Live Services – this includes the aboveground concrete trench that runs parallel to the western boundary and the underground services that continue from the concrete trench and run through the Western Lot area. Other services are the sewer line that runs along the western boundary (refer to **Section 7.3**) and the Sydney Water Mains line that transects the southern portion of the Site. The mains are located in an underground tunnel over 20 metres below the ground surface and therefore may not need to be considered for the remediation work.

Site Boundary – the extent to which excavations can abut the site boundary will be governed by the vertical extent of contamination requiring excavation. The stability of the ground and above ground structures must be considered when excavating close to the western site boundary and northern boundary (refer to excavation depths presented on **Figure 4**). Appropriate batters should be formed to minimise instability in these areas, or ground stability works should be completed, including piling or shoring. Note that rail tracks are present to the south (Illawarra rail line) and to the north (stabling yard) of the gasworks site. These structures pose significant constraints on excavation works. Any movement of the tracks poses a serious derailment risk. As such, a geotechnical assessment must be performed, and methods for stabilising excavations must be approved by RailCorp prior to commencement of excavation works. In addition, continuous monitors will need to be installed on the tracks, and an emergency response plan must be developed and implemented if any track movement is identified.

Trees – There are a number of well established and mature trees present on the Site, including a stand that was positioned to provide screening coverage along the western and northern site boundary. Where trees may be retained to continue and even improve the visual impact to adjoining land users, excavation of localised soils should be minimised to maintain the root system. An evaluation should be made that considers the benefits of retaining particular tress against the degree of contamination in localised areas.

Lithology – The Site lithology consists of stiff and highly plastic red/grey podzolic soil underlain by Ashfield Shales. Previous investigations indicate that tar material has migrated deep into these materials up to depths of at least 8m below the ground surface. The vertical extent of excavation may be limited by the capability of the excavation machinery, where removing stiff clay and hard shales may become problematic and specialised equipment may be necessary. The source control approach outlined in **Section 5.6** should provide guidance to the limitation of removing tar impacted materials at depth.

8.6.3 Remediation Equipment and Machinery

The machinery required to undertake the preferred remediation approach is likely to include:

- Piling and/or shoring machinery to stabilise excavated areas particularly in areas of deep excavations around the Southern Gasholder, the Western site boundary and the northern site boundary.
- Excavators with the capacity to excavate potentially hard/stiff ground at depth, and possibly requiring a long arm reach.

- Machinery to manage excavated material and facilitate stockpiling, including bulldozers, front-end loaders, excavators, bobcats, etc.
- Haulage trucks to transport excavated material from the Site, likely to be B-Double trucks for easier manoeuvring in limited spaces.

8.6.4 Remediation Staging and Works Program

Staging of the remedial works should consider the limited space onsite and protection of the Southern Gasholder structure. A likely staging format would include the following:

- Obtainment of relevant licenses and approvals for the remediation works, including any related to the use of an alternate soil treatment site;
- Site establishment and preparation of remediation site – including security, access, site sheds, decontamination, services, setting up environmental safeguards, decommissioning existing groundwater wells, groundwater sampling of retained wells (refer to **Section 10.3.3**), stripping/shredding site vegetation, erecting odour tent and protecting live services;
- Establishment of alternative treatment site – considering all requirements as above;
- Geotechnical investigation;
- Underpinning/piling works at remediation site;
- Removal of contaminated material including (refer to **Figure 4**):
    1. Remove contents in Tar Wells;
    2. Remove contents in Nth Gasholder;
    3. Excavate surface ash/coke fill (pink & orange areas only, as shown on **Figure 4**) with consideration to archaeological monitoring, oversize materials and pipework;
    4. Excavate tar source area around Nth Gasholder and Tar Wells (pink area) to benching level (i.e. 3-4m) with consideration to archaeological monitoring, oversize materials, pipework and dewatering;
    5. Begin benching excavation at 3-4m depth within tar impacted soils (orange area) with considerations to archaeological monitoring, oversize materials, pipework and dewatering;
    6. Complete excavations indicated above in stage 4 to nominated depth (i.e. at least 8m). Validate & backfill completed excavations;
    7. Continue benching excavations indicated above in stage 5;
    8. Excavate deep tar impacts at BHE/BHF (pink area) with consideration to archaeological monitoring, oversize materials, pipework and dewatering. Validate & backfill completed excavations;
    9. Complete excavations indicated in stage 5 to limits of orange area.Validate & backfill completed excavations indicated above in stage 11;

