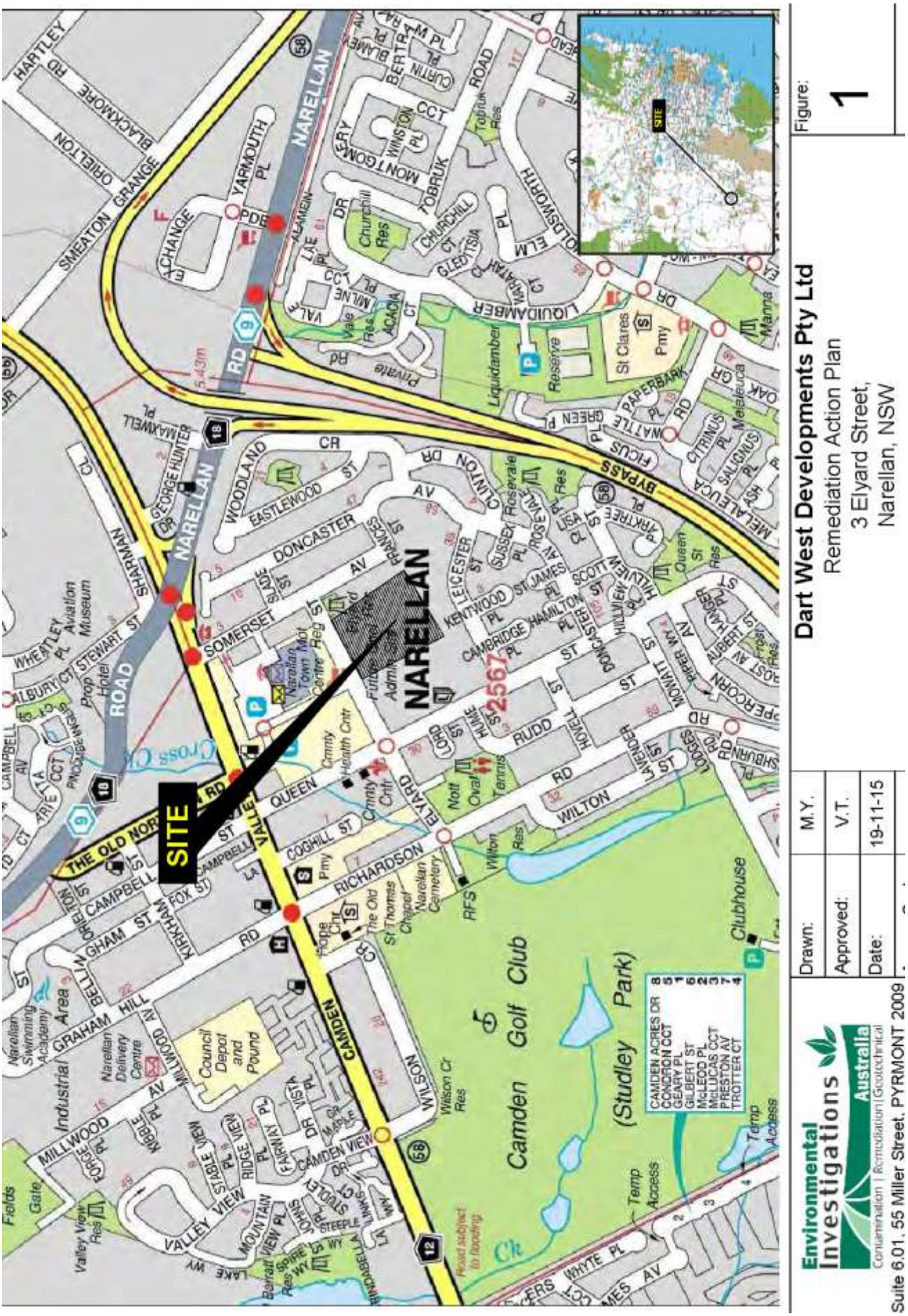
Attachment 2



LEGEND

Approximate site boundary

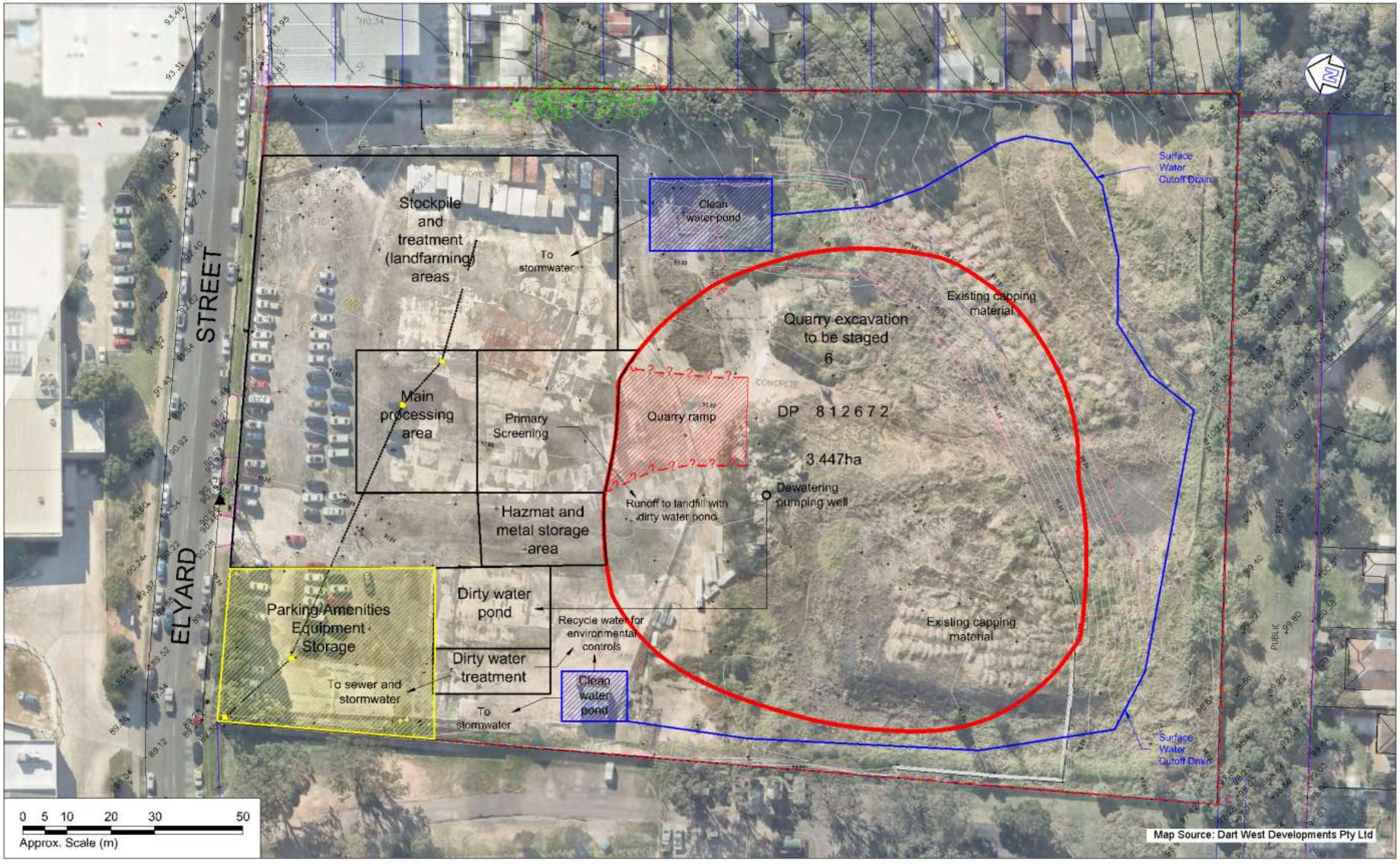
Environmental Investigations Australia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009

Drawn:	V.T.
Approved:	G.B.
Date:	19-11-15
Approx Scale:	1:800@ A3

Dart West Developments Pty Ltd
Remediation Action Plan
3 Elyard Street,
Narellan, NSW
Site Layout

Figure: 2

Project: E1445.1 AT



LEGEND

Approximate quarry / landfill boundary

Approximate site boundary

Environmental Investigations Australia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009

Drawn:	M.Y.
Approved:	V.T.
Date:	19-11-15
Approx Scale:	1:800@ A3

Dart West Developments Pty Ltd
Remediation Action Plan
3 Elyard Street,
Narellan, NSW
Landfill Remediation Strategy Plan

Figure: 3

Project: E1445.1 AT

Appendix A
Summary of previous investigations

The following is a summary of the previous investigation taken from the various documents provided by the client. The provide conclusions and recommendations some of which have been addressed in subsequent reports or advice.

SMEC (2003) PSI

Groundwater related findings, as earlier summarised in the LTMP (WSP 2011):

- The PSI was requested as part of a pre sale investigation to determine the depth of landfilling, the level of contamination present in the landfill and the condition of the clay cap.
- The scope of intrusive works included: collection of 13 clay cap samples; logging of landfill wastes at 5 locations; installation of 3 groundwater monitoring wells; collection of 3 leachate samples; landfill gas monitoring on 2 occasions; chemical analysis of 14 soil and 3 leachate samples.
- The ground conditions encountered included concrete pavement (0.1 to 0.34m thick); clay capping with inclusions of sand, gravel, ash, slag, blue metal (0.55 to 0.8m thick); and, landfilled waste (proven to 6.6m depth but anecdotally up to 20m in depth) comprising wire, metal, timber, tyres, plastic, particle board, paper, concrete, fabric, hessian, bricks, clay, cables, marble sheeting, sandstone blocks, fibrous cement sheeting (potentially containing asbestos), cardboard, roof tiles, mirror, taping and pipes.
- Significant settlement can be expected within the landfill;
- Groundwater wells were installed into test pits TP2, TP4 and TP5. The wells (GW2, GW4 and GW5) were constructed by inserting slotted PVC piping with filter socks to depths of up to 6.8m in the pits. A complete account of well installation was not provided.
- Groundwater inflows were encountered at depths of between 2.5m and 4.5m during investigation works. Groundwater was discoloured and had a moderate odour.
- The 3 leachate samples were analysed at a NATA accredited laboratory for M8, TPH, BTEX, PAH, phenols, VOC and ammonia. The results were compared against ANZECC (2000) guidelines (80% Protection level). Cadmium, copper, lead, nickel, zinc and ammonia were found to exceed the selected guidelines. WSP note the same contaminants exceeded the ANZECC (2000) guidelines 95% protection level guideline values (i.e. a moderately disturbed ecosystem). WSP note the laboratory detection limit for cadmium and chromium were above the guideline value. WSP notes no assessment criteria were provided for TPH, PAH, phenols or VOC in water. The following concentration ranges were reported: TPH C6 C9 (49 and 216ug/l), TPH C10 – C14 (559 – 2400 µg/l), TPH C15 C28 (2310 – 4350 µg/l). TPH C29 36 (340– 841ug/l). WSP note BTEX and PAH were below ANZECC (2000) guidelines (including low reliability guidelines).
- It was recommended that further investigation of soil, groundwater, landfill gas, durability and geotechnical aspects were required to facilitate redevelopment of the site.

EES (2004) DSI

Groundwater related findings, as earlier summarised in the LTMP (WSP 2011):

- The DSI was completed as part of a residential development approval process required by Camden Council.
- The scope of intrusive works included collection of 7 surface soil samples (SS1 – SS7); 13 soil sampling boreholes (BH1, 2, 4, 5, 8, 12, 13, 14, 17, 19, 20, 22 and 29); installation of 11 shallow gas wells (BH3, 15, 16, 18, 23 to 29 inclusive); installation of 1 deep gas probe (BH10); installation of 2 shallow water and gas wells (BH6 and 7); installation of 1 monitoring well and gas well within the landfill (BH9); installation of 5 deep water and gas wells (BH11, 30 to 33 inclusive); 1 surface gas survey; 1. leachate sampling round; 2 gas sampling rounds; chemical analysis of 3 to 24 soil samples and 1 to 7 leachate samples depending on the analyte under consideration.
- The EES Investigation made use of 20 monitoring wells, including 4 deep monitoring wells in the shale formation underlying the landfill. The wells that are still in good condition. Former deep groundwater wells are shown on Figures 2 and 3 in Appendix A.

- Three characteristic soil profiles were encountered, namely Natural Profile (i.e. out with the former landfill): Fill Profile (i.e. fill layer overlying Natural Profile (stiff clay over shale) characteristic of site levelling) and Landfill Profile (i.e. clay cap overlying wastes and Natural Profile (shale)).
- Wells installed to capture leachate: one monitoring well (BH9) was installed within the landfill area. Fill was encountered to 6.6m depth overlying shale to the termination depth of the bore (6.9 m below ground level, mBGL). The well was screened across both fill and natural shale. BH6 and BH7 were drilled outside of the landfill extent; however, landfill material was encountered at both locations to 2.6m in BH6 overlying natural shale and to the termination depth of BH7 (3.3 mBGL). It was not known whether the landfill extent continued further than originally thought or the fill found at BH6 and BH7 was part of a separate filling occasion during which the site level in the north west site area was raised. The wells were installed to investigate any impacts to perched water at these locations. EES indicated BH9 represented leachate generated within the landfill and samples from BH6 and BH7 represented perched water possibly interconnected with the landfill cell.
- In addition, 5 wells (BH11, BH30 to BH33) were installed to investigate groundwater conditions in the natural shale. EES reported confined conditions in the shale but noted a high piezometric head in BH33 complicated the groundwater level pattern and was considered to be anomalous. Groundwater flow direction was inferred to be from southeast to northwest with the main discharge zone expected to be Cross Creek located approximately 250m from the site.
- EES indicated a potential for groundwater in the shale to be in interaction with leachate in the landfill cell as the leachate level was approximately equivalent to the piezometric head in the underlying aquifer. EES also noted a number of potential scenarios of leachate movement including (a) migration of leachate into the shale and (b) discharge of groundwater from the shale into the landfill, if the landfill penetrated the full extent of the confining layer.
- Two groundwater sampling events were undertaken on 20 August and 8 October 2004. Strong landfill and solvent odours were recorded during sampling of BH9 with a slight hydrocarbon odour observed in BH6. High salinity levels (8390 18210 us/cm were recorded in wells screened in the shale aquifer (BH11, BH30, BH31, BH2 and BH33). The highest salinity was found in BH9, located within the landfill and the lowest were reported in shallow/perched wells BH6 and BH7 (3,080 and 3,310us/cm). Groundwater temperature was noted to be highest BH9 and lowest in BH6 and BH7.
- Groundwater sampling results were compared against both ANZECC (2000) Freshwater (FW) and Marine (MW) Guidelines and NSW EPA (1994) Guidelines for assessing service station sites. Heavy metal concentrations in all wells were reported to be below site criteria; however, the laboratory detection limit was above the assessment criteria for aluminium, copper, zinc, cadmium and chromium.
- Ammonia was found above criteria in BH9 (580mg/L), BH7 (10mg/L), BH6 (1mg/L), BH31 (1.8mg/L), BH32 (4.4mg/L) and BH33 (2.7mg/L). TPH C10 C36 was found above the LOR in BH9 and BH7 only, with concentrations of 8180ug/l and 605ug/l respectively. TPH C6 C9 was found above the LOR in BH9 only (950ug/l). BTEX components were found below the limit of reporting (LOR) in all samples with the exceptions of BH30 (toluene .1ug/l), BH32 (toluene – 1.1ug/l), BH33 (toluene – 3.2ug/l, xylene – 8.4ug/l) and BH9 (benzene – 4.4ug/l, toluene – 480ug/l, ethyl benzene – 43ug/l) and xylene (99ug/l). Only toluene concentrations in BH9 were above the ANZECC 2000 assessment criteria. Phenol was also found above the ANZECC 2000 FW and MW guidelines in BH9.
- Based on the available information at the time, EES (2004) made the following conclusions:
  - The backfilled quarry is assumed to be 7m deep with a radius of 66m (approximate area 13684m2) with an assumed total waste volume including capping of approximately 95,800m3.
  - The approximate volume of leachate within the backfilled quarry, assuming a porosity of 0.25, is 17 mega litres.
  - EES concluded a confined aquifer is located approximately 5m below the base of the landfill (80m AHD) and the potential for interaction between the confined aquifer and leachate within the landfill was considered to be low. EES further concluded a perched aquifer was present in the northwest corner of the site with a hydraulic head similar to the landfill leachate;

- Groundwater flow directions in the confined aquifer were concluded to be towards the northwest;
- Groundwater levels in BH33, located to the east of the landfill were not considered to be part of the regional groundwater gradient and EES considered that landfill leachate was potentially migrating from the landfill cell towards the well location.
- EES considered elevated heavy metals (copper, lead and zinc) reported by SMEC were due to inappropriate sampling techniques and were not considered contaminants of concern.
- Phenol and toluene were identified as the main contaminants of concern in leachate. A potential for migration of these contaminants from the landfill to the surrounding aquifer was identified owing to the detection of toluene in perimeter wells located outside of the landfill extent.
- Elevated concentrations of hydrocarbons in BH7 were considered to be in perched water, localised and due to soil contamination at this location.

- Based on the available information at the time, EES (2004) made the following recommendations:
  - Development should not take place within the footprint of the landfill cell, due to potential landfill gas migration issues.
  - Confirmation that elevated concentrations of TPH are not present in an aromatic form.
  - Management of leachate and associated plume is undertaken. A number of options were presented by EES, including completion of a risk assessment to determine potential impacts to receptors, modelling to predict the extent and duration of any impacts from leachate on the surrounding groundwater, on going groundwater monitoring program and/or reduction the head of leachate by extraction and treatment.