10. Excavate contamination hotspots (MW13s, MW04s & BH14, shown as green areas) with consideration to archaeological monitoring, oversize materials, pipework and clean overburden. Validate & backfill completed excavations;
11. Excavate contamination hotspot (TP16, shown in green area) with consideration to archaeological monitoring, oversize materials, pipework and clean overburden. Validate & backfill completed excavations;
12. Remove impacted material (to the practicable extent) from the Retaining Wall;
13. Validate and backfill all existing surfaces to site level;

- Continual water treatment, stockpiling, loading and haulage of material off site.

8.6.5 Disused Former Gasworks Services

Previous investigations have shown that former gasworks services include tar pipes and cast iron pipes. The tar pipes are potentially laden with residual tar, which should be removed from the pipes to separate these wastes from metal pipe wastes. Options for this process would be ancillary to the primary remediation works. However, consideration should be given to chemical extraction or high pressure washing to separate these materials.

It is unknown if existing cast iron pipes contain tar or other residual contaminants. Regardless, cast iron pipes free of tar (or other materials) should be considered for recycling.

8.6.6 Stabilising Open Excavations

A non-percussive piling technique should be applied where piling is required to stabilise and protect the Southern Gasholder structure and around areas requiring deep excavations. A geotechnical investigation should be undertaken prior to any remedial work to determine the requirements in this regard.

The requirements for protecting any live services should consider the information provided in **Section 7.3**. The requirement for protecting structures adjoining the Site, including live rail lines, are provided in **Section 7.3.3.**

8.6.7 In-ground Concrete Structures

A previous archaeological assessment (Heritage Concepts, November 2006) indicated that the concrete slabs existing on the northern site boundary (embankment) do not have historical significance.

It may be beneficial to retain these structures in place, considering the stability of the northern boundary embankment. Any associated contamination impacts in the localised areas would have to be evaluated during the remediation work to re-assess the benefits of retaining these structures.

There will be a requirement to validate any fill material left insitu if these structures are to remain.

8.6.8 Marker Layers

Marker layers should be used to define areas that contain residual contamination that may be exposed during future construction/maintenance on the Site. The marker layer provides a warning mechanism if contamination is to be exposed. These areas should be documented in the EMP.

The use of marker layers can be applied to lateral faces of excavations. However, they should only be applied at depths that may be exposed in the future, which may be limited to 1.5m depth. In that regard, it is expected that markers layers may not be installed in the primary source zones other than around the Southern Gasholder.

Marker layer material should be resistant to volatile organics chemicals. In this regard, marker layer material made from High Density Polyethylene (HDPE) should be used given it is an inert polymer highly resistant to chemical degradation. This material would be suitable to withstand exposure to BTEX chemicals.

8.6.9 Survey Requirements

Formed excavation will require surveying to determine quantities of material removed and inturn backfill requirements. A survey of all retained structures, site features of importance and finished levels should be undertake once all excavation/backfill works have been completed.

Survey diagrams will also facilitate engineering/design drawings for future site layout and infrastructure.

Newly installed wells will also require surveying to facilitate the MNA approach detailed in **Section 10.3.3.**

8.7 Site Reinstatement

The material used for backfilling will need to meet the criteria outlined in **Section 9.3.** This may also extend to the beneficial re-use of some onsite materials, as outlined in **Section 9.4.**

The requirements for backfilling and compaction must follow all appropriate Australian Standard and Construction Codes of Practice. In particular, the RailCorp Infrastructure Engineering Standards – Geotechnical Guides, that includes:

- TMC 411 – Earthworks Manual, September 2006;
- SPC 411 – Specification Earthwork Materials, October 2006; and
- ESC 410 - Earthworks and Formation, September 2006.

These standards are provided in **Appendix E**.

At the time of preparing this RAP, a landscape design was being prepared by others for the Site. The details of this plan should be considered during the remedial works, particularly in regard to vegetation, fencing and drainage/stormwater.

8.8 Environmental Management

An Environmental Management Plan (EMP) for the proposed remediation works should be prepared that identifies environmental hazards and risks involved with the remediation and the control measures required to mitigate the risks. The EMP should

be prepared in accordance with NSW EPA Model EMP: *Environmental Management Plan for Landscaping Works* (2002), which can be applied to remediation sites.

The environmental risks that require management include:

- Soil and water;
- Air (dust, odour, vapours);
- Noise and vibration; and
- Visual Aspect.

The EMP should include the following information and control plans:

- Soil and Water Management Plan – This plan should include erosion and sediment controls, stockpiling and contamination controls.
- Air Quality Management Plan – This plan should include dust, odour and vapour controls.
- Noise and Vibration Management Plan – This should include details of noise and vibration standards to be met, noise and vibration monitoring requirements and noise and vibration control measures to be implemented.
- Traffic Management Plan – This should include details on site access/exit, preferred transport routes, special conditions to site entry/exit, transport materials and community impacts.
- Waste Management Plan - This plan will outline waste management procedures, including waste recycling and reuse measures and waste storage and disposal measures. The waste management plan will be developed to minimise the generation of waste and maximise reuse, recovery and recycling of waste products.
- Monitoring and Auditing – The monitoring methods, locations, frequency, criteria, reporting and responsibilities will be detailed in this section of the EMP.

8.8.1 Management of Soil and Water

The soil and water management plan should be based on the NSW EPA (1997) guidelines "Managing Urban Stormwater: Treatment Techniques" and the NSW Department of Housing (1998) guidelines "Managing Urban Stormwater Soils and Construction". The aims of the soil and water management plan will be to minimise the potential for erosion, minimise the risk of contamination from construction equipment and to avoid contamination migrating from the Site.

The soil and water management plan should address the following issues:

- erosion and sediment control measures;
- contamination control measures (e.g. measures to manage existing contamination and potential for remediation machinery spillages, etc);
- the methods for handling and storage of impacted soil or water to minimise potential exposure to the materials or migration offsite;
- monitoring requirements (testing procedures, frequency of sampling, etc);

- specific methods of on-site reuse and disposal of soil and wastewater generated during construction;
- reference to the Occupational Health and Safety Plan for procedures to minimise the risk of exposure of construction employees to potential contaminants;
- diversion of clean stormwater runoff around construction sites and areas (where possible);
- use of crushed rock or similar material on construction site and parking; and
- bunding of temporary fuel and chemical storage areas in accordance with DEC requirements.

Erosion and Sedimentation Control

The general measures for management of erosion and sedimentation are as follows:

- Sediment and erosion control measures will be installed prior to any remedial activities and will be maintained in an effective condition until earthworks have been completed and the Site has been remediated. The soil and water management plan will identify the areas nominated for erosion and sediment control, work sites, general access and parking requirements;
- The area of soil exposure will be minimised as much as possible at any time. Land disturbance will occur for the shortest possible time. Access to the site will be controlled, and vehicles and machinery will be kept to well-defined areas within the Site. Soil disturbance will be undertaken in stages and areas to minimise impacts and to have more manageable catchments;
- Run-off generated outside specific remedial sites will be diverted around these locations;
- Water runoff generated within the site will be directed to the excavation areas. This water will be pumped out with collected groundwater for treatment as outlined in **Section 8.3.3**;
- Straw bales or other silt barriers will extend a sufficient distance to prevent water escaping around the side of the trap and will be of double thickness in areas likely to receive a higher runoff;
- Truck tyres and equipment tyres will be inspected and cleaned. **Section 8.3.3** provides further detail to the decontamination required;
- Disturbed areas will have a barrier system installed and other excavated areas backfilled as soon as possible. Proposed landscaping will be undertaken as soon as practicable after the main remedial works have been completed; and
- A monitoring program will be implemented to ensure that the soil and water management plan is successful. This may be in the form of a site audit checklist. The monitoring program will assist in the early identification of potential problems in the areas affected by the remedial procedures.