EES (2006) RAP

The EES (2006) RAP focussed on excavation and screening of all landfilled materials. Suitable material would be retained and used to backfill the resultant excavation and unsuitable material would be disposed of at a licensed landfill. The information is summarised from the site audit undertaken by Graeme Nyland (Environ, 2006) as follows:

Description	Proposed Remediation Method	Auditor Comments
Landfill waste	Excavation and sorting of landfill materials. Visual assessment by an environmental officer to identify potential asbestos. Identified asbestos will be disposed offsite and a 2m soil/ fill buffer surrounding the location will be excavated and isolated for validation sampling. A further 5m buffer will be cordoned off for potential future removal if the initial buffer is contaminated. Buffer material will be disposed offsite if required. Sorting and reuse or disposal of remaining materials as follows: Putrescible waste e.g. wood : reuse in landscaping or dispose offsite Oversize material: crushing and reuse in backfilling pit Gravels: reuse in backfilling pit Soil: reuse in backfilling pit or dispose offsite Refill excavation with recycled materials or clean fill.	It is noted that the landfill extent shown in figures in the RAP is schematic only. Based on logs, the Auditor considers the landfill is likely to extend further to the northwest and northeast than depicted. EES has advised (4 May 2006) that revised drawings will be prepared following preliminary test pitting at the commencement of works. The RAP often implies that "An assessment of landfill waste for off site disposal was ... completed ..." with results indicating a lack of contamination detections. The Auditor notes that landfill waste material at the site has not been characterised by laboratory analysis during any of the investigations undertaken to date. The remediation method is considered appropriate since removal of waste material will address associated contamination and landfill gas issues and long term groundwater contamination issues.
Landfill leachate	Extract leachate for onsite recycling, onsite evaporation via shallow evaporation ponds or disposal to sewer under a trade waste agreement. Recycling options are discussed in the RAP including washing of hardstand areas, dust mitigation, irrigation on stockpiled soil and use in vehicle washing. Further investigation of the water quality is proposed in the RAP during the initial stages of the site works to determine the most appropriate means of leachate management.	The Auditor was initially concerned that reuse of landfill leachate could contribute to the groundwater plume in the short term. However, EES has advised (4 May 2006) that it is the intention for leachate water to be irrigated over stockpiles at a rate suitable to allow evaporation to remove the majority of water, with any runoff from the stockpiled soil redirected back to the excavation pit. The Auditor agrees that this method would be unlikely to have a significant *effect* on the movement of leachate and its impact on the surrounding groundwater. The remediation method is considered appropriate since removal of leachate will address long term groundwater contamination issues
Landfill gas	Prior to excavation of the landfill waste, a landfill gas extraction system would be established to remove the majority of accumulated landfill gas. The system proposed comprises a series of trenches and deep extraction wells connected to a passive release vent raised approximately 5 m above the surface of the landfill. A flaring system is proposed as an alternative if passive venting is not approved or if venting rates are too high. An assessment of the most appropriate means of management would be made at the time of construction of the gas extraction system.	A detailed assessment of the landfill gas production and composition has not been undertaken to date. While the landfill gas is known to be methane rich (maximum 83% methane) it has not been analysed for odorous/ toxic components. The proposed venting of landfill gas would be a once off occurrence at the commencement of remediation with some minor emissions likely during remedial works but no_ ongoing emissions following waste removal. This process is considered acceptable with regards to the release of methane, however, it may also result in the concentrated release of odorous or toxic components. The initial assessment of

		landfill gas discharge should include composition analysis to allow for consideration of this issue. Flaring or some other form of landfill gas treatment may be warranted. Provided the above is considered, the remediation method is considered appropriate since it will reduce the ongoing risks posed by landfill gas during the remediation works and will address long term landfill gas issues.
Soil stockpile	A 20,000 m³ stockpile of reportedly clean soil is present on site and is to be redistributed on the site or removed prior to remedial works.	EES has advised (4 May 2006) that validation reports for this material will be reviewed and further validation would be carried out if validation to date was insufficient.
Northwest Part of Site fill	Remediation of this area is not explicit within the RAP. The RAP focuses on remediation of the landfill area. Other areas of the site, including the northwest fill, are addressed via validation following completion of the main remediation works. Section 6.1 .3 "Validation of Unexcavated Areas of the Site" states that "Where there is known contamination outside of the main excavation (e.g. BH7) or where additional contamination is discovered during the validation of unexcavated portions of the site, there would be a need for specific excavation to chase out that contamination." It is inferred that remediation would be proposed by excavation and offsite disposal of contaminated soils.	Validation of unexcavated areas is proposed in the RAP by grid based sampling to address the minimum requirements of the EPA (1995) "Sampling Design Guidelines". It is not explicitly stated, but it assumed that this sampling would be limited to surface sampling since the main objective was to identify potential contamination of surface soils due to stockpiling activities. It would also be undertaken following completion of the main remediation works. The Auditor did not consider this approach is appropriate for the northwest fill area, and recommends the following: Delineation investigations, not simply grid based locations; Deep investigations and sampling targeting zones of previously identified contamination; and Investigations prior to commencement of remediation works since disturbance of this area would occur if the evaporation ponds depicted in Figure 4 of the RAP were constructed. The inferred remediation method is considered appropriate provided the areas requiring remediation are accurately defined.
Unidentified impacts	As above, additional remediation may be warranted in any areas of contamination identified by validation sampling outside the landfill area. It is not stated explicitly, but it is implied that such remediation would be achieved by excavation and offsite disposal of contaminated soils.	Investigations at the site to date have focussed on the quarrying/ landfilling activities. In order to ensure that the process entitled "Validation of Unexcavated Areas of the Site" identifies possible additional impacts associated with other site uses, either past or current, at least half of the proposed validation samples should be extended deeper than the ground surface. These should be in building footprint areas or other areas of the site not previously investigated. Surface samples only would be considered acceptable in areas that had been used for

	stockpiling during remediation only, with no potential historical operational sources of contamination.

In summary the Auditor concluded the remediation approach described by EES was generally appropriate and adequately addressed the required information in accordance with the EPA guidelines.

GEC (2011) Geotechnical Comments & Specifications

The anticipated remediation and earthworks is summarised as follows:

- Excavation of fill materials and landfilled wastes at the crest of the former northern quarry boundary and construction of a 2m thick clay core (approximate required volume of 6,000m3) to assist with the control of perched groundwater (encountered at approximately 90m AHD) in the northern half of the site underlain by fill materials;
- Excavation and screening of fill materials from beneath approximately 7,600m2 of the north western portion of the site (approximate volume of 17,000m3). Reuse of geotechnically suitable fill materials to backfill the resultant void. The fate of geotechnically unsuitable materials from the screening process was not discussed;
- Construction of a 2m thick clay cap incorporating a 100mm thick gas venting layer across the approximate area (10,330m2) of the former backfilled quarry using an estimated 19,330m3 of imported clay material.

DLA (2011) RAP

The key components of the DLA (2011) RAP were summarised in previous reports and included:

- The remedial works are designed to render the site suitable for a mixture of residential (with minimal access to soil) and open space uses.
- The preferred remedial strategy is identified as On Site Capping and Containment. An LTMP would need to be developed which obligates future site owners to maintenance and monitoring schedules. This document would also place limitations to future development.
- The groundwater investigation in the RAP marks up former quarry access road in the north west portion of the site as 'shallow waste pit'.
- Design of a cut off wall as an impermeable structure with a minimum 100 year design life. Design of the cut off structure buffer zones to minimise possible future permeation of groundwater from the site. Design of a pump well and treatment system as a backup system for the unremediated zone. Specification of the cut off wall are not given.
- As a conservative measure, to further reduce the potential for groundwater to transport contaminants off site, permanent diversions will be installed on the up gradient side of the landfill to counteract the recharge sources. The diversion will be installed so as to prevent both surface water and infiltrated through flow from reaching the landfill basin.
- The RAP summarises additional groundwater sampling works conducted by DHA in July 2011. Groundwater samples were collected from 6 locations (MW1, MW2, MW4, MW6, MW7 and MW8) and analysed for TPH, PAH, BTEX, metals, pH, ammonia, nitrate, TDS, sulphate, sulphide, BOD and e coli. Hydrocarbon contaminants were found below the LOR in all wells except MW4 which reported slight detections of TPH C10 14 (82ug/l), TPH C15 28 (390ug/l) and naphthalene (7.1ug/l). Total chromium exceeded the ANZECC (2000) guideline for chromium VI in MW4 and MW2 (located downgradient of the landfill) exceeded the guideline for copper and lead.
- The remedial strategy has three main aims, namely, to negate the risk of gas intrusion into future structures or services; prevent migration of impacted soil or groundwater; and, facilitate the preferred intended land use.

- The onsite remediation strategy incorporates five main elements, namely, Stakeholder Consultation; Pre Remediation Works; Excavation and Remediation Works; Waste Classification; and, Validation.
- Environmental and occupational health & safety management requirements are also presented.
- The proposed remedial approach can be summarised as follows:
  - Construct clay core as described in Section 4.4;
  - Dewater fill materials to the north of clay core;
  - Excavation and screening of fill materials as described in Section 4.4;
  - Excavate existing clay cap across backfilled quarry;
  - Establish anchoring points for HDPE membrane;
  - Excavate localised TPH hotspots;
  - Offsite disposal of chemically unsuitable soils to licensed landfill;
  - Validate residual soils as being suitable for use;
  - Validate imported clean fill materials as being suitable for use on site;
  - Compact underlying fill / wastes and place HDPE membrane;
  - Construct clay cap as described in Section 4.4, bullet 3 above;
  - Place and compact clean imported fill to final design levels as described in Section 4.4, bullet 4 above;
  - Conduct soil gas validation; and
  - Develop and implement a Detailed LTMP.

EIA (2011) Gas and Groundwater Monitoring Report

Groundwater related findings based on the gas well locations, methane laboratory analysis, borehole records and a gas monitoring, as earlier summarised in the LTMP (WSP 2011):

- Thirteen gas wells (codes GWM01 to GWM13) were drilled at the locations shown on Figure 2 in Appendix A.
- GWM01 to GWM08 inclusive were installed around the perimeter of the landfill and GWM09 to GWM13 inclusive were targeted to the footprint of the former backfilled quarry.
- The wells were installed with screens from approximately 1.5m to 5m in clayey fill and shale. No distinct saturated zone was recorded; however, moist conditions were recorded in shale in all wells. Standing groundwater was recorded in 8 of the wells at depths of between 1.3m and 5.8 mBGL. Survey data was not available for these wells at the time of writing of the LTMP.

WSP (2012a) Gas & Groundwater Monitoring Report

- Gas monitoring and groundwater level gauging was conducted in all (23) available wells on the site, on 18 January 2012.
- Deep wells BH11, BH30, BH31and BH33 and several shallow wells could not be located and were assumed to be destroyed.
- Recorded Standing Water Levels (SWLs) in the wells are listed in Appendix B.
- Recordings of a pumping test in the landfill (conducted by EIA on 14 November 2011) were analysed and resulted in a relatively high estimate of hydraulic conductivity of 44 m/day (assuming a fill thickness of 5m). The result is related to the fill material only and was considered likely to be an overestimate, given steady state conditions were not reached during the test.
- A Preliminary Hydrogeological Conceptual Model was developed and the following Potential Pathways for Contaminant Migration were identified:
  - In shallow groundwater within fill and weathered shale down hydraulic gradient and off site to the north and north west;
  - In deeper groundwater within fractured shale down hydraulic gradient and off site to the north and north west, due to the potential for downward movement of groundwater from the shallow to the deep groundwater body;

- In shallow and deep groundwater to the west, east and south (i.e. against the dominant groundwater flow direction) due to the potential for radial flow.

The closest sensitive environmental receptor (Cross Creek) is located approximately 150m west and northwest (and down gradient) of the site. According to the Geology Sheet for the area (1:100,000: Wollongong – Port Hacking Geological Series Sheet (9029 – 9129)) both the creek bed and the area between the site and the creek is underlain by Bringelly Shale. As such, groundwater movement in the Bringelly Shale between the site and the creek is considered to be the pathway of concern

Leachate quality (in the landfill) as reported in previous investigations was compared against both ANZECC (2000) Freshwater (FW) and Marine (MW) Guidelines and NSWEPA (1994) Guidelines for assessing service station sites. The following contaminants were found above the guidelines and/or laboratory limit of reporting (LOR):

- Ammonia (580mg/L) was found above both the ANZECC 2000 FW (0.9mg/L) and MW (0.91mg/L) guidelines.
- Phenol (800ug/l) was found above the ANZECC 2000 FW(320ug/l) and MW(400ug/l) guidelines.
- Toluene concentrations (480ug/l) were above the ANZECC 2000 low reliability assessment criteria (180ug/l).
- Benzene (4.4ug/l), toluene (480ug/l), ethyl benzene (43ug/l) and xylene (99ug/l) were found above the LOR but below the ANZECC 2000 assessment criteria.
- TPH C10 C36 and TPH C6 C9 were found above the LOR, with concentrations of 8180ug/l 950ug/l respectively.
- LOR was above the assessment criteria for aluminium, copper, zinc, cadmium and chromium.

Groundwater quality (outside the landfill) from sampling by EES in 2004 was compared against both ANZECC (2000) Freshwater (FW) and Marine (MW) Guidelines. The following summarises the results from the sampling events (refer to Figures 2 and 3 in Appendix A for well locations):

- Ammonia was found above ANZECC 2000 assessment criteria in BH7 (10mg/L), BH6 (1mg/L), BH31 (1.8mg/L), BH32 (4.4mg/L) and BH33 (2.7mg/L);
- TPH C10 C36 was found above the LOR in BH7 (605ug/l). There is currently no ANZECC 2000 assessment criteria for TPH;
- BTEX components were found below the limit of reporting (LOR) in all samples with the exceptions of BH30 (toluene – 0.1ug/l), BH32 (toluene – 1.1ug/l), BH33 (toluene – 3.2ug/l, xylene – 8.4ug/l). All BTEX components were found below the assessment criteria.
- LOR was above the assessment criteria for aluminium, copper, zinc, cadmium and chromium.

Additional groundwater quality analysis outside the landfill was conducted by DHA in 2011. Groundwater samples were collected from 6 shallow well locations (MW1, MW2, MW4, MW5, MW7 and MW8) and analysed for TPH, PAH, BTEX, metals, pH, ammonia, nitrate, TDS, sulphate, sulphide, BOD and e coli (refer to Figures 2 and 3 for most well locations).

Hydrocarbon contaminants were found below the LOR in all wells except MW4 which reported slight detections of TPH C10 14 (82ug/l), TPH C15 28 (390ug/l) and naphthalene (7.1ug/l). The following analytes were found above the assessment criteria:

- Total chromium exceeded the ANZECC (2000) guideline for chromium VI in MW4; and
- Copper and lead exceeded the ANZECC (2000) guideline in MW2.

The key discussion points in the model are considered:

- The results of monitoring indicated a potential for leachate generation with contaminant concentrations above the ANZECC 2000 assessment criteria. Contaminants of concern found above the assessment criteria in leachate to date are ammonia, phenol and toluene.

- Considering the time since landfilling ceased (approximately 30 years), it is likely that leachate generation has already reached its peak and is in decline.
- The contaminants of potential concern found in leachate, with the exception of ammonia, were found below the assessment criteria in all sampled groundwater wells outside of the landfill. This indicates (based on available monitoring data) that the majority of contaminants found in leachate have not migrated beyond the landfill.
- Elevated ammonia was detected outside of the landfill in BH7 (10mg/L), BH6 (1mg/L), BH31 (1.8mg/L), BH32 (4.4mg/L) and BH33 (2.7mg/L) in August/October 2004. The highest ammonia concentration found in monitoring wells screened in shale was 4.4mg/L.
- BH6 and BH7, although not within deepest fill are located within an area which may be an extension of the landfill or are within part of a separate filling occasion during which the site level in the north west site area was raised. There is currently insufficient evidence to assess whether the elevated ammonia found in BHs 6 and 7 are indicative of localised elevated concentrations or are reflective of concentration migrating in shallow groundwater down gradient of the main landfill.
- BH32 and BH33 are located up hydraulic gradient of the landfill and screened within the deep shale groundwater body. Elevated ammonia concentrations may be sourced from radial flow resulting from mounding of leachate and shallow groundwater within the landfill. Potential off site (up gradient) sources of ammonia should also be considered.
- Ammonia was also found above criteria in BH31, located west of the landfill. This is likely to be indicative of either off site migration of groundwater impacts sourced from the southern section of the landfill moving northwest (and down gradient) or the result of radial flow due to mounding within the landfill;
- Ammonia and all other contaminants of concern were found below assessment criteria in BH11 and BH30, located northwest / north northwest and down gradient of the landfill. This may indicate a lack of contaminant migration beyond the immediate vicinity of the landfill, based on the 2004 monitoring event. Further monitoring is required to further assess the potential for contaminant movement.

The proposed remediation strategy was considered appropriate considering that the low permeability capping reduces recharge and thus mounding which reduces the potential for radial groundwater flow into the shale from the landfill. It was noted that by reducing leachate levels in the landfill, a larger thickness of unsaturated zone may develop thus creating a larger area for methane gas accumulation and migration above the water table.

The following key limitations associated with the P HCM are noted with regards to previous investigations completed to date:

- The only deep well within the landfill area (BH9) was screened across both fill and natural shale. As such, the water levels and contaminant concentrations in BH9 may be representative of mixed water (leachate and groundwater) rather than 'pure' leachate; however this is to yet be determined as it depends on the depth of groundwater within the natural shale.
- BH9 was the only well drilled to date which proves the base of the landfill. This well was drilled to only 0.3m below the base of fill, which provides a low level of confidence as to whether natural ground was really intercepted. In addition, the quarry may have been deeper in sections.
- Insufficient detail is available on the history of quarrying and landfilling at the site. Historical aerial photographs / quarry survey drawings may provide further information on landfilling activities, in particular the history of infilling in the area around EES (2004) investigation bores, BH6 and BH7 outside of the main landfill area.
- The laboratory limit of reporting for heavy metals has not been appropriate in previous groundwater monitoring events as it was above the assessment criteria;
- The amplitude of seasonal fluctuations in groundwater and leachate levels is not known. Gas migration potential above the water table will vary according to the thickness of the unsaturated zone at any one time.

EI/WSP (MAY 2013) GAS MONITORING INVESTIGATION 1 ELYARD STREET, NARELLAN, NSW

Based on the results presented in the table above, EI/WSP draws the following conclusions:

- The existing wells outside the landfill (and not within proposed building footprints) recorded similar results to those recorded previously. The results are generally classified as CIRIA 1 (no gas protection required) and CIRIA 2 (requires damp proof membrane and subfloor venting) with respect to carbon dioxide only. The exception was GWM04 where the CIRIA 3 classification remained. At GWM03 the CIRIA 2 classification was decreased to CIRIA 1 due to decreased gas concentrations.
- The new wells within the proposed building footprints (L1 – L6) recorded similar results to those recorded previously. Results are classified as CIRIA 2 with respect to carbon dioxide only with the exception of L6 where methane concentrations have been detected at up to 25% v/v. At L5 the CIRIA 1 classification was increased to CIRIA 2 due to an increased flow rate and gas concentrations.
- The existing wells on the edge of the landfill recorded similar results to those recorded previously. Results are generally classified as CIRIA 1 (no gas protection required) and CIRIA 2 (damp proof membrane and subfloor venting) with respect to carbon dioxide with the exception of GWM08 where methane concentrations have been previously detected at up to 85 % v/v resulting in CIRIA 3 classifications. During the current monitoring event methane was not detected. Methane has also previously been detected at GWM12 at 1.6% v/v but was not detected at GWM12 during the current monitoring round. At GWM01, the CIRIA 1 classification was increased to a CIRIA 2 classification due to an increased flow rate and gas concentration. At GWM08 and MW6s the CIRIA 2 classifications have been increased to CIRIA 3 due to increased flow rates and gas concentrations.
- The new wells on the edge of the landfill (P1 – P6) recorded results generally classified as CIRIA 1 or CIRIA 2 for either methane or carbon dioxide. The exception is P6 which remains classified as CIRIA 4.
- The existing wells in the landfill recorded similar results to those recorded during previous monitoring events. The results are generally classified as CIRIA 2 and CIRIA 3 for methane or methane and carbon dioxide with the exception of GWM09. At GWM09 a consistent methane concentration is recorded around 80%v/v, resulting in classifications up to CIRIA 6. CIRIA 5 and CIRIA 6 classifications represent a high to very high risk and are not considered to be suitable for residential development without reduction of the gas regime (e.g. venting to atmosphere) and use of a quantitative risk assessment to assist with the design of protection measures in conjunction with proposed foundation layouts. At GWM13 the CIRIA 3 classification was increased to CIRIA 4 due to an increased flow rate and gas concentrations. At MW8 the CIRIA 4 classification was reduced to CIRIA 3 due to a decreased flow rate.
- Similar to previous monitoring events, the new wells in the landfill recorded results classified as CIRIA 1 at F4, CIRIA 2 at F1 and CIRIA 3 at F2 and F3.
- Concentrations of hydrogen sulphide and carbon monoxide were reported below the respective adopted guideline values of 10ppm and 30ppm (NOHSC, 1995).
- The cap on BH32 continues to have a gas extraction tube fitted which was folded and sealed with a cable tie until further sampling is required. Prior to obtaining a sample, the GFM430 unit was connected to the extraction tube prior to the cable tie being removed to facilitate recording of flow from the well.
- The 12 scheduled monthly monitoring events have been completed (July 2012 – June 2013).

ORD05

Attachment 2

Appendix B
Summary Tables

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Revised Remediation Action Plan
3 Elyard Street, Narellan, NSW
Report No. E1445 AT_RAP Rev3

Summary Table Groundwater Sampling 8 December 2015.

Well ID: / Sample Date: / Location: / Analyte Name	Units	LOR	MW4 8/12/2015 Within Landfill	GW13 8/12/2015 Within Landfill	GW08 8/12/2015 Edge Landfill	GW09 8/12/2015 Within Landfill	Waste water Criteria 2015 16 *
Benzene	µg/L	0.5	<0.5	1.0	<0.5	<0.5	100
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	500
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	1000
m/p xylene	µg/L	1	<1	<1	<1	<1	
o xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	
Naphthalene	µg/L	0.5	<0.5	<0.5	<0.5	2.3	
Total Xylenes	µg/L	1.5	<1.5	<1.5	<1.5	<1.5	1000
Total BTEX	µg/L	3	<3	<3	<3	<3	
Biochemical Oxygen Demand (BOD5)	mg/L	5	70	16	21	27	230
Total Suspended Solids Dried at 103 105°C	mg/L	5	**740**	450	**3200**	**790**	600
Oil and Grease	mg/L	5	<5	<5	<5	<5	200
Nitrate Nitrogen, NO3 N	mg/L	0.005	<0.01	<0.025	<0.01	<0.025	
Sulphate, SO4	mg/L	1	310	7.5	3.7	2.7	2000
Nitrite Nitrogen, NO2 as N	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	
Total Kjeldahl Nitrogen	mg/L	0.05	27	81	12	100	
Total Nitrogen (calc)	mg/L	0.05	27	81	12	100	150
Ammonia Nitrogen, NH_3 as N	mg/L	0.005	27	88	7.6	110	100
Total Phosphorus (Kjeldahl Digestion)	mg/L	0.01	0.46	0.13	1.3	0.40	
Total Dissolved Solids Dried at 175 185°C	mg/L	10	**1600**	**2700**	**1600**	**2000**	500 10,000
pH	pH Units	0.1	7.6	7.7	8.0	7.8	7 10
Aluminium, Al	µg/L	5	18	<5	<5	<5	100,000
Arsenic, As	µg/L	1	1	27	4	1	1000
Cadmium, Cd	µg/L	0.1	<0.1	<0.1	<0.1	<0.1	1000
Chromium, Cr	µg/L	1	3	8	<1	2	3000
Cobalt, Co	µg/L	1	2	4	<1	3	5000
Copper, Cu	µg/L	1	<1	<1	<1	<1	5000
Iron, Fe	µg/L	5	230	150	14	78	50,000
Lead, Pb	µg/L	1	1	<1	<1	<1	2000
Manganese, Mn	µg/L	1	500	320	300	120	10,000
Molybdenum, Mo	µg/L	1	<1	<1	2	<1	100000
Nickel, Ni	µg/L	1	3	4	3	5	3000
Zinc, Zn	µg/L	5	<5	<5	<5	<5	5000
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	30

Notes:
* Sydney Water Industrial Customers Acceptance Standards for 2015 16 (Ref SW039 06/15).
Values shown in **bold** highlight results which exceed acceptance standards.

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ORD05

Attachment 2

6.3 Groundwater and Leachate Quality

This section presents field observations and sampling results from the groundwater sampling event completed for all wells in the groundwater monitoring network, on 26 and 27 June 2012. **Table 6.2** lists the recorded groundwater field parameters and visual / olfactory observations during groundwater purging after stabilising.

No phase separated hydrocarbons were observed in any of the wells. Copies of laboratory certificates are included in **Appendix H**. The full groundwater sampling field sheets are provided in **Appendix F** and the calibration sheet for the water quality meter is provided in **Appendix G**.

Table 6.3 presents analytical results which exceeded the adopted site criteria, together with the hydrogeological setting of the monitoring wells.

Analytical results are summarised in **Appendix C** and copies of laboratory certificates are included in **Appendix H**.

Table 6.2 Field Parameters of Groundwater Sampling Event

Well ID	SWL[1] (mTOC)[2]	pH	Temp (°C)	Conductivity (mS/cm at 25 °C)	Dissolved Oxygen (ppm)	Redox / ORP[3] (mV)	Observations
F1	1.30	7.0	15.9	2.27	0.1	-70	Clear, strong putrid odour
F3	4.40	6.6	22.5	3.65	0.4	-100	Clear, strong putrid odour
MW2	2.10	7.1	19.7	6.44	0.8	-70	Cloudy, black, putrid odour
MW4	1.94	6.9	16.4	3.68	0.3	-120	Clear, grey, strong putrid odour
BH7	0.43	7.4	17.7	1.34	1.0	-60	Cloudy grey/brown, putrid odour
MW34	1.32	7.0	18.2	5.69	0.3	-40	Cloudy, brown, slight putrid odour
MW34D	1.85	6.5	20.8	17.6	0.9	10	Slightly cloudy (brown), possibly slight putrid odour
MW5	1.18	6.4	16.2	8.9	1.1	120	Clear, no odour
MW5D	0.99	6.5	19.9	14.6	0.4	60	Slightly cloudy, no or slight odour
GW108	4.36	6.77	20.9	2.89	0.5	-80	Clear, putrid odour
GW108D	4.31	6.33	20.7	14.0	0.8	20	Clear, no odour
MW21	5.93	6.7	18.4	3.51	0.5	210	Slightly cloudy, no odour
BH32	8.79	6.8	19.4	11.6	-[4]	-[4]	Cloudy, no odour

1. SWL = Standing water level
2. mTOC = metres below top of well casing
3. Oxygen Reducing Potential. Field results converted to Standard Hydrogen electrode readings by adding 199mV
4. Due to sampling method with bailer

WSP Environmental Pty Ltd

Narellan Groundwater Investigation

Analytical results - Groundwater monitoring event 27 and 28 June 2012

			Inorganics				Metals								PAH/Phenols																						BTEX						TPH				
			Ammonia	Nitrate (as N)	pH (Lab)	TDS	Lead (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Mercury (Filtered)	Nickel (Filtered)	Zinc (Filtered)	Acenaphthene	Acenaphthylene	Anthracene	Benz[a]anthracene	Benzo(a) pyrene	Benzo(b&j)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Phenolics Total	Pyrene	Benzene	E thylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH+C10 - C36
			mg/L	mg/L	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL			0.005	0.005	0.01	5	0.001	0.001	0.0001	0.001	0.001	0.00005	0.001	0.001	1	1	1	1	1	2	1	1	1	1	1	1	1	50	1	1	1	1	2	1	2	10	50	100	50	50
ANZECC 2000 FW 95%			0.9				0.0034		0.0002		0.0014	0.0006	0.011	0.008																															
Dutch Intervention values							0.075	0.05	0.006	0.03	0.075	0.0003	0.075	0.8			5	0.5	0.05		0.05	0.2		1		0.05	70		2000		30	150	1000			70					600
EPA 1994 Freshwater Ecosystems							0.001																							500	140	300			300					
Field_ID	**LocCode**	**Sample Date**																																												
BH32	BH32	28/06/2012	1.6	<0.005	7.1	5500	<0.001	0.003	<0.0001	<0.001	<0.001	<0.00005	<0.001	0.005	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
BH34S	MW34	28/06/2012	78	<0.005	7.1	2900	<0.001	0.006	<0.0001	<0.001	<0.001	<0.00005	0.004	0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	100	170	<100	320
BH34D	MW34D	28/06/2012	0.5	<0.005	6.8	11,000	<0.001	0.001	<0.0001	<0.001	<0.001	<0.00005	0.002	0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
BH7	BH7	28/06/2012	7.8	<0.005	7.4	790	<0.001	0.002	<0.0001	<0.001	<0.001	<0.00005	<0.001	0.003	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
F1	F1	28/06/2012	26	<0.005	7.3	1400	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.00005	<0.001	<0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
DUP	F1	28/06/2012	27	<0.005	7.3	1300	<0.001	<0.001	<0.0001	0.001	<0.001	<0.00005	<0.001	0.002	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
TRIP L	F1	28/06/2012	22.3	0.06	7.8	1300	<0.001	<0.001	<0.0001	0.001	<0.001	<0.0001	<0.001	<0.005	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	<50	-	<1	<2	<2	<2	<2	<2	<20	<50	340	<50	340 - 390
F3	F3	28/06/2012	85	<0.005	7.1	1700	<0.001	0.002	<0.0001	0.003	<0.001	<0.00005	0.001	<0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	110	210	<100	370
GW108S	GW108	27/06/2012	4.8	<0.005	7	1500	<0.001	0.007	<0.0001	<0.001	<0.001	<0.00005	0.001	0.002	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
GW108D	GW108D	27/06/2012	0.85	<0.005	6.7	9100	<0.001	0.001	<0.0001	<0.001	<0.001	<0.00005	0.026	0.008	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
MW2	MW2	28/06/2012	74	<0.005	7.3	3400	<0.001	0.009	<0.0001	0.001	<0.001	<0.00005	0.006	<0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	92	220	<100	362
MW21	MW21	28/06/2012	0.12	5.1	7.1	1800	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.00005	<0.001	<0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
MW4	MW4	28/06/2012	26	<0.005	7.1	2900	<0.001	<0.001	<0.0001	0.001	<0.001	<0.00005	<0.001	<0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	4	<50	<1	<1	<1	<1	<2	<1	<3	<10	87	170	<100	307
MW5S	MW5	27/06/2012	0.04	0.02	6.7	6200	<0.001	<0.001	0.0001	<0.001	0.004	<0.00005	0.017	0.005	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
MW5D	MW5D	27/06/2012	1.9	<0.005	6.9	8500	<0.001	0.001	<0.0001	<0.001	<0.001	<0.00005	0.003	0.005	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<3	<10	<50	<100	<100	<250
Relative percent differences (RPD) between primary sample from F1 and field duplicates (intralab DUP and interlab TRIP)																																													
RPD DUP			4%	N.A.	0%	7%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	67%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
RPD TRIP			15%	16%	0%	7%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	189%	N.A.	44%
Statistical Summary																																													
Number of Detects			15	3	15	15	0	9	1	5	1	0	8	9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	5	0	5
Minimum Concentration			0.04	<0.005	6.7	790	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.00005	<0.001	<0.001	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<1	<50	<1	<1	<1	<1	<2	<1	<2	<10	<50	<100	<50	<250
Maximum Concentration			74	5.1	7.8	11,000	<0.001	0.009	0.0001	0.003	0.004	<0.0001	0.026	0.065	<1	<1	<1	<1	<1	<2	<1	<1	<1	<1	<1	<1	<5	<1	<50	<1	<1	<2	<2	<2	<2	<3	<20	110	340	<100	390
Maximum Detect			74	5.1	7.8	11,000	ND	0.009	0.0001	0.003	0.004	ND	0.026	0.065	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	110	340	ND	390
Average Concentration			21	0.38	7.1	3973	0.0008	0.0023	5.3E-05	0.0008	0.0007	0.000027	0.0042	0.0085	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.87	0.5	25	0.5	0.5	0.53	0.53	1	0.53	1.5	5.3	44	107	48	198
Number of Guideline Exceedances			11	0	0	0	0	0	0	0	1	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3.3 Additional Groundwater Analysis (DLA, 2011)

Groundwater was sampled from six (6) locations to confirm and provide further detail on the findings of previous assessments. The Dutch mineral oil criterion has been adopted as the acceptance criteria for hydrocarbons in groundwater. Minor concentrations of naphthalene and semi-volatile hydrocarbons are present within the groundwater from MW-4, though each complies with the respective Site Acceptance Criteria (SAC). No other areas of the landfill were found to contain organic contaminants within the groundwater.

Table 2a – Groundwater Organic Analytical Results (µg/L)

Detected Analytes	*SAC*	*MW1*	*MW2*	*MW4*	*MW6*	*MW7*	MW8
Benzene	*950*	<1	<1	<1	<1	<1	<1
Ethylbenzene[2]	*80*	<1	<1	<1	<1	<1	<1
m+p Xylene[3]	*75*	<2	<2	<2	<2	<2	<2
o-xylene		<1	<1	<1	<1	<1	<1
TPH C_6-C_9	*ID*	<10	<10	<10	<10	<10	<10
TPH C_{10}-C_{14}		<50	<50	82	<50	<50	<50
TPH C_{15}-C_{28}	*Sum <600*	<100	<100	390	<100	<100	<100
TPH C_{29}-C_{36}		<100	<100	<100	<100	<100	<100
Naphthalene	*16*	<1	<1	7.1	<1	<1	<1

Localised exceedances of the ANZECC 2000 heavy metal thresholds can be observed in MW4 and MW2. The total chromium measured in MW4 marginally exceeded the more sensitive threshold value for chromium VI though would require speciation to determine the risk to any receptors. The water sample from MW2, down gradient of the landfill, contained elevated concentrations of copper and lead. No significant concentrations of heavy metals were measured in any other well

Table 2b– Groundwater Inorganic Analytical Results (µg/L)

Analyte	SAC	*MW1*	*MW2*	*MW4*	*MW6*	*MW7*	MW8
Arsenic[3]	*13*	6	1	3	3	<1	4
Cadmium	*0.2*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium[3]	*1*	<1	<1	**3**	<1	<1	<1
Copper	*1.4*	<1	**5**	1	1	<1	1
Lead	*3.4*	<1	**21**	<1	<1	<1	<1
Mercury	*0.6*	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Nickel	*11*	1	2	2	2	1	3

Zinc	***8***	2	<1	2	<1	3	2

3.4 Methane Gas Analysis (DLA, 2011)

Preliminary investigations by DLA have indicated that methane detection is limited to the landfill area of the development. Lateral migration within the soil pore space or as dissolved phase in groundwater does not appear to be a significant risk in the current Site configuration. Whilst MW3 and MW4 produced methane concentrations of 58% and 79% respectively, monitoring wells on the edge of the landfill and outside of the landfill failed to indicate any presence of methane gas.

Additional monitoring is recommended throughout the remediation to ensure the safety of construction workers and to determine if the remediation methodology achieves the desired objective to prevent the risk of gas intrusion.

3.5 Chemicals of concern

The landfill is a potential source of landfill gases (including methane, sulphides, carbon dioxide and carbon monoxide) and also leachate. In addition to landfill gas and leachate the fill materials placed in the landfill may contain chemicals of concern. The following lists the most likely chemicals of concern based on the former land-use and the findings of the DSI.

- *Landfill gasses:*
  - Methane (CH4);
  - Hydrogen sulfide (H2S);
  - Carbon monoxide (CO); and
  - Carbon dioxide (CO2).
- *Landfill leachate:*
  - Organics (petroleum hydrocarbons, benzene, toluene ethylbenzene xylene (BTEX) and phenols);
  - Inorganic (heavy metals, nutrients (NO_3^-, NH_4^+ and PO43);
- *Soil contamination:*
  - Organics (petroleum hydrocarbons, BTEX, PAHs)
  - Inorganic (heavy metals and asbestos)

inorganic groundwater results are presented in Table 22, the SMEC organic groundwater results are shown in Table 23.

The Environmental & Earth Sciences inorganic soil results are shown in Table 20 and organic soil results in Table 21. The Environmental & Earth Sciences inorganic groundwater results are presented in Table 24 organic groundwater results in Table 25 and the inorganic groundwater chemistry results are presented in Tables 26 and 27.

TABLE 18

SMEC INORGANIC SOIL RESULTS - HEAVY METALS

Sample	Depth (m)	Copper	Lead	Zinc	Cadmium	Chromium total	Nickel	Arsenic	Mercury
S1 - TP1	0.15-0.8	30	*19*	56	<1.0	*12*	*12*	8	<0.1
S2 - TP2	0.1-0.8	17	*19*	42	<1.0	*12*	*7*	7	<0.1
S3 - TP3	0.2-1.0	17	*17*	26	<1.0	*13*	*4*	7	<0.1
S4 - TP4	0.15-0.7	20	*32*	52	<1.0	*11*	*9*	7	<0.1
S5 - TP5	0.1-0.9	23	*20*	66	<1.0	*18*	*12*	*13*	<0.1
S6 - H6	0.2-0.6	32	*23*	47	2.0	*18*	*14*	*19*	<0.1
S8 - H8	0.2-0.6	31	*30*	72	<1.0	*11*	*18*	5	<0.1
S9 - H9	0.2-0.6	28	*17*	64	2.0	*13*	*21*	7	<0.1
S10 - H10	0.2-0.6	94	*19*	75	*4.0*	*18*	*29*	*17*	<0.1
S11 - H11	0.2-0.6	46	*17*	62	*3.0*	*14*	*14*	4	<0.1
S12 - H12	0.2-0.6	34	*30*	94	1.0	*24*	*32*	7	<0.1
S13 - H13	0.35-0.6	27	*14*	41	*5.0*	*34*	*41*	6	<0.1
Guideline[2]		4000	1200	28000	80	400 (VI)	2400	400	40
Guideline[3]		-	*10*	-	*2*	*10* (VI)	*4*	*10*	*0.4*
Guideline[4]		-	100	-	20	100 (VI)	40	100	4

Notes:
1. all results expressed in mg/kg on a dry weight basis
2. guideline levels taken from NEPM Schedule B (7a) (1999) — *Health based soil investigation levels*, Column D for residential with minimal access to soils use
3. inert waste guideline taken from NSW EPA (1999) *assessment classification and management of liquid and non-liquid wastes* (Table 16 of this report)
4. solid waste guideline taken from NSW EPA (1999) *assessment classification and management of liquid and non-liquid wastes* (Table 16 of this report)
5. values in italics exceed the inert waste guidelines

Environmental & Earth Sciences

TABLE 19

SMEC ORGANIC SOIL LABORATORY RESULTS

Sample	S1-TP1	S2-TP2	S3-TP3	S4-TP4	S5-TP5	S6-H6	Site Criteria
Depth (m)	0.15-0.8	0.1-0.8	0.2-1.0	0.15-0.7	0.1-0.9	0.2-0.6	
Total PAHs	ND	ND	ND	ND	ND	ND	80[3]
Naphthalene	ND	ND	ND	ND	ND	ND	-
Benzo[a]pyrene	ND	ND	ND	ND	ND	ND	4[3]
Phenol's	ND	ND	ND	ND	ND	ND	34000[2]
Oxygenated hydrocarbons	ND	ND	ND	ND	ND	ND	-
carbon disulfide	ND	ND	ND	ND	ND	ND	-
Fumigants	ND	ND	ND	ND	ND	ND	-
Halogenated aliphatic hydrocarbons	ND	ND	ND	ND	ND	ND	-
Halogenated aromatic hydrocarbons	ND	ND	ND	ND	ND	ND	-
Trihalomethanes	ND	ND	ND	ND	ND	ND	-
TPH							
C_6-C_9	<2	<2	<2	<2	<2	<2	65[3]
C_{10}-C_{14}	<50	<50	<50	<50	<50	<50	-
C_{15}-C_{28}	<100	<100	<100	<100	<100	<100	TPH C_{16}-C_{35} aromatics 360[2]
C_{29}-C_{36}	140	<100	<100	<100	<100	<100	
Total C_{10}-C_{36}	140	ND	ND	ND	ND	ND	aliphatics 22400[2]
Total MAHs	ND	ND	ND	ND	ND	ND	
Benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1[3]
Toluene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	130[3]
Ethyl benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	50[3]
Xylene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	25[3]

Notes:
1. all results expressed in mg/kg
2. guideline values taken from Column D of the NEHF (1998) *Health-based soil investigation levels*
3. guideline values are taken from NSW EPA (1994) *Guidelines for assessing service station sites*
4. ND – not detected
5. - not analysed, or no guideline applicable
6. not all analytes tested have been reported, however no other organic COCs were detected

ORD05

Attachment 2

Environmental & Earth Sciences

TABLE 19 (CONT)

SMEC ORGANIC SOIL LABORATORY RESULTS

Sample	S8-H8	S9-H9	S10-H10	S11-H11	S12-H12	S13-H13	Site Criteria
Depth (m)	0.2-0.6	0.2-0.6	0.2-0.6	0.1-0.6	0.35-0.6	0.2-0.6	
Total PAHs	11.5	1.2	ND	ND	ND	ND	80[2]
Naphthalene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
Benzo[a]pyrene	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	4[2]
Phenol's	ND	ND	ND	ND	ND	ND	34000[2]
Oxygenated hydrocarbons	-	-	-	-	-	-	-
carbon disulfide	-	-	-	-	-	-	-
Fumigants	-	-	-	-	-	-	-
Halogenated aliphatic hydrocarbons	-	-	-	-	-	-	-
Halogenated aromatic hydrocarbons	-	-	-	-	-	-	-
Trihalomethanes	-	-	-	-	-	-	-
TPH							
C_6-C_9	<2	<2	<2	<2	<2	<2	65[3]
C_{10}-C_{14}	58	<50	<50	<50	<50	<50	-
C_{15}-C_{28}	473	<100	110	<100	166	143	TPH C_{15}-C_{35}
C_{29}-C_{36}	800	<100	312	<100	370	246	aromatics 360[2]
Total C_{10}-C_{35}	1331	ND	422	ND	536	389	aliphatics 22400[2]
Total MAHs	-	-	-	-	-	-	1[3]
Benzene	-	-	-	-	-	-	130[3]
Toluene	-	-	-	-	-	-	50[3]
Ethyl benzene	-	-	-	-	-	-	25[3]
Xylene	-	-	-	-	-	-	

1000 service stations

Notes:
1. all results expressed in mg/kg
2. guideline values taken from Column D of the NEHF (1998) *Health-based soil investigation levels*
3. guideline values are taken from NSW EPA (1994) *Guidelines for assessing service station sites*
4. ND – not detected
5. - not analysed, or no guideline applicable
6. not all analytes tested have been reported, however no other organic COCs were detected

residential = minimal access to soils

Appendix C
Borehole Logs

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: PUMPING WELL

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Mechanical Excavator (8 Tonnes)
Drill date: 09-11-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 375mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
▼ 1.129m BGL (14-11-11)	0.00		Ground Surface	0.523m Stickup	
	0.50		*Fill* Grey-dark grey/brown gravely clay and sand with brick, timber and concrete fragments throughout, fine to medium grained, medium density, moist	Blank UPVC 375mm (Casing)	
	1.00		*Clayey Fill* Light grey-grey/red, fine grained, moderate to high plasticity gravely clay, very stiff, moist		
	1.50		*Fill* Grey-dark grey/brown gravely clay and sand with brick, timber, plastic and concrete fragments throughout, fine to medium grained, medium density, moist	Backfill Material	
	2.00				
	2.50				
	3.00				
	3.50				
	4.00				
	4.50			UPVC base cap	
	5.00		Borehole ended at 4.895m		
	5.50				

FCR = FIELD CONTAMINATION RANKING

0 = No visual signs of contamination and/or detectable odours
1 = Slight visual signs of contamination and/or odours
2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

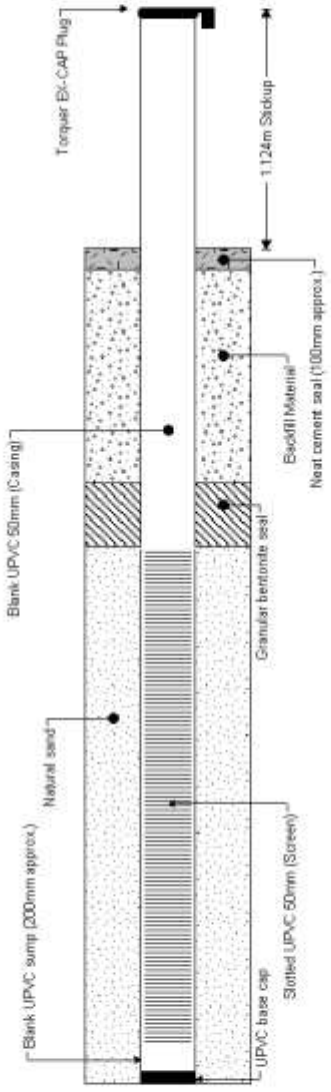
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW101

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
▼ 1.985m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00		Ground Surface ***Fill*** Brown/grey-dark grey/orange clay, gravel and sand with small (<10mm) brick and concrete fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 3.92m		

FCR = FIELD CONTAMINATION RANKING

0 = No visual signs of contamination and/or detectable odours
1 = Slight visual signs of contamination and/or odours
2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

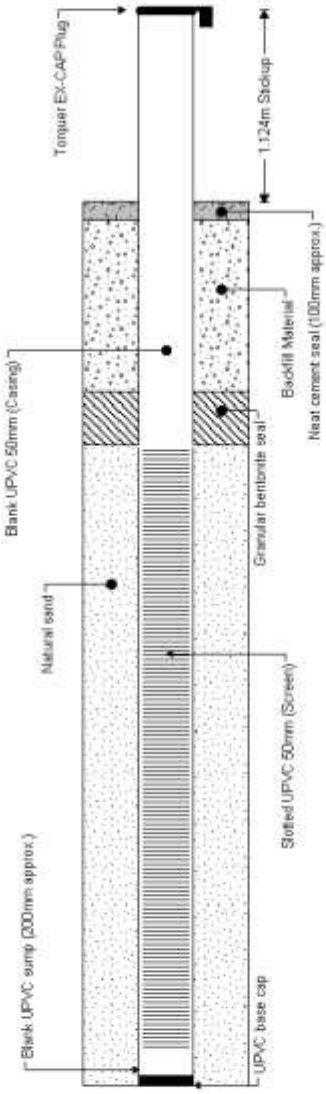
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW102

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
2.43m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00		Ground Surface ***Fill*** Brown/grey-dark grey/orange clay, gravel and sand with small (<10mm) brick and concrete fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 5.04m		

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1 = Slight visual signs of contamination and/or odours
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3 = Strong visual signs of contamination and/or odour

COMMENTS:

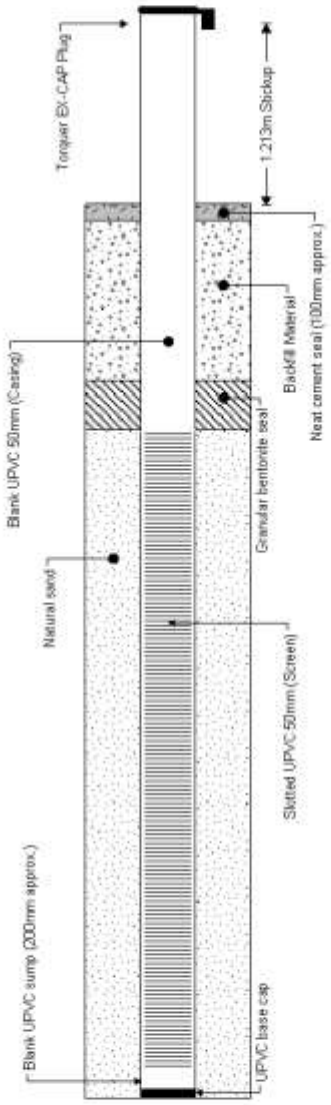
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW103

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
1.321m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50		Ground Surface ***Fill*** Brown/grey-dark grey/orange clay, gravel, sand with small (<5mm) concrete and timber fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 5.56m		

FCR = FIELD CONTAMINATION RANKING

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW104

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
No Groundwater/Seepage Found (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00		Ground Surface *Fill* Brown/grey-dark grey/orange clay, gravely sand, fine to medium grained, medium density, moist *Clayey Fill* Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist *Shale/Siltstone* Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 5.26m	Torquer EX-CAP Plug 1.033m Stickup Blank UPVC 50mm (Casing) Backfill Material Neat cement seal (100mm approx.) Granular bentonite seal Natural sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	

FCR = FIELD CONTAMINATION RANKING

0 = No visual signs of contamination and/or detectable odours
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3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW105

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 29-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
No Groundwater/Seepage Found (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00		Ground Surface ***Fill*** Brown/grey-dark grey/orange clay, gravely sand, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 3.97m	Torquer Ez-CAP Plug 0.772m Stickup Backfill Material Neat cement seal (100mm approx.) Granular bentonite seal Blank UPVC 50mm (Casing) Natural sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	

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COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW106

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 29-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
No Groundwater/Seepage Found (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50		Ground Surface ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 3.24m	Torquer EX-CAP Plug; 1.012m Stickup; Blank UPVC 50mm (Casing); Granular bentonite seal; Backfill Material; Neat cement seal (100mm approx.); Natural sand; Slotted UPVC 50mm (Screen); Blank UPVC sump (200mm approx.); UPVC base cap	

FCR = FIELD CONTAMINATION RANKING

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1 = Slight visual signs of contamination and/or odours
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3 = Strong visual signs of contamination and/or odour

COMMENTS:

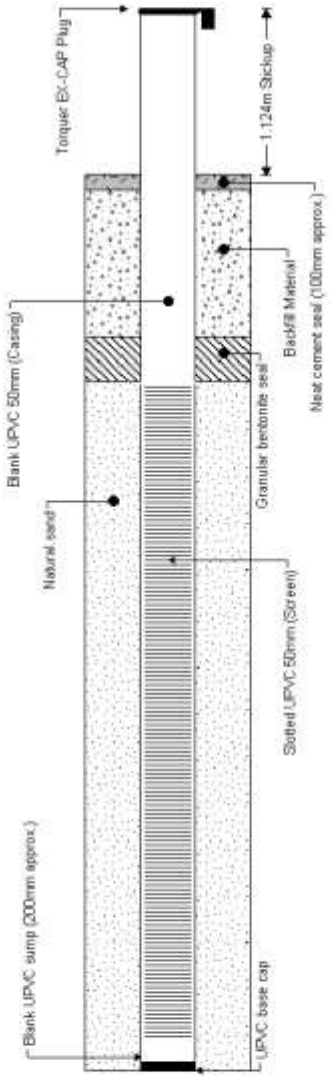
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW107

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 29-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
5.825m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00		Ground Surface ***Fill*** Brown/grey-dark grey/orange clay, gravel, sand with concrete, timber and brick fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 6.06m		

FCR = FIELD CONTAMINATION RANKING

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COMMENTS:

ORD05

Attachment 2

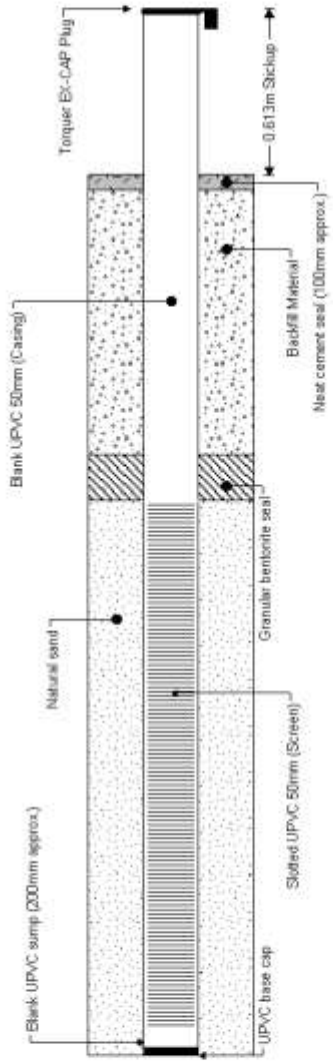
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW108

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 29-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
4.317m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00		Ground Surface ***Fill*** Brown/grey-dark grey/orange clay, gravel, sand with concrete, timber, glass, plastic and brick fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clayey fill, very stiff, moist ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, moist Borehole ended at 5.96m		

FCR = FIELD CONTAMINATION RANKING

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COMMENTS:

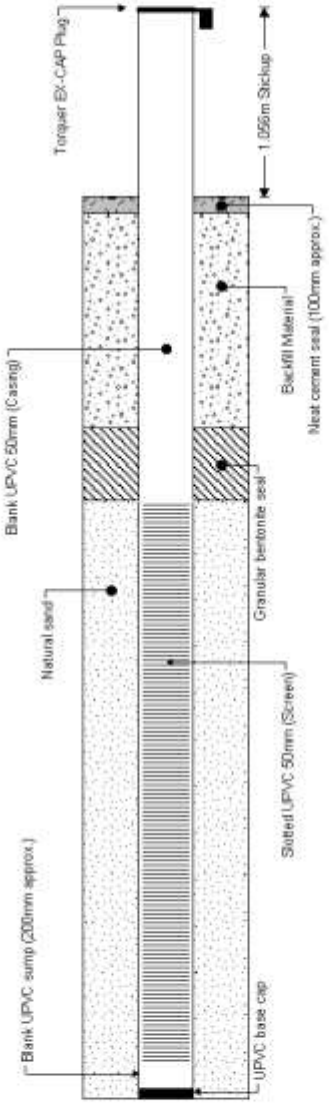
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW109

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
2.078m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00		Ground Surface ***Fill*** Grey-dark grey/brown gravely clay and sand with brick, timber and concrete fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely caly, very stiff, moist ***Fill*** Grey-dark grey/brown gravely clay and sand with brick, timber, plastic and concrete fragments throughout, fine to medium grained, medium density, moist Borehole ended at 5.05m		

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COMMENTS:

ORD05

Attachment 2

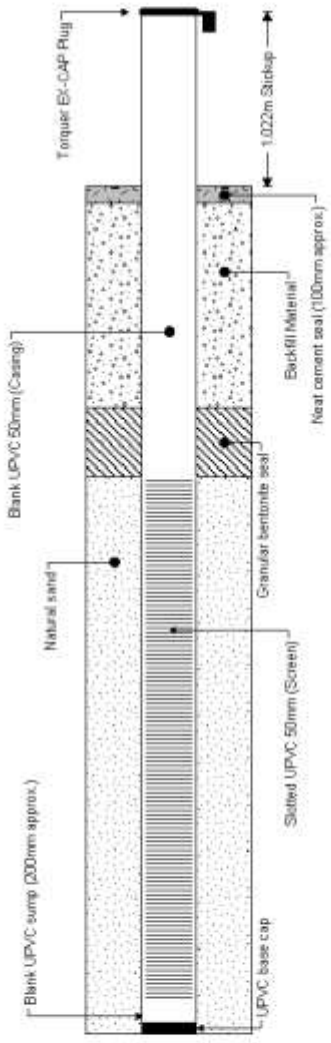
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW110

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
1.938m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00		Ground Surface *Fill* Grey-dark grey/brown gravely clay and sand, fine to medium grained, medium density, moist *Clayey Fill* Light grey-grey/red, fine grained, moderate to high plasticity gravely clay, very stiff, moist *Fill* Grey-dark grey/brown gravely clay and sand with brick, timber, plastic and concrete fragments throughout, fine to medium grained, medium density, moist Borehole ended at 4.987m		

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1 = Slight visual signs of contamination and/or odours
2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW111

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 29-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
No Groundwater/Seepage Found (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00		Ground Surface ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely caly, very stiff, moist Borehole ended at 6.05m	Torquer EX-CAP Plug; 1.000m Stickup; Backfill Material; Neat cement seal (100mm approx.); Blank UPVC 50mm (Casing); Granular bentonite seal; Natural sand; Slotted UPVC 50mm (Screen); Blank UPVC sump (200mm approx.); UPVC base cap	

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

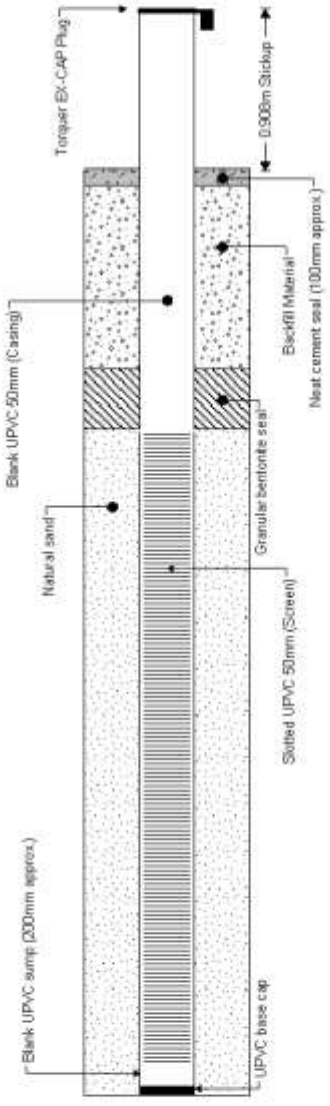
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW112

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 29-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
No Groundwater/Seepage Found (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00		Ground Surface *Fill* Grey-dark grey/brown gravely clay and sand with brick, timber and concrete fragments throughout, fine to medium grained, medium density, moist *Clayey Fill* Light grey-grey/red, fine grained, moderate to high plasticity gravely caly, very stiff, moist *Fill* Grey-dark grey/brown gravely clay and sand with brick, timber, plastic and concrete fragments throughout, fine to medium grained, medium density, moist Borehole ended at 6.05m		

FCR = FIELD CONTAMINATION RANKING

0 = No visual signs of contamination and/or detectable odours
1 = Slight visual signs of contamination and/or odours
2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: GW113

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger
Drill date: 28-09-2011

Sheet: 1 of 1
Bore License No.:
Hole size: 75mm
Engineer: A.B.
Checked by: V.J.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
2.895m BTOC (14-11-11)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00		Ground Surface ***Fill*** Grey-dark grey/brown gravely clay and sand with brick, timber and concrete fragments throughout, fine to medium grained, medium density, moist ***Clayey Fill*** Light grey-grey/red, fine grained, moderate to high plasticity gravely clay, very stiff, moist ***Fill*** Grey-dark grey/brown gravely clay and sand with brick, timber, plastic and concrete fragments throughout, fine to medium grained, medium density, moist Borehole ended at 4.671m	Torquer EX-CAP Plug 1.361m Stickup Backfill Material Neat cement seal (100mm approx.) Blank UPVC 50mm (Casing) Granular bentonite seal Natural sand Slotted UPVC 50mm (Screen) UPVC base cap Blank UPVC sump (200mm approx.)	

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Project ID:	CES090605-CMC	**Easting:**	
Project:	Narellan _Ellyard Street	**Northing:**	
Client:	Caldwell Martin Cox	**Elevation:**	
Location:	Ellyard Street	**Environmental Log:**	CTP1

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 18-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8599 2100 FAX: (02) 9552 4599

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			FID/PID (ppm)			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	0	250	500	750	
0	Test Pit			FILL: Concrete							
				FILL: Silty Clay with plastic, bricks, wood, wire and rubble. Bands of heavier clay found with increasing depth. Water ingress at 1.4m							
1											
2											
				End of test pit.							
3											
4											
5											
6											

Drill Company:	Other	**Date Commenced:**	1/21/2010
Drill Model:	Excavator	**Date Completed:**	1/21/2010
Hole Diameter (mm):		**Logged/checked by:**	Ashling McNeill

Sheet: 1 of 1

ORD05

Attachment 2

Project ID: CES090605-CMC **Easting:**

Project: Narellan _Ellyard Street **Northing:**

Client: Caldwell Martin Cox **Elevation:**

Location: Ellyard Street **Environmental Log:** CTP2

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 19-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8569 2200 FAX: (02) 9552 4399

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			FID/PID (ppm)			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	=	250	500	750	
0	Test Pit			FILL: Concrete							
				FILL: Silty Clay with plastic, bricks, wood, wire and roofing materials. Bands of heavier clay found with increasing depth. Water present at 2.3m							
1											
2											
				End of test pit							
3											
4											
5											
6											

Drill Company: Other

Drill Model: Excavator

Hole Diameter (mm):

Date Commenced: 1/21/2010

Date Completed: 1/21/2010

Logged/checked by: Ashling McNeill

Sheet 1 of 1

ORD05

Attachment 2

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 19-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8569 2200 FAX: (02) 9552 4580

Project ID: CES090605-CMC
Project: Narellan _Ellyard Street
Client: Caldwell Martin Cox
Location: Ellyard Street
Easting:
Northing:
Elevation:

Environmental Log: CTP3

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			PID/PID (ppm)			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	0	250	500	750	
0				FILL: Concrete							
				FILL: Silty Clay with boulders and plastic, brown, petroleum odour.							
1											
				FILL: Silty Clay with grit, railway sleeper and bricks, with bands of heavy mottled clay , brown/black. Water ingress from 1.3m.							
2											
3											
4				FILL: Brick stacked in a silty clay matrix, red.							
				End of test pit.							
5											
6											

Test Pit

Drill Company: Other
Drill Model: Excavator
Hole Diameter (mm):

Date Commenced: 1/21/2010
Date Completed: 1/21/2010
Logged/checked by: Ashling McNeill

Sheet: 1 of 1

Project ID: CES090605-CMC **Easting:**

Project: Narellan _Ellyard Street **Northing:**

Client: Caldwell Martin Cox **Elevation:**

Location: Ellyard Street **Environmental Log:** **CTP4**

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 19-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8599 2200 FAX: (02) 9552 4399

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	FID/PID (ppm): 0 / 250 / 500 / 750	
0	Test Pit			FILL: Concrete				
				FILL: Silty Clay, brown/orange, loose. Bricks encountered from 1.2m.				
1								
				FILL: Clay, brown with orange mottling, contains bricks and metal rod. Water ingress from 1.7m.				
2				FILL: Grit in a clay matrix, blue/black, loose, sheen, petroleum odour.				
				End of test pit.				
3								
4								
5								
6								

Drill Company: Other

Drill Model: Excavator

Hole Diameter (mm):

Date Commenced: 1/21/2010

Date Completed: 1/21/2010

Logged/checked by: Ashling McNeill

Sheet: 1 of 1

ORD05

Attachment 2

Project ID:	CES090605-CMC	**Easting:**	
Project:	Narellan _Ellyard Street	**Northing:**	
Client:	Caldwell Martin Cox	**Elevation:**	
Location:	Ellyard Street	**Environmental Log:**	**CTP5**

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 19-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8569 2300 FAX: (02) 9552 4399

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			FID/PID (ppm)			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	ø	250	500	750	
0	Test Pit			FILL: Concrete							
1				FILL: Silty Clay high grit content, brown/black, compact, contains wood, bricks present.							
2				FILL: Clay, brown with orange mottling, contains bricks and metal can. Water ingress from 2.2m.							
				FILL: Refusal concrete slab							
				End of test pit.							
3											
4											
5											
6											

Drill Company:	Other	**Date Commenced:**	1/21/2010
Drill Model:	Excavator	**Date Completed:**	1/21/2010
Hole Diameter (mm):		**Logged/checked by:**	Ashling McNeill

Sheet: 1 of 1

Project ID: CES090605-CMC **Easting:**

Project: Narellan _Ellyard Street **Northing:**

Client: Caldwell Martin Cox **Elevation:**

Location: Ellyard Street **Environmental Log:** **CTP6**

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 18-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
Ph: (02) 9409 2300 FAX: (02) 9552 4309

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	PID/PID (ppm) 0 250 500 750	
0				FILL: Concrete				
				FILL: Silty Clay, brown/grey mottled, compact, contains wire and bricks.				
1								
	Test Pit			FILL: Clay, red/brown, plastic				
2								
				FILL: Fractured Shale, with high concentration of bricks and wood.				
3				SHALE: Shale				
				End of test pit.				
4								
5								
6								

Drill Company: Other **Date Commenced:** 1/21/2010

Drill Model: Excavator **Date Completed:** 1/21/2010

Hole Diameter (mm): **Logged/checked by:** Ashling McNeill

Sheet: 1 of 1

ORD05

Attachment 2

Project ID:	CES090605-CMC	**Easting:**	
Project:	Narellan _Ellyard Street	**Northing:**	
Client:	Caldwell Martin Cox	**Elevation:**	
Location:	Ellyard Street	**Environmental Log:**	**CTP7**

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 19-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8569 2200 FAX: (02) 9592 4899

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION					WELL DETAIL
							FID/PID (ppm)			
Depth	Method	Water	Symbol	Description	Sample ID	Type	0 250 500 750			
0				FILL: Concrete						
				FILL: Clay, orange mottled, compact.						
1				FILL: Silty Clay, brown/black, compact.						
				FILL: Clay with grit, plastic, brown/orange, stacked bricks from 2.2m.						
2										
	Test Pit									
3				SHALE: Shale						
				End of test pit.						
4										
5										
6										

Drill Company:	Other	**Date Commenced:**	1/20/2010
Drill Model:	Excavator	**Date Completed:**	1/20/2010
Hole Diameter (mm):		**Logged/checked by:**	Ashling McNeill

Sheet: 1 of 1

ORD05

Attachment 2

Project ID: CES090605-CMC **Easting:**

Project: Narellan _Ellyard Street **Northing:**

Client: Caldwell Martin Cox **Elevation:**

Location: Ellyard Street **Environmental Log:** CTP8

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 16-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8568 2200 FAX: (02) 9552 4399

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	FID/PID (ppm) 0 250 500 750	
0				FILL: Bitumen				
				FILL: Gravel consists coal, black.				
1	Test Pit			FILL: Silty Clay,brown with wood and bricks.				
				FILL: Clay, brown/orange and compact.				
2				FILL: Concrete Slab End of test pit.				
3								
4								
5								
6								

Drill Company: Other

Drill Model: Excavator

Hole Diameter (mm):

Date Commenced: 1/20/2010

Date Completed: 1/20/2010

Logged/checked by: Ashling McNeill

Sheet: 1 of 1

ORD05

Attachment 2

Project ID: CES090605-CMC **Easting:**

Project: Narellan _Ellyard Street **Northing:**

Client: Caldwell Martin Cox **Elevation:**

Location: Ellyard Street **Environmental Log:** **CTP9**

CONSULTING EARTH SCIENTISTS
Jones Bay Wharf 19-21, Lower Level Suite 121
26-32 Pirrama Road Pyrmont 2009
PH: (02) 8498 2200 FAX: (02) 9552 4399

DRILLING INFO.			LITHOLOGY		SAMPLING INFORMATION			PID/PID (ppm)			WELL DETAIL
Depth	Method	Water	Symbol	Description	Sample ID	Type	C	250	500	750	
0	Test Pit			FILL: Bitumen with sandy gravel underlying the bitumen							
				FILL: Silty Clay with grit, brown/black changes colour to mottled orange/brown clay with depth. Wood debris and plastic present.							
2				FILL: Bricks stacked in a clay matrix							
				FILL: Concrete, refusal.							
				End of test pit.							
3											
4											
5											
6											

Drill Company: Other

Drill Model: Excavator

Hole Diameter (mm):

Date Commenced: 1/20/2010

Date Completed: 1/20/2010

Logged/checked by: Ashling McNeill

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: F1

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 18-06-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
▼ 0.6m BGL (27-06-12)	-1.00 to 10.50		Ground Surface ***Concrete*** ***Fill*** Dark brown gravelly clay with solid waste landfill materials including ash, bricks, plastics, scrap metal, rags and glass from 1.3mBGL , fine-coarse grained, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 10.1m	Torquer EX-CAP Plug Blank UPVC 50mm (Casing) 0.7m Granular bentonite seal Backfill Material Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) Specialised Sand UPVC base cap Granular bentonite seal	0.2 0.2 0.2

FCR = FIELD CONTAMINATION RANKING

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1 = Slight visual signs of contamination and/or odours
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3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: F2

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 07-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
2.14m BGL (27-06-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50		Ground Surface ***Concrete*** ***Fill*** Dark grey/brown silty gravelly clay with solid waste landfill materials including scrap metal, plastics and wood, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 6m	Torquer Ex-CAP Plug 0.77m Blank UPVC 50mm (Casing) Granular bentonite seal Backfill Material Slotted UPVC 50mm (Screen) Specialised Sand Blank UPVC sump (200mm approx.) UPVC base cap Granular bentonite seal	14.5 1.2 0.1

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

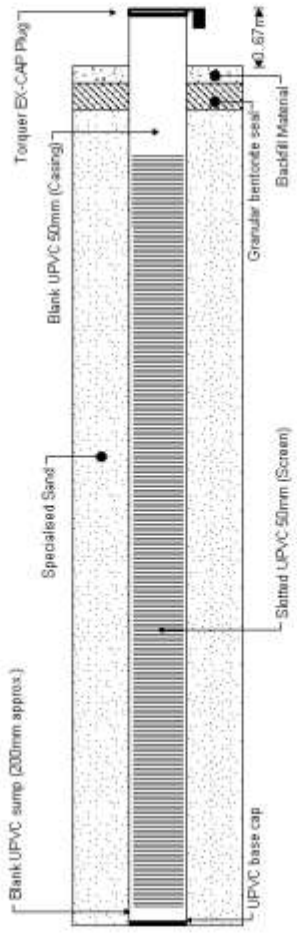
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: F3

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 20-06-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
2.52m BGL (27-06-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.00, 10.50, 11.00, 11.50, 12.00		Ground Surface ***Fill*** Brown/orange-grey gravelly clay, medium plasticity, moist, no odour ***Fill*** Dark brown silty gravelly clay with mixed waste landfill materials including concrete, tile, cable, wood, plastics, scrap metal, moist-wet, putrescible odour Drillers noted potential drilling through petroleum drums @ 8.8-9mBGL, strong hydrocarbon odour Refusal in waste timbers Hole collapse back to 10m BGL Borehole ended at 11.8m		0.2 0.4 0.2

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COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: F4

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 01-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
4.4m BGL (27-06-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.00, 10.50, 11.00, 11.50		Ground Surface ***Fill*** Brown/orange-grey gravelly clay with plastic, concrete and bricks, moist, no odour ***Fill*** Dark brown gravelly clay with mixed waste landfill materials including concrete, wood and plastics, moist, putrescible odour Refusal in landfill waste materials Borehole ended at 10.4m	Torquer Ex-CAP Plug; 0.75m; Blank UPVC 50mm (Casing); Granular bentonite seal; Backfill Material; Slotted UPVC 50mm (Screen); Blank UPVC sump (200mm approx.); Specalised Sand; UPVC base cap	0 0.3

FCR = FIELD CONTAMINATION RANKING

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

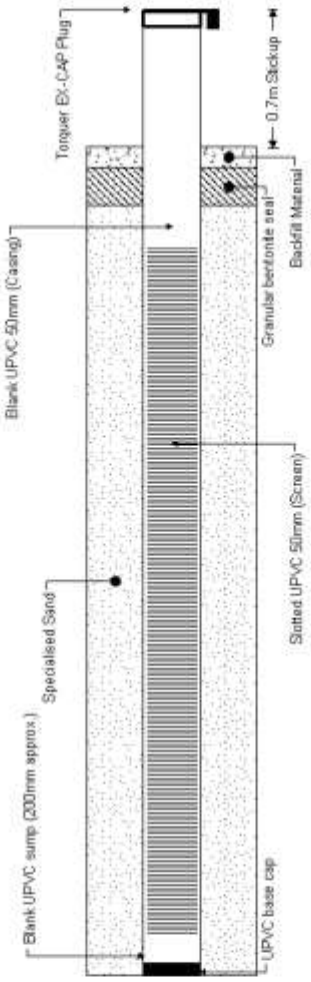
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: L1

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers
Drill date: 29-05-2012

Sheet: 1 of 1
Bore License No:
Hole size: 100mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
3.4m BGL (27-6-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50		Ground Surface ***Asphalt*** ***Fill*** Brown/grey gravelly clay, fine to medium grained, dry, no odour ***Gravelly Clay*** Brown-grey/red, medium plasticity, very stiff, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Refusal in hard Shale Borehole ended at 4.4m		0.1 0.0 0.0 0.3

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2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: L2

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers
Drill date: 29-05-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 100mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
1.89m BGL (27-6-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50		Ground Surface ***Asphalt*** ***Fill*** Brown gravelly clay, fine to coarse grained, dry, no odour ***Gravelly Clay*** Brown/red, medium plasticity, very stiff, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Refusal in hard Shale Borehole ended at 4.2m	Torquer Ex-CAP Plug 0.77m Stickup Blank UPVC 50mm (Casing) Granular bentonite seal Backfill Material Specialised Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	0.0 0.0 0.0

FCR = FIELD CONTAMINATION RANKING

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2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

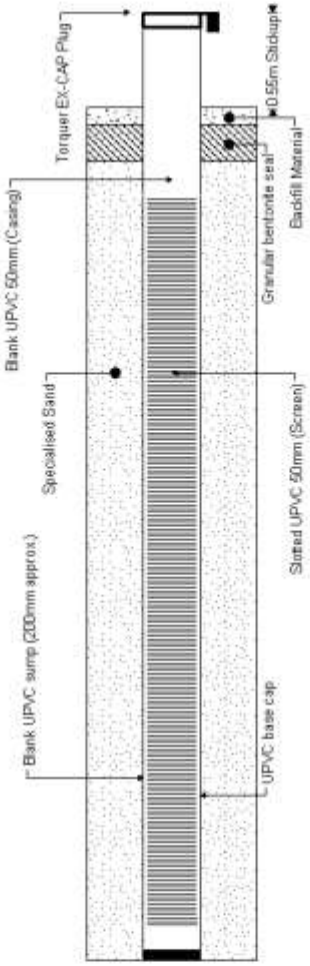
Monitoring Bore: L3b

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers
Drill date: 20-06-2012

Sheet: 1 of 1
Bore License No:
Hole size: 100mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
	-1.00				
	-0.50				
	0.00		Ground Surface		
	0.50		***Fill*** Light brown/orange gravelly clay, fine to coarse grained, dry, no odour		
	1.00		***Gravelly Clay*** Brown/red, medium plasticity, very stiff, moist, no odour		
	1.50		***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry, no odour		
	2.00				
	2.50				
	3.00				
	3.50				0.0
	4.00				
	4.50				0.0
	5.00		Borehole ended at 5m		



FCR = FIELD CONTAMINATION RANKING

0 = No visual signs of contamination and/or detectable odours
1 = Slight visual signs of contamination and/or odours
2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: L4

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers
Drill date: 01-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 100mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
1.72m BGL (27-6-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00		Ground Surface ***Concrete*** ***Fill*** Brown gravelly clay, fine to coarse grained, dry, no odour ***Shale/Siltstone*** Light brown-grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 5m	Torquer EX-CAP Plug; 0.73m Stickup; Backfill Material; Granular bentonite seal; Blank UPVC 50mm (Casing); Specialised Sand; Slotted UPVC 50mm (Screen); Blank UPVC sump (200mm approx.); UPVC base cap	0.2 0.1 0.1

FCR = FIELD CONTAMINATION RANKING

0 = No visual signs of contamination and/or detectable odours
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3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: L5

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 08-06-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
8.03m BGL (27-6-12)	-1.00 to 18.50		Ground Surface ***Fill*** Brown/orange silty clay with grass rootlets, fine grained, moist, no odour ***Gravelly Clay*** Brown/red gravelly clay, medium plasticity, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 18.2m	Torquer Ex-CAP Plug; 0.7m Backfill Material; Granular bentonite seal; Blank UPVC 50mm (Casing); Speciaised Sand; Slotted UPVC 50mm (Screen); Blank UPVC sump (200mm approx.); UPVC base cap	0.0 0.0 0.0 0.0 0.0 0.4 3.7

FCR = FIELD CONTAMINATION RANKING

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: L6

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 19-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
7.08m BGL (19-6-12)	-1.00 to 18.50		Ground Surface ***Fill*** Dark grey-brown gravelly clay, fine-coarse grained, dry, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 18m	Torquer Ex-CAP Plug 0.8m Backfill Material Granular bentonite seal Blank UPVC 50mm (Casing) Speciality Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	6.0 0.0 0.0

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical

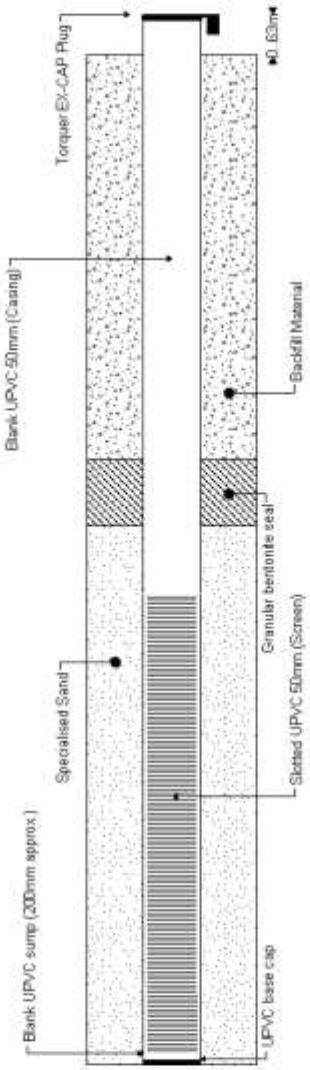
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: MW5D

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 30-05-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
0.99m BGL (27-6-12)	-1.00 to 15.50		Ground Surface **Concrete** **Fill** Light brown/orange gravelly clay, medium plasticity, moist, no odour **Gravelly Clay** Orange/light brown, fine-coarse grained, moist, no odour **Shale/Siltstone** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 15m		0.0 0.0 0.0 0.0 2.9

FCR = FIELD CONTAMINATION RANKING

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1 = Slight visual signs of contamination and/or odours
2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: MW108D

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 19-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	PID Readings (ppm)
3.63m BGL (27-6-12)	-1.00 to 18.00		Ground Surface	
			Fill Dark grey-brown shale (crushed roadbase), fine-coarse grained, dry, no odour	
			Fill Brown/grey gravelly clay, fine to medium grained, dry, no odour	0.2
			Fill Orange/light brown gravelly sand with clay, fine-coarse grained, wet, no odour	0.6
			Shale/Siltstone Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour	0.0
			Interbeded soft clay layers @ 11m BGL	
			Borehole ended at 18m	

Bore construction details: Torquer Ex-CAP Plug; +0.7m; Blank UPVC 50mm (Casing); Backfill Material; Granular bentonite seal; Slotted UPVC 50mm (Screen); Specialised Sand; Blank UPVC sump (200mm approx.); UPVC base cap

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: MW34

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers
Drill date: 29-05-2012

Sheet: 1 of 1
Bore License No:
Hole size: 100mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
▼ 0.52m BGL (28-6-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50		Ground Surface ***Asphalt*** ***Fill*** Brown/grey gravelly clay, fine to medium grained, moist, no odour ***Fill*** Brown/grey gravelly clay, fine to coarse grained, moist, no odour ***Gravelly Clay*** Orange/brown-grey, medium plasticity, very stiff, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 6.3m	Torquer Ex-CAP Plug 0.6m Stickup Blank UPVC 50mm (Casing) Granular bentonite seal Backfill Material Specialised Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	0.0 0.0 0.0 0.0 0.0

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2 = Obvious visual signs of contamination and/or odour
3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: MW34D

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 31-05-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
1.17m BGL (27-06-12)	-1.00 to 16.00		Ground Surface ***Concrete*** ***Fill*** Dark brown gravelly clay with asphalt fragments, medium plasticity, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 16m	Torquer Ex-CAP Plug; ø0.88m; Blank UPVC 50mm (Casing); Backfill Material; Granular bentonite seal; Specialised Sand; Slotted UPVC 50mm (Screen); Blank UPVC sump (200mm approx.); UPVC base cap	0.1; 0.0; 0.0; 0.0; 0.0; 0.0

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COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: P1

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers/Washbore with casing advance
Drill date: 08-06-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
▼ 0.59m BGL (27-6-12)	-1.00 to 10.00		Ground Surface ***Fill*** Brown silty clay with grass rootlets, fine grained, moist, no odour ***Fill*** Brown/orange gravelly clay, fine to coarse grained, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 10m	Torquer Ex-CAP Plug Blank UPVC 50mm (Casing) Backfill Material Granular bentonite seal ~0.7m Stickup Specialised Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	0.0 0.0 0.0

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COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: P2

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers/Washbore with casing advance
Drill date: 07-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
3.74m BGL (27-6-12)	-1.00 to 11.00		Ground Surface ***Fill*** Brown silty clay with grass rootlets, fine grained, moist, no odour ***Fill*** Brown/orange gravelly clay, fine to coarse grained, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 11m	Torquer Ex-CAP Plug Blank UPVC 50mm (Casing) Backfill Material 0.7m Stickup Granular bentonite seal Specialised Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	0.0 0.0 0.0 0.0 0.3 2.4

FCR = FIELD CONTAMINATION RANKING

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COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical

PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: P3

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers/Washbore with casing advance
Drill date: 31-05-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
▼ 5.18m BGL (27-6-12)	-1.00 to 16.00		Ground Surface ***Fill*** Sandy gravelly clay (crushed sandstone) with ash pieces, fine-coarse grained, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 16m	Torquer Ex- CAP Plug Blank UPVC 50mm (Casing) Backfill Material Granular bentonite seal ~0.76m Stickup~ Specialised Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	0.0 0.0 0.0 0.0 0.0 0.2

FCR = FIELD CONTAMINATION RANKING

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3 = Strong visual signs of contamination and/or odour

COMMENTS:

ORD05

Attachment 2

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: P4

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers/Washbore with casing advance
Drill date: 01-06-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
8.26m BGL (27-6-12)	-1.00 to 18.00		Ground Surface ***Fill*** Silty gravelly clay with grass rootlets , fine-coarse grained, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 18.1m	Torquer EX-CAP Plug Blank UPVC 50mm (Casing) Backfill Material Specialised Sand Granular bentonite seal -0.67m Stickup Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	0.0 0.0 0.0 0.0 0.0

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COMMENTS:

Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: P5

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Augers/Washbore with casing advance
Drill date: 08-06-2012

Sheet: 1 of 1
Bore License No:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
7.86m BGL (27-6-12)	-1.00 to 18.00		Ground Surface ***Fill*** Grey-dark grey crushed shale gravel, fine-coarse grained, dry, no odour ***Fill*** Brown gravelly clay, fine-coarse grained, moist, no odour ***Gravelly clay*** Orange/brown-grey, medium-high plasticity, very stiff, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine to medium grained, dry-wet, no odour Borehole ended at 18m	Torquer Ex-CAP Plug Blank UPVC 50mm (Casing) Backfill Material Granular bentonite seal -0.85m Stickup Specialised Sand Slotted UPVC 50mm (Screen) Blank UPVC sump (200mm approx.) UPVC base cap	No PID readings

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COMMENTS:

ORD05

Attachment 2

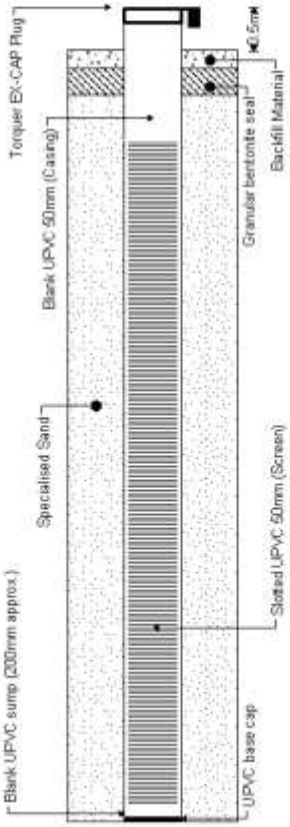
Environmental Investigations
Contamination Assessment Management & Geotechnical
PO Box 215
ST PETERS NSW 2044
Ph: (02) 9516-0722 Fax: (02) 9516-0741

Monitoring Bore: P6

Project No: E1445.1
Site Address: 1 Elyard Street, Narellan, NSW
Client: Elyard Gardens
Drill Method: Solid Flight Auger/Washbore with casing advance
Drill date: 30-05-2012

Sheet: 1 of 1
Bore License No.:
Hole size: 125mm
Engineer: E.S.
Checked by: E.G.

SUBSURFACE PROFILE

SWL (m)	Depth (m)	Symbol	Description	Bore construction details	PID Readings (ppm)
8.21m BGL (27-06-12)	-1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.00, 10.50, 11.00, 11.50		Ground Surface ***Fill*** Dark brown-brown gravelly clay with ash fragments, fine-medium grained, moist, no odour ***Fill*** Brown gravelly clay with scrap metal, geomat fabrics, plastic bags, moist, no odour ***Shale/Siltstone*** Grey-orange/grey, highly weathered, fine-medium grained, dry-wet, no odour Borehole ended at 11.5m		2.3 0.3 0.8

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COMMENTS:

Location	Filling depth (m)	Total depth (m)	Profile encountered
SS1	>0.2	0.2	Fill light grey/brown clay, some slag and aerated concrete
SS6	>0.2	0.2	Fill grey brown clay including concrete and bitumen
SS7	>0.2	0.2	Capping material stiff orange clay with rubble and shale
TP1	>6.0	6.0	concrete + capping to 0.8m, landfill to 6.0m
TP2	>6.5	6.5	concrete + capping to 0.8m, landfill to 6.5m
TP3	>4.5	4.5	concrete + capping to 1.0m, landfill to 4.5m
TP4	>6.8	6.8	concrete + capping to 0.7m, landfill to 6.8m
TP5	>6.8	6.8	concrete and capping to 0.9m, landfill to 6.8m
H6	-	~<1.0	capping fill
H7	-	0.17	capping fill
H8	-	~<1.0	capping fill
H9	-	~<1.0	capping fill
H10	-	0.63	capping fill
H11	-	0.63	capping fill
H12	-	0.665	capping fill
H13	-	0.94	capping fill
BH3	>1.7	1.7	brown clay to 1.2m then wood, bitumen, plastic in clay matrix
BH4	0.5	1.0	concrete/fill to 0.5 natural at 0.5m
BH5	2.2	2.6	concrete/fill to 2.2m natural at 2.2m
BH6	2.6	3.0	bitumen/fill to 2.6m natural at 2.6m
BH7	>3.3	3.3	concrete/fill to at least 3.3m
BH8	>2.4	2.4	concrete/fill to at least 2.4m
BH9	6.9	6.9	heavy clay to 0.8m, landfill to 6.6m, shale to 6.9m
BH11	0.5	11.5	bitumen/fill to 0.5m, natural soils from 0.5m
BH12	1.4	1.65	concrete/fill to 1.4m, natural soils from 1.4m
BH13	0.4	0.93	fill to 0.4m, natural soils from 0.4m
BH14	0.8	1.25	fill to 0.8m, natural soils from 0.8m
BH17	2.6	3.0	fill to 2.6m, natural soils from 2.6m
BH20	>0.6	0.6	concrete/fill to at least 0.6m
BH21	>0.74	0.74	fill to at least 0.74m
BH22	0.3	1.2	fill to 0.3m, natural from 0.3m
BH23	>0.7	0.7	capping fill to at least 0.7m
BH24	>0.72	0.72	capping fill to at least 0.72
BH25	>0.5	0.5	capping fill to at least 0.5m
BH26	>0.5	0.5	capping fill to at least 0.5m
BH27	>2.2	2.2	concrete/fill to at least 2.2m
BH28	>1.3	1.3	fill to at least 1.3m
BH29	>0.74	0.74	concrete/fill to at least 0.74

ORD05

Attachment 2

LOCATION See figure 2	Borehole Log: BH1	Proj.manager PG	Logged by DPS
SURFACE ELEVATION JOB NUMBER 104080			Approved
GROUNDWATER NGWE DATUM	PROJECT: Diblar Jimbalia - Narellan		
DRILL METHOD Push Tube DATE 28/07/2004			

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Loss	Moisture content %	Fill	Bedrock	Fill sampling	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA ec - H2O	CHEMICAL DATA EC 1:5	CONSTRUCTION DETAILS / COMMENTS
BH1	Bitumen, blue metal and some crushed sandstone											7.0				No odour throughout
Natural	Firm/stiff, dark brown silty clay, labile to crumbly and a length of fabric		0.2					M2				6.5				
	Stiff, orange medium grained clay with smooth fabric		0.4	P/G				M2				6.5				
	Becoming very stiff		0.6													
			0.8									6.5				
			1.0					M3								
			1.2									5.5				
	Very stiff, grey mottled heavy clay											6.0				
	End of Hole @ 1.3m		1.4													

Environmental & Earth Sciences

PLA.054

LOCATION See figure 2			Borehole Log: BH3	Proj.manager PG	Logged by DPS
SURFACE ELEVATION	JOB NUMBER 104060				Approved
GROUNDWATER NGWE	DATUM		PROJECT: Diblar Jimbalia - Narellan		
DRILL METHOD Push Tube	DATE 28/07/2004				

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	FID Background	FID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pH - KCl	CHEMICAL DATA EC dS/m	CONSTRUCTION DETAILS / COMMENTS
BH3 FRI	Concrete		0.2												Piezo
	Stiff/firm, mixed grey, yellow, brown clay with minor ironstone - labile fabric		0.4	P/G	■			M3			6.5				No odour
			0.6												Backfill
	Firm/stiff mixed orange clay with dark brown/ black clayey sand, crumbly, consistency for clayey sand, labile consistency for orange clay and copper wire		0.8					M2			8.0				No odour
			1.0	P/G	■						8.5				Bentonite
			1.2												
	Bitumen like material in clay matrix		1.4	P/G	■			D			8.0				Minor tar odour
	Broken glass, wood, insulation bat plastic, fragments of porcelin and possible ash		1.6	P/G	■										Slotted screen
	landfill odour		1.8												Gas probe
	End of Hole @ 1.7m - refusal on possible wood		2.0	P/G	■			M3							
			2.2												
			2.4												
			2.6												
			2.8												
			3.0												

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Attachment 2

LOCATION See figure 2		Borehole Log: BH5	Proj.manager PG
SURFACE ELEVATION	JOB NUMBER 104080		Logged by DPS
GROUNDWATER 1.4m	DATUM	PROJECT: Diblar Jimbalia - Narellan	Approved
DRILL METHOD Push Tube	DATE 29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lab	Moisture content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH-100	CHEMICAL DATA pH - H2O	CHEMICAL DATA EC dS/m	CONSTRUCTION DETAILS / COMMENTS
BH5	Concrete		0.0												
Fill	Roadbase and crushed black shale		0.2								8.0				No odour throughout
	Stiff, olive brown mixed clay with minor sandstone and shale rubble (fcm3)		0.4					M2							Possibly fill associated with storm water pipe trench
			0.5	P/G							6.0				
			0.6								7.0				
			1.0					M3							
			1.2												
	Very dense, possible ash material wth blue metal incoherent clay lenses, sand and wood		1.4												Interface drainage
			1.6								7.5				
			1.8	P/G											
	Possibly some light vitrous black slag or coal		2.0												
Natural	Stiff, olive brown, partially mottled orange clay with diffuse iron concretions		2.2					M2							
			2.4	P/G							6.5				
	Trending to stiff, orange clay with brown clay lined root channel		2.6					M2							
	End of Hole @ 2.6m		2.8												
			3.0												

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LOCATION See figure 2
SURFACE ELEVATION JOB NUMBER 104050
GROUNDWATER 2.2m DATUM
DRILL METHOD Push Tube DATE 29/07/2004

Borehole Log: BH7

Proj.manager PG

Logged by DPS

Approved

PROJECT: Dibiar Jimbalia - Narellan

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA Pt - soil	CHEMICAL DATA Ec dS/m	CONSTRUCTION DETAILS COMMENTS
BH7	Concrete		0.2												
Fill	Stiff, black crushed shale and orange sandstone			P				M2			7.5				
	Stiff, mixed brown, fine sandy clay		0.4					M3			7.0				Backfill
	Dark grey/black sandy silty clay with minor rubble		0.6												
	Very stiff, grey/brown mottled clay with minor iron concretion		0.8					M1			6.0				
	Dark brown/grey clayey silty sand with high organic matter content, roots and rotten grass		1.0					M3							Bentonite
	Mixed, brown clay and sand with rubble and wood		1.2								5.5				
	Firm/stiff, mixed, dark grey to black clayey sand, just cohesive with gravel		1.4					M2							Sand
	Stiff, mixed brown to dark brown clay with glass, rubble and wood		1.6								8.0				
			1.8	P/G											
			2.0					M2			8.5				Slotted
			2.2												
			2.4												
			2.6												
			2.8												
			3.0												
			3.2												
	End of Hole @ 3.3m		3.4												

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Attachment 2

LOCATION See figure 2				Borehole Log: BH9	Proj.manager PG / Logged by PG
SURFACE ELEVATION		JOB NUMBER	104080		Approved
GROUNDWATER	3.6m	DATUM		PROJECT: Diblar Jimbalia - Narellan	
DRILL METHOD	PT & SFA	DATE	29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES: TYPE / Undisturbed / Disturbed / Lost	Moisture content % / PID / Background / PID reading	CHEMICAL DATA: pH - soil / pH - H2O / Ec - H2O / EC (dS/m)	CONSTRUCTION DETAILS / COMMENTS
BH9	Brown heavy clay with fragments of concrete throughout (concrete slab at 0.5m) no odour		0.5	D	8.0		Bentonite plug
	Brown/black clay matrix with wood, plastic ceramics throughout and large wood piece at 1.5m		1.0	D-M	8.5		
	Darker colour (black) at ~ 1.8m increased VM and some steel pieces		1.5				Drilling cuttings
	Wood at 2m still - 2.4m still fresh		2.0	M-W	8.0		
	Wood at 2.5m		2.5				
	Concrete between 3.0-3.6m		3.0				
			3.5				1-3mm graded sand
	Odour increasing once through wood		4.0				
			4.5				
			5.0				slotted
			5.5				
			6.0				
			6.5				
	Approximate depth of shale		6.9				
	End of Hole @ 6.9m in natural shale						

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LOCATION See figure 2		Borehole Log: BH10Cont	Proj.manager PG
SURFACE ELEVATION	JOB NUMBER 104080		Logged by PG
GROUNDWATER NGWE	DATUM	PROJECT: Dibiar Jimbalia - Narellan	Approved
DRILL METHOD Solid flight auger	DATE 29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth (metres)	SAMPLES: TYPE	SAMPLES: Undisturbed	SAMPLES: Disturbed	SAMPLES: Lost	Moisture, Inorganic %	PID Background	PID Reading	CHEMICAL DATA: pH - soil	CHEMICAL DATA: pH H2O	CHEMICAL DATA: pH - H2O	CHEMICAL DATA: EC H2O/m	CONSTRUCTION DETAILS / COMMENTS
BH10 Cont			10.5					D-M							Slotted
			11.0												
	End of Hole @ 11.2m		11.5												

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LOCATION See figure 2		Borehole Log: BH11Cont	Proj.manager PG
SURFACE ELEVATION	JOB NUMBER 104060		Logged by DPS
GROUNDWATER NGWE	DATUM	PROJECT: Diblar Jimbalia - Narellan	Approved
DRILL METHOD Solid flight auger	DATE 29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth (metres)	SAMPLES: TYPE	SAMPLES: Undisturbed	SAMPLES: Disturbed	SAMPLES: Lost	Moisture content %	PID Background	PID Reading	CHEMICAL DATA: pH - soil	CHEMICAL DATA: pH - H2O	CHEMICAL DATA: pH - KCl	CHEMICAL DATA: EC µS/cm	CONSTRUCTION DETAILS / COMMENTS
BH11 Cont			10.5					M							Drill cuttings
	End of Hole @ 11.5m		11.0												
			11.5												

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LOCATION See figure 2			**Borehole Log: BH13**	Proj.manager PG	Logged by DPS
SURFACE ELEVATION		JOB NUMBER 104080			Approved
GROUNDWATER NGWE		DATUM	**PROJECT: Dibiar Jimbalia - Narellan**		
DRILL METHOD Push Tube		DATE 30/07/2004			

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Soil	Moisture content %	PID Background	PID Readings	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pH - HNO3	CHEMICAL DATA EC (dS/m)	CONSTRUCTION DETAILS / COMMENTS
BH13 Fill	Stiff, brown mixed clay, crumbly containing shale fragments and coal		0.2	P/G				D-			7.5				No odour throughout
			0.4					M1							
Natural	Very stiff, orange brown mottled clay, brittle		0.6	P/G				M1			5.0-5.5				
			0.8												
	End of Hole @ 0.93m - natural soil		1.0												

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Attachment 2

LOCATION See figure 2			Borehole Log: BH15	Proj.manager PG	Logged by DPS
SURFACE ELEVATION		JOB NUMBER 104080			Approved
GROUNDWATER	NGWE	DATUM	PROJECT: Diblar Jimbalia - Narellan		
DRILL METHOD	Push Tube	DATE 29/07/2004			

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	PID Background	PID Headspace	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA Redox	CHEMICAL DATA EC 1:5 soln	CONSTRUCTION DETAILS / COMMENTS
BH15 Disturbed	Firm, brown, fine sandy silty clay, crumbly with minor rubble and charcoal on surface		0.2	P/G				M1			6.5				No odour throughout Cuttings; Bentonite plug
Natural	Stiff, light orange clay, brittle		0.4					M1							
Natural	Trending to very stiff/hard mottled orange grey clay		0.6												
			0.8					D							1 - 3mm graded sand
			1.0												
	Hard fractured shale in light grey silty clay matrix, brittle		1.2					D							
	End of Hole @ 1.21 - refusal on shale		1.4												
			1.5												
			1.8												
			2.0												
			2.2												
			2.4												
			2.6												
			2.8												
			3.0												

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LOCATION See figure 2			Borehole Log: BH17	Proj manager PG	Logged by DPS
SURFACE ELEVATION		JOB NUMBER 104080			Approved
GROUNDWATER	NGWE	DATUM	PROJECT: Dibiar Jimbalia - Narellan		
DRILL METHOD	Push Tube	DATE 29/07/2004			

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA ORP - H2O	CHEMICAL DATA EC (dS/m)	CONSTRUCTION DETAILS / COMMENTS
BH17 Fill	Stiff grey, brown, orange mixed fine sandy silt containing concrete, rubble, sandstone and black shale, powdery landfill batter		0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.5	P/G				D			7.0 8.0				No odour throughout
Disturbed Natural	Very stiff, grey, maroon mottle clay, brittle consistency		2.8 3.0	P/G				M1			5.5				

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LOCATION See figure 2		Borehole Log: BH19	Proj.manager PG
SURFACE ELEVATION	JOB NUMBER 104060		Logged by DPS
GROUNDWATER NGWE	DATUM	PROJECT: Dibiar Jimbalia - Narellan	Approved
DRILL METHOD Push Tube	DATE 30/06/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture Content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pH - KCl	CHEMICAL DATA EC 1:5	CONSTRUCTION DETAILS / COMMENTS
BH19 Fill	Concrete		0.2												No odour throughout
Natural	Orange grey mottled clay with ~30% cemented iron concentrations, labile (plastic)		0.4	P/G				M3			6.0-6.5				
	Increasing iron concentration		0.6												
	Very hard grey shale		0.8												
	End of Hole @ 0.8m - refusal on shale														

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LOCATION See figure 2		Borehole Log: BH21	Proj. Manager PG / Logged by DPS
SURFACE ELEVATION	JOB NUMBER 104080		
GROUNDWATER NGWE	DATUM	PROJECT: Diblar Jimbalia - Narellan	Approved
DRILL METHOD Push Tube	DATE 30/06/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	PID Background	PID Reading	CHEMICAL DATA	CONSTRUCTION DETAILS / COMMENTS
BH21	Bitumen											
Fill	Stiff, dark brown grey clay containing rubble and blue metal		0.2					M2			7.0	No odour throughout
	Dense, black shale with coal		0.4	P/G				M3			7.0	
Disturbed	Firm, brown silty clay, crumbly		0.6					M2				
Natural			0.8									
Natural	Stiff, orange grey mottled clay, brittle with pieces of fractured shale and root clones		1.0	P/G				M1			5.0	
			1.2									
	End of Hole @ 1.2m - refusal on shale											

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LOCATION See figure 2		Borehole Log: BH23	Proj.manager PG
SURFACE ELEVATION	JOB NUMBER 104080		Logged by DPS
GROUNDWATER NGWE	DATUM	PROJECT: Diblar Jimbalia - Narellan	Approved
DRILL METHOD Push Tube	DATE 29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES LOM	Moisture content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH-100	CHEMICAL DATA ps - 100	CHEMICAL DATA EC mS/cm	CONSTRUCTION DETAILS / COMMENTS
BH23	Concrete		0.2												Drill cuttings
	Road base							M2			7.0-				Bentonite
	Stiff, orange grey mottled yellow clay, labile		0.4	P/G							8.0				Slots
			0.6	P/G				M1			6.5				1-3mm graded sand
	Rubble - sandstone, glass, wood in sandy clay														
	End of Hole @ 0.7m		0.8												
			1.0												
			1.2												
			1.4												
			1.5												
			1.8												
			2.0												
			2.2												
			2.4												
			2.5												
			2.8												
			3.0												

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LOCATION See figure 2		Borehole Log: BH25	Proj.manager PG / Logged by DPS
SURFACE ELEVATION	JOB NUMBER 104060		Approved
GROUNDWATER NGWE	DATUM	PROJECT: Dibiar Jimbalia - Narellan	
DRILL METHOD Push Tube	DATE 29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Number	SAMPLES Diameter	SAMPLES Unit	Moisture content %	PID Reading	CHEMICAL DATA	CONSTRUCTION DETAILS / COMMENTS
BH25	Grass										Bentonite
Fill	Firm, grey/orange mixed sandy clay with shale fragments, bitumen, crumbly consistance		0.2	P/G				M1		6.5	No odour throughout
	Very stiff, orange/brown ironstone		0.4	P/G				M1		6.5	Screen 1-3mm graded sand
	End of Hole @ 0.5m		0.6								

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LOCATION See figure 2		Borehole Log: BH27	Proj.manager PG
SURFACE ELEVATION	JOB NUMBER 104080		Logged by DPS
GROUNDWATER NGWE	DATUM	PROJECT: Dibiar Jimbalia - Narellan	Approved
DRILL METHOD Push Tube	DATE 29/07/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pH - H2O2	CHEMICAL DATA TD strips	CONSTRUCTION DETAILS / COMMENTS
BH27 FILL	Concrete		0.2					D							Drill cuttings
	Broken pavers and bricks in a orange/brown sandy clay		0.4	P/G				D			7.0				Bentonite
	Loose, incoherent brown gravelly clayey sand		0.6												
	Very stiff, mottled orange/grey clay with some iron concretions and a coke piece		0.8	P/G				M1			6.5				1 - 3mm graded sand
			1.0												
	Stiff, mixed brown silty clay, crumbly		1.2					M1							
			1.4								7.0				
	Orange clay with some black fight slag and iron stone		1.6												
			1.8					M1			7.5				
			2.0	P/G											
	End of Hole @ 2.2m - refusal on shale - not know if is on floater of natural		2.2												
			2.4												
			2.6												
			2.8												
			3.0												

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LOCATION See figure 2			Borehole Log: BH29	Proj.manager PG	Logged by DPS
SURFACE ELEVATION	JOB NUMBER 104080				Approved
GROUNDWATER NGWE	DATUM		PROJECT: Diblar Jimbalia - Narellan		
DRILL METHOD Push Tube	DATE 28/07/2004				

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Lab Number	SAMPLES Gauge	SAMPLES Unit	Moisture content %	PID Background	PID Reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA Ec - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH29	Concrete														Bentonite
	Firm, mixed grey sandy clay/brown clay with some sandstone fragments, crumbly to labile		0.2	P/G				M2-M3			6.5				1-3mm graded sand
	Loose, grey poorly sorted light grey sand		0.4					D			7.0				Bentonite backfill
	Broken pavers and concrete pieces		0.8					D							
	End of Hole @ 0.74m		0.8												

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Attachment 2

LOCATION See figure 2		Borehole Log: BH30Cont	Proj.manager PG / Logged by DS
SURFACE ELEVATION	JOB NUMBER 104080		
GROUNDWATER 11.0m	DATUM	PROJECT: Diblar Jimbalia - Narellan	Approved
DRILL METHOD Air (100m@5F)	DATE 7/10/2004		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES: TYPE / Undisturbed / Disturbed / Soil	Moisture Content % / PID Background / PID Reading	CHEMICAL DATA: pH - soil / pH-H2O / pH-H2O / EC-soil	CONSTRUCTION DETAILS / COMMENTS
BH30 Cont	Shale		10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0		W, W, MW, DW		Bentonite; 1-3mm graded sand; Screen
	Dried out at 13.0m (may be result of drilling technique)						
	Shale						

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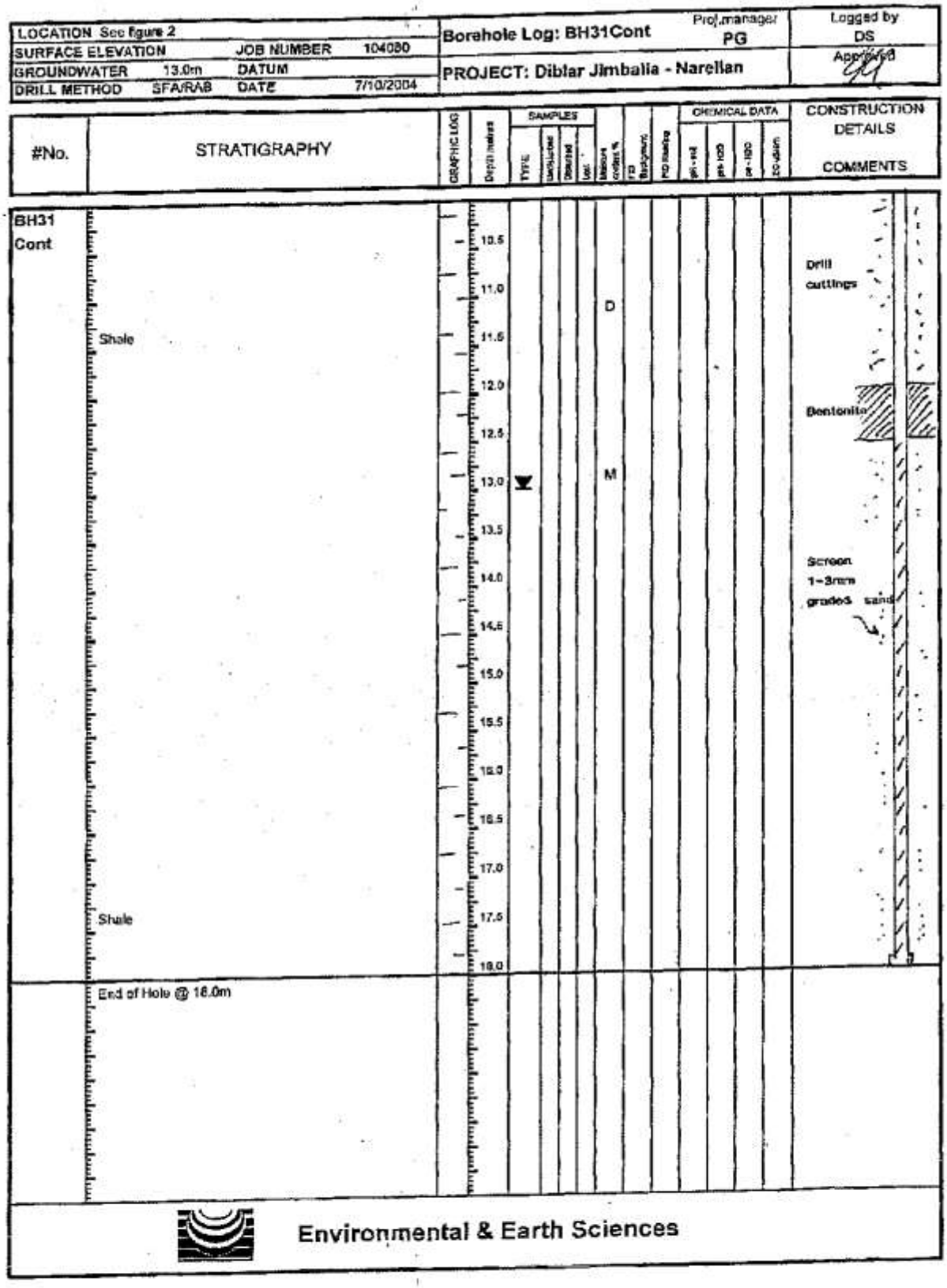
LOCATION See figure 2
SURFACE ELEVATION
JOB NUMBER 104080
GROUNDWATER 13.0m
DATUM
DRILL METHOD SFA/RAB
DATE 7/10/2004
Borehole Log: BH31Cont
Proj.manager PG
Logged by DS
Approved
PROJECT: Dibiar Jimbalia - Narellan
#No.
STRATIGRAPHY
GRAPHIC LOG
Depth metres
SAMPLES
TYPE
CHEMICAL DATA
CONSTRUCTION DETAILS
COMMENTS
BH31 Cont
Shale
Shale
End of Hole @ 18.0m
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
D
M
Drill cuttings
Bentonite
Screen 1-3mm graded sand
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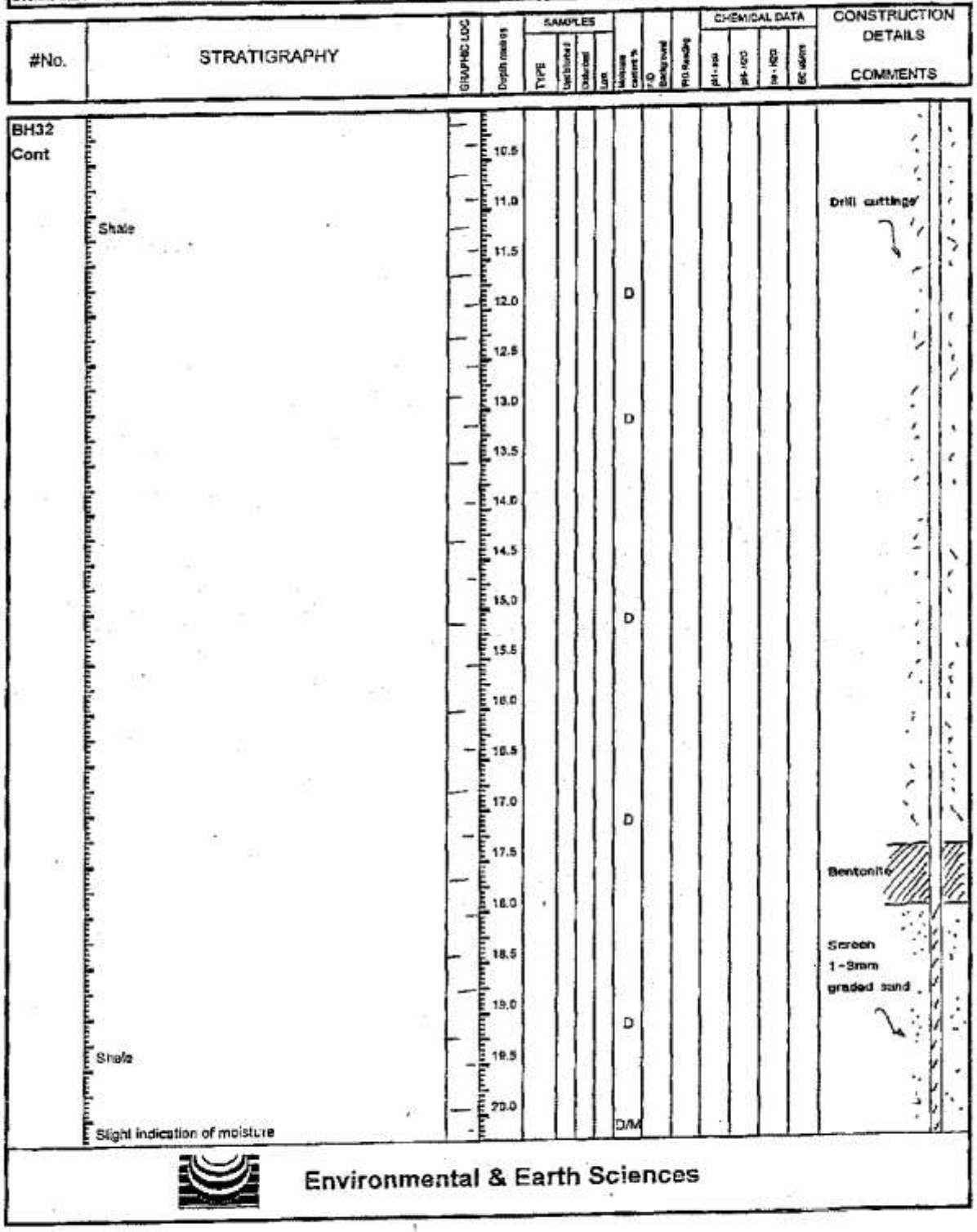
Attachment 2

LOCATION See figure 2		Borehole Log: BH32Cont	Proj.manager PG / Logged by DS
SURFACE ELEVATION	JOB NUMBER 104080		
GROUNDWATER NGWE	DATUM	PROJECT: Dibiar Jimbalia - Narellan	Approved
DRILL METHOD SFA/RAB	DATE 7/10/2004		



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LOCATION See figure 2			Borehole Log: BH33	Proj manager PG	Logged by DS
SURFACE ELEVATION		JOB NUMBER 104080			Approved
GROUNDWATER	11.5m	DATUM	PROJECT: Diblar Jimbalia - Narellan		
DRILL METHOD	SFA/RAB	DATE 7/10/2004			

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES TYPE	SAMPLES Undisturbed	SAMPLES Disturbed	SAMPLES Lost	Moisture content %	PID Background	PID reading	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA ec - H2O	CHEMICAL DATA SO4 soluble	CONSTRUCTION DETAILS / COMMENTS
BH33 Fill	Sandy gravel with crushed rock, brick fragments and fine sand		0.5												No odour throughout
	Brown/red clay with trace of fine sand		1.0					D							
	Grey/light grey extremely weathered shale with fragments of shale and clay		1.5												Drill cuttings
	Weathered shale		2.0					D							
			2.5												
			3.0												
			3.5												
			4.0					D							
			4.5												
			5.0												
			5.5												
			6.0					D							
			6.5												
			7.0												
			7.5												
			8.0												
			8.5												
			9.0					D							
			9.5												
	Shale		10.0												

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Attachment 2

LOCATION See figure 2				Surface Samples	Proj.manager PG / Logged by DS
SURFACE ELEVATION		JOB NUMBER	104080		
GROUNDWATER	NA	DATUM		PROJECT: Diblar Jimbalia - Narella	Approved
DRILL METHOD	shovel	DATE	28/07/2004		

#No.	STRATIGRAPHY	SOIL ORIGIN	Depth metres	SAMPLES: TYPE	Undisturbed	Disturbed	Lost	Moisture content %	PID Screening	PID Reading	CHEMICAL DATA: pH - soil	pH - H2O	pH - H2O2	Electrical Conductivity	CONSTRUCTION DETAILS / COMMENTS
SS1	Fill-mixed light grey brown clay, containing rubble aerated concrete, FC sheeting, black shale hole terminated at 0.2m		0.1 0.2			■		D			6.5				
SS2	Disturbed Natural - minor charcoal + rubble on surface - Brown fine sandy silty clay - crumbly roots washed pebles - black shale - firm hole terminated at 0.2m		0.1 0.2			■		D			7.0				
SS3	Natural - Dark brown - fine silty sandy clay roots, charcoal - firm hole terminated at 0.2m		0.1 0.2			■		D			6.5				
SS4	Natural as for SS3		0.1 0.2			■		D			6.5				
SS5	Disturbed Natural - Brown silty clay - minor iron concretions, roots, crumbly - firm hole terminated at 0.2m		0.1 0.2			■		D			6.0				
SS6	Fill - mixed brown grey clay - containing rubble, concrete bitumen glass hole terminated at 0.2m		0.1 0.2			■		D			7.5				
SS7	Capping - Fill - clay orange - stiff mixed with rubble and shale hole terminated at 0.2 m		0.1 0.2			■		D			7.0				

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Appendix D
Soils Criteria

Revised Remediation Action Plan
3 Elyard Street, Narellan, NSW
Report No. E1445 AT_RAP Rev3

Soil Remediation Criteria

Chemical	Unit	HIL B	HIL D
Metals			
Arsenic – As[10]	mg/kg	500 [2]	3,000
Cadmium Cd	mg/kg	150	900
Chromium(VI) – Cr(VI) [10]	mg/kg	500 [12]	3,600
Copper – Cu	mg/kg	30,000 [11]	240,000
Lead – Pb [10]	mg/kg	1,200 [3]	1,500
Mercury – Hg (inorganic) [4,5]	mg/kg	120	730
Nickel – Ni [10]	mg/kg	1,200	6,000
Zinc – Zn [10]	mg/kg	60,000 [11]	400,000
Petroleum Hydrocarbons			
F1 [8]	mg/kg	180 / 210 [8]	260
F2 [9]	mg/kg	300 / 160 [9]	NL [13]
Naphthalene	mg/kg	3 [1b (sand)]	NL [13]
Benzo(a)pyrene	mg/kg		
Carcinogenic PAHs (as B(a)P TEQ) [6]	TEQ	4	40
Total PAHs [7]	mg/kg	400	4,000
Monocyclic Aromatic Hydrocarbons (BTEX)			
Benzene	mg/kg	0.6 / 65	3
Toluene	mg/kg	390 / 105	NL [13]
Ethyl benzene	mg/kg	NL / 125	NL [13]
Xylenes (total)	mg/kg	NL / 105	230
Volatile Organic Chlorinated Compounds (VOCCs)[14]			
Tetrachloroethylene (PCE)	mg/kg	240	
Trichloroethylene (TCE)	mg/kg	0.94	
cis 1,2 dichloroethylene (cis 1,2 DCE)	mg/kg	160	
Vinyl chloride (VC)	mg/kg	0.059	
Asbestos			
Asbestos (friable or fines)	w/w	0.001%	0.001%
Asbestos (bonded)	w/w	0.04%	0.05%

NOTES:

1. Generic land uses are described in detail in Schedule B7 Section 3
   a. HIL A Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.
   b. HIL B Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high rise buildings and apartments.
   c. HIL C Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site specific assessment may be more appropriate.
   d. HIL D Commercial/industrial, includes premises such as shops, offices, factories and industrial sites.
2. Arsenic: HIL assumes 70% oral bioavailability. Site specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).

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3. Lead: HIL is based on blood lead models (IEUBK for HILs A, B and C and adult lead model for HIL D where 50% oral bioavailability has been considered. Site specific bioavailability may be important and should be considered where appropriate.
4. Methyl mercury: assessment of methyl mercury should only occur where there is evidence of its potential source. It may be associated with inorganic mercury and anaerobic microorganism activity in aquatic environments. In addition the reliability and quality of sampling/analysis should be considered.
5. Elemental mercury: HIL does not address elemental mercury. A site specific assessment should be considered if elemental mercury is present, or suspected to be present,
6. Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.
7. Total PAHs: HIL is based on the sum of the 16 PAHs most commonly reported for contaminated sites (WHO 1998). The application of the total PAH HIL should consider the presence of carcinogenic PAHs and naphthalene (the most volatile PAH). Carcinogenic PAHs reported in the total PAHs should meet the B(a)P TEQ HIL. Naphthalene reported in the total PAHs should meet the relevant HSL.
8. To obtain F1 subtract the sum of BTEX concentrations from the C_6 C_{10} fraction.
9. To obtain F2 subtract naphthalene from the $>C_{10}$ C_{16} fraction.
10. Aged EIL values for contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c NEPM 2013.
11. EIL is dependent on background concentrations, cation exchange value of the soils and pH
12. EIL is dependent on background concentrations, cation exchange value or clay content
13. The soil saturation concentration (Csat) is defined as the soil concentration at which the pore water phase cannot dissolve any more of an individual chemical. The soil vapour that is in equilibrium with the pore water will be at its maximum. If the derived soil HSL exceeds Csat, a soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'.
14. US EPA Regional Screen Levels Residential Soil (Jun 2015)

ORD05

Attachment 2

Appendix E
Remediation Option Review

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E1 Remediation Options & Technologies

Anumber of soil remediation options were reviewed to examine the suitability of each method for the purpose of making the site suitable for the intended land use(s). As part of this remedial options review process and with due regard for surrounding land uses, the geological and hydrogeological limitations at the site and the following issues were considered:

- Prioritisation of works in areas of most concern;
- Ability of remedial method to treat contamination with respect to natural and infrastructure limitations;
- Remedial timetable;
- Cost effectiveness;
- Defensible method to ensure the site is remediated to appropriate levels / validation criteria; and
- Regulatory compliance.

The following sections provide details on various remediation options for the material found on site.

E1.1 FILL, Soils & Residual Clays

E1.1.1 Bioventing

Bioventing stimulates the natural in situ biodegradation of aerobically degradable compounds in soil by increasing oxygen flow to existing soil microorganisms. In contrast to soil vapour vacuum extraction, bioventing uses low air flow rates to provide only enough oxygen to sustain microbial activity. Oxygen is most commonly supplied through direct air injection into residual contamination in soil. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapours move slowly through biologically active soil. Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, non chlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.

Factors that may limit the applicability and effectiveness of the process include:

- A high water table within 1 2 m of the surface, saturated soil lenses, or low permeability soils all may reduce bioventing performance.
- Vapours can build up in basements or underneath buildings within the radius of influence of air injection wells. This problem can be alleviated by extracting air near the structure of concern.
- Extremely low soil moisture content may limit biodegradation and the effectiveness of bioventing.
- Monitoring of off gases at the soil surface may be required.
- Aerobic biodegradation of many chlorinated compounds may not be effective unless there is a co metabolite present, or an anaerobic cycle.

E1.1.2 Enhanced Bioremediation

Enhanced bioremediation is a process in which indigenous or inoculated micro organisms (e.g., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water, converting them to harmless end products. Nutrients, oxygen, or other additives are used to enhance bioremediation and contaminant desorption from subsurface materials. In the presence of sufficient oxygen (aerobic conditions), and other nutrient elements, microorganisms will ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen (anaerobic conditions), the organic contaminants will be ultimately metabolized to methane, limited amounts of carbon dioxide, and trace amounts of hydrogen gas. Under sulfate reduction conditions, sulfate is converted to sulfide or elemental sulfur, and under nitrate reduction conditions, nitrogen gas is ultimately produced.

Factors that may limit the applicability and effectiveness bio remediation of the process include:

- Interaction between the soil matrix and microorganisms influence the results;
- Contaminants may be subject to leaching requiring treatment of the underlying ground water;
- Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones. The system should not be used for clay, highly layered, or heterogeneous subsurface environments because of oxygen (or other electron acceptor) transfer limitations.
- High concentrations of heavy metals, highly chlorinated organics, long chain hydrocarbons, or inorganic salts may be toxic to microorganisms;
- A surface treatment system, such as air stripping or carbon adsorption, may be required to treat extracted groundwater prior to re injection or disposal; and
- The length of time required for treatment can range from 6 months to 5 years and is dependent on many site specific factors.

E1.1.3 Capping and Containment

The "cap and contain" method employs a risk minimisation approach similar to "ongoing management", where impacted soils are managed on site so as not to pose an ongoing risk to the environment or human health. Impacted soils are contained by the placement of an impervious barrier or clean fill materials on top of the impacted material to prevent exposure to site occupiers, workers or the environment. The base of this "clean zone" would be clearly marked by a demarcation barrier to indicate that below this depth workers could potentially be exposed to contamination, which would then trigger additional health, safety and environmental controls.

Capping and containment may be an appropriate remedial option for soil containing both organic and inorganic contaminants that contain residual contamination, particularly if the mix of contaminants is not easily treated. The conditions for this remedial action alternative are:

- The contaminant is relatively non mobile, including low volatility, insoluble and has low migration potential in a soil matrix;
- The primary exposure route to the contaminant and risk to human health is through direct dermal contact, dust inhalation or soil ingestion;
- The primary exposure route for the environment is mitigated through low leaching potential or migration to groundwater; and
- The contained area can be monitored and incorporated into any final land use plans.

In the use of capping and containment, the focus of the response is to prevent contact with, or exposure to the contaminated soils by human receptors and/or eliminate transport by water to off site receptors.

E1.1.4 Chemical Oxidation/Injection

Chemical oxidation remedial strategies involve the addition of an oxidising agent to the soil or groundwater. The rate and extent of degradation of a target chemical of concern is dependent on its susceptibility to oxidative degradation as well as the site conditions, such as pH, temperature, the concentration of oxidant, and the concentration of secondary oxidant consuming substances such as natural organic matter.

Factors which may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation;
- Some chemicals of concern are resistant to oxidation; and
- There is a potential for process induced detrimental effects.

E1.1.5 Excavation and Off site Disposal

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off site receptors. Wastes must be classified in accordance with the NSW EPA Guidelines.

Based on the required disposal of the landfill material, this option would adequately address the remediation goals through the removal of the contaminants from the site. Furthermore, with the removal of any identified contaminated fill soils, the long term liability associated with soil contamination shall be minimised, along with substantial improvement of subsurface site conditions with regard to contamination of soil and groundwater.

E.1.1.6 Land Farming

Ex situ land farming is a proven treatment for petroleum hydrocarbon impacted soils. In general the higher the molecular weight or number of rings in a compound, the slower the degradation rate.

Factors that may limit the applicability and effectiveness of the land farming include:

- The large amount of space required;
- Conditions affecting biological degradation of contaminants (e.g., temperature, rain fall) are largely uncontrolled, which increases the length of time to complete remediation.
- Only suitable for organic contaminants.
- Volatile contaminants, such as solvents, must be pre treated because they would volatilise into the atmosphere, causing air pollution.
- Dust control is an important consideration, especially during tilling and other material handling operations.
- Runoff collection facilities must be constructed and monitored.

For soils with petroleum hydrocarbon concentrations in excess of 8%, land farming is considered unsuitable as a remedial strategy due to the limiting effect that the hydrocarbons have on the capacity of the soil to allow the transfer of nutrients to the contaminant utilising bacteria. The highest recorded TPH concentrations for the Narellan site are in the order of 1%, which makes land farming feasible; however, only if this method is performed in such a way as to allow biological degradation to occur, as recommended under NSW EPA (2014) *Best Practice Note: Landfarming.*

E1.2 Groundwater

E1.2.1 Enhanced Bioremediation

Bioremediation is a process in which indigenous micro organisms (i.e., fungi, bacteria, and other microbes) degrade organic contaminants found in soil and/or ground water.

Enhanced bioremediation attempts to accelerate the natural biodegradation process by providing nutrients, electron acceptors, and competent degrading microorganisms that may otherwise be limiting the rapid conversion of contamination organics to innocuous end products.

Oxygen enhancement can be achieved by either sparging air below the water table or circulating hydrogen peroxide (H_2O_2) throughout the contaminated ground water zone. Under anaerobic conditions, nitrate is circulated throughout the ground water contamination zone to enhance bioremediation. Additionally, solid phase peroxide products (e.g., oxygen releasing compound (ORC)) can also be used for oxygen enhancement and to increase the rate of biodegradation.

Air sparging below the water table increases ground water oxygen concentration and enhances the rate of biological degradation of organic contaminants by naturally occurring microbes. Air sparging also increases mixing in the saturated zone, which increases the contact between ground water and soil. Oxygen enhancement with air sparging is typically used in conjunction with SVE or bioventing to enhance removal of the volatile component under consideration.

During hydrogen peroxide enhancement, a dilute solution of hydrogen peroxide is circulated through the contaminated ground water zone to increase the oxygen content of ground water and enhance the rate of aerobic biodegradation of organic contaminants by naturally occurring microbes.

Solubilized nitrate is circulated throughout ground water contamination zones to provide an alternative electron acceptor for biological activity and enhance the rate of degradation of organic contaminants. Development of nitrate enhancement is still at the pilot scale. This technology enhances the anaerobic biodegradation through the addition of nitrate.

Bio enhanced remediation strategies are slow and may take several years for plume clean up.\

E1.2.2 Air Sparging

In air sparging, air is injected into a contaminated aquifer where it traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps to flush (bubble) the contaminants up into the unsaturated zone where a vapour extraction system is used to remove the vapour phase contamination.

In principal the more volatile a contaminant the more appropriate air sparging as a remediation strategy is. Methane can be added to the system to enhance co metabolism of chlorinated organics.

Factors that may limit the applicability and effectiveness of the process include:

- Preferential air flow pathways reducing the contact between sparged air and the contaminants;
- Air injection wells must be designed for site specific conditions; and
- Soil heterogeneity may cause some zones to be relatively unaffected.

E1.2.3 Chemical Oxidation

In a chemical oxidation system oxidants are added to the system in order to oxidise the chemical of concern to less toxic species. The Chemical oxidants most commonly employed include peroxide, ozone, and permanganate. These oxidants cause the rapid and complete chemical destruction of many toxic organic chemicals while some chemicals are subject to partially degradation and subsequently reduced by bioremediation.

In general oxidants are capable of achieving high treatment efficiencies (e.g., > 90 percent) for unsaturated aliphatic (e.g., trichloroethylene [TCE]) and aromatic compounds (e.g., benzene), with very fast reaction rates (90 percent destruction in minutes). Field applications have clearly affirmed that matching the oxidant and in

situ delivery system to the contaminants of concern (COCs) and the site conditions is the key to successful implementation and achieving performance goals.

Oxidation using liquid hydrogen peroxide (H_2O_2) in the presence of native or supplemental ferrous iron (Fe^{+2}) produces Fenton's Reagent which yields free hydroxyl radicals (OH). These strong, nonspecific oxidants can rapidly degrade a variety of organic compounds. Fenton's Reagent oxidation is most effective under very acidic pH (e.g., pH 2 to 4) and becomes ineffective under moderate to strongly alkaline conditions. The reactions are extremely rapid and follow second order kinetics.

Ozone gas can oxidize contaminants directly or through the formation of hydroxyl radicals. Like peroxide, ozone reactions are most effective in systems with acidic pH. Due to ozone's high reactivity and instability, O_3 is usually produced onsite, and requires closely spaced delivery points (e.g., air sparging wells). In situ decomposition of the ozone can lead to beneficial oxygenation and bio stimulation.

The following factors may limit the applicability and effectiveness of chemical oxidation include:

- Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation.
- Some COCs are resistant to oxidation.
- There is a potential for process induced detrimental effects. Further research and development is ongoing to advance the science and engineering of in situ chemical oxidation and to increase its overall cost effectiveness.

E1.2.4 Reactive Barrier Wall

Construction of a permeable reactive barrier (PRB) involves the subsurface emplacement of reactive materials through which a dissolved contaminant plume enters on one side of the PRB and treated water exits the other side. This in situ method for remediating dissolved phase contaminants in groundwater combines a passive chemical or biological treatment zone with subsurface fluid flow management.

PRBs can be installed as permanent or semi permanent units. The most commonly used PRB configuration is that of a continuous trench in which the treatment material is backfilled. The trench is perpendicular to and intersects the groundwater plume.

Alternately low permeability walls can be used to direct a groundwater plume toward a permeable treatment zone.

E1.2.5 Pump and Treat

As its name implies a pump and treat remedial involves the pumping of contaminated of ground water pumping include removal of dissolved contaminants from the subsurface, and containment and treatment the water. The treated groundwater is then either re introduced into the aquifer or disposed off site.

The criteria for well design, pumping system, and treatment are dependent on the physical site characteristics and contaminant type. While treatment options may include a train of processes such as gravity segregation, air strippers, and activated carbon filters designed to remove specific contaminants.

The first step in determining whether ground water pumping is an appropriate remedial technology is to conduct a site characterization investigation. Site characteristics, such as hydraulic conductivity, will determine the range of remedial options possible. Chemical properties of the site and plume need to be determined to characterize transport of the contaminant and evaluate the feasibility of ground water pumping. To determine if ground water pumping is appropriate for a site, one needs to know the history of the contamination event, the properties of the subsurface, and the biological and chemical contaminant characteristics. Identifying the chemical and physical site characteristics, locating the ground water contaminant plume in three dimensions, and determining aquifer and soil properties are necessary in designing an effective ground water pumping strategy.

The following factors may limit the applicability and effectiveness of ground water pump and treat options as a remedial option:

- The time frame required to achieve the remediation goal;
- The pumping system fail to contain the contaminant plume as predicted;
- Residual saturation of the contaminant in the soil pores cannot be removed by ground water pumping.
- A pump and treat option is not suitable for contaminants with:
  - high residual saturation;
  - high sorption capabilities; and
  - homogeneous aquifers with hydraulic conductivity less than 10^{-5} cm/sec.
- Potential high operating costs;
- Biofouling of the extraction wells and associated treatment stream may severely affect system performance;
- Subsurface heterogeneities, may severely affect system performance;
- Potential toxic effects of residual surfactants in the subsurface;
- Drawdown pumping generally produces large volumes of water requiring storage and or treatment

E1.2.6 Excavation

Excavation and disposal of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off site receptors. Excavation can also be used to remove primary sources of any groundwater contamination (such as buried tanks or drums and waste disposal areas) and remove the secondary sources of impact (contaminated fill, residual soils and impacted bedrock and bedrock fractures such as joints and bedding planes).

Table E 12 2 Remediation Technology Matrix

Technology	Matrix	Asbestos		Heavy metals		TPH		VOC		Landfill Gas		Long Term Monitoring		EMP		Individual Scores	Overall Ranking	Preferred Option
Bioventing	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
	Ground gas	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Yes	1	Possible	2	13		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14	40	No
Enhanced	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
Bioremediation	Ground Gas	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Yes	1	Yes	1	12	39	No
Capping and	Soil	Yes	3	Yes	3	Yes	3	Yes	3	Yes	3	Yes	1	No	3	19		Possible
Containment	Ground Gas	Yes	3	Yes	3	No	1	No	1	Yes	3	Yes	1	No	3	15		Possible
	Groundwater	N/A	0	No	1	No	1	No	1	No	1	Yes	1	No	3	8	42	Possible
Chemical	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
Oxidation	Ground Gas	N/A	0	Yes	3	Yes	3	Yes	3	Yes	3	Possible	2	Yes	1	15		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Yes	1	Yes	1	12	40	No
Excavation	Soil	Yes	3	Yes	3	Yes	3	Yes	3	Yes	3	N/A	0	No	3	18		Yes
Reuse & Disposal	Ground Gas	Yes	3	Yes	3	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	19		Yes
	Groundwater	N/A	0	Possible	2	Possible	2	Possible	2	Possible	2	Possible	2	Possible	2	12	49	Yes
Land Farming	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
	Ground Gas	N/A	0	No	1	Possible	2	Possible	2	Possible	2	N/A	0	Possible	2	9		No
	Groundwater	N/A	0	No	1	No	1	No	1	No	1	N/A	0	No	3	7	29	No
Air Sparging	Soil	N/A	0	No	1	Yes	3	Yes	3	Yes	3	N/A	0	No	3	13		No
	Ground Gas	N/A	0	No	1	No	1	No	1	Yes	3	Possible	2	Possible	2	10		No
	Groundwater	N/A	0	No	1	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14	37	No

Technology	Matrix	Asbestos		Heavy metals		TPH		VOC		Landfill Gas		Long Term Monitoring		EMP		Individual Scores	Overall Ranking	Preferred Option
Reactive Barrier	Soil	N/A	0	N/A	0	Yes	3	Yes	3	Yes	3	No	3	No	3	15		No
Wall	Ground Gas	N/A	0	N/A	0	No	1	No	1	No	1	Yes	1	Yes	1	5		No
	Groundwater	N/A	0	Yes	3	Yes	3	Yes	3	Yes	3	Possible	2	Possible	2	14	34	No
Pump and Treat	Soil	N/A	0	No	1	No	1	No	1	No	1	N/A	0	No	3	5		No
	Ground Gas	N/A	0	Possible	2	Yes	3	Yes	3	Yes	3	Yes	1	Possible	2	14		No
	Groundwater	N/A	0	Yes	3	Yes	3	Yes	3	Yes	3	Yes	1	Possible	2	15	34	No

Note: For scoring and ranking guidelines see **Section E1.3** below.

E1.3 Remediation Options and Ranking

The various remediation option were reviewed in a technology matrix (**Table E 1**) to assess whether their suitability against the various subsurface materials at the site and the primary objectives of the remediation works program. The ranking of the remedial options identifies the following options to remediate the Narellan site including:

- Groundwater recovery and treatment
- Soil excavation with segregation for on site reuse and off site disposal

The ranking of the remediation options is based on:

- The suitability of the method for each of the materials or chemicals of concern with the following scoring applied – Not applicable = 0, Not suitable = 1, Possible = 2, Suitable (Yes) = 3.
- The options also consider the need for longer term monitoring and/or the requirements that an EMP is prepared to cover residual contamination; these aspects are ranked as N/A = 0, requires EMP/monitoring (Yes) = 1, possibly requires EMP/monitoring = 2, does not require an EMP/monitoring = 3.

The scores are added to give the individual score for each of the soil, groundwater and soil/ground gas media and these individual scores are added to give the overall rating or ranking of the remediation option. The preferred option is arbitrarily selected as above 40 points option is suitable below or equal to 40 option is not suitable.

The preferred remedial option(s) is discussed further in **Section 5.3**.