Stockpile Control

Impacted material will be stockpiled in a designated area prior to loading and transporting off site. Any materials that are not impacted and require temporary

storage will be stockpiled separately from stockpiles of impacted materials. It may be necessary to cover these stockpiles (i.e. HDPE sheeting) in some circumstances to control dust and odours. The size of stockpiles should be minimised as much as practicable prior to transporting off site (or other fate). Straw bales or silt fences will be erected around soil stockpiles, and diversion drains will be constructed if necessary, to prevent the migration of soil particles.

8.8.2 Management of Air Quality

The NSW DEC currently adopts the air quality goals set out in the Action for Air Report (1998) and Action for Air Report Update (2002) which form the NSW Government's 25-year Air Quality Management Plan. This plan was devised in conjunction with the National Environment Protection Council's (NEPC) National Environmental Protection Measure (NEPM) for air quality, the Ambient Air Quality Measures (1998) and Variations (2003). The DEC standards generally adopt those set out by the NEPC in the Ambient Air Quality Measures (NEPC, 1998) report.

Construction activities typically generate air emissions as a result of vehicles travelling along unsealed roads, the stockpiling of large amounts of materials, and exposure of soils. In addition, the combustion of fuels to power construction machinery also produces air emissions.

Odour and Vapour Control

Odour management is a key concern for the EMP objectives, especially given the proximity of some remediation activities in highly impacted areas to the adjacent Burren Street residences. Some of the contaminated material exposed during excavation work is expected to generate strong odours and potential vapour hazards, based on the elevated concentrations of BTEX compounds and naphthalene, particularly in the vicinity of source tar materials. The use of a specialised odour tent should be used as a primary control method to manage these emissions. The specific features of the odour tent are that it should:

- be large enough to accommodate the required excavation machinery;
- be large enough to accommodate stockpiled material;
- cover the footprint of work zones or the entire tar impacted area (see orange and pink shaded zones on **Figure 4**);
- comprise a fan-forced vapour treatment system installed in accordance with current standards.

Material being transported from the Site is also expected to generate significant odour and vapour hazards. Specialised haulage trucks may be required to transport this material. The special features of the trucks may include a trailer section that can minimise vapour emission during transport.

In addition, the following actions should also be undertaken:

- odour monitoring will be performed along the site boundaries, particularly the western boundary adjacent to the residential properties.
- weekly and random site surveillance inspections are to be undertaken by specific personnel that visit the site for this purpose alone. The inspections

should include observations of nuisance level odours, and recorded in an on-site activities log to trace conditions at the Site;

- plastic sheeting (VLDPE or PVC) should be used to cover excavated surfaces that may be exposed for long periods;
- appropriate odour suppressants (e.g. Anotec or AirRepair) should be sprayed over the offending soils; and
- a phone number will be made available for local residents to contact the on-site superintendent to advise if dust and/or odour nuisance occurs (refer to **Section 8.2**).

Dust Control

The remedial actions shall be performed in such a way as to minimise the production of fugitive emissions emanating from the site. The following dust and fugitive emission control procedures will be strictly adhered to:

- water sprays will be used across the Site to suppress dust. Water spray equipment will be available on-site for use from the first mobilisation to the Site until the remedial works have reached practical completion;
- all loads transported from the Site will be securely covered with a tarpaulin;
- speed limits will be imposed for vehicles on-site, including the access road from Erskineville Road;
- green mesh will be installed on the site boundary fencing to lower wind velocity entering the Site, therefore reducing dust generation;
- monitoring of dust emissions during excavations will be undertaken to check for the presence of potential airborne contaminants from the waste material, particularly during remediation of materials containing asbestos (refer to **Section 7.2**);
- response monitoring of reported incidences relating to nuisance dust emissions from the Site;
- all materials processing equipment will have dust attenuation measures that make the equipment suitable for use in industrial/commercial areas and which comply with regulatory requirements; and
- there will be no burning of any material on-site.

8.8.3 Management of Noise and Vibration

The DEC's Environmental Noise Control Manual (ENCM) provides guidelines for assessing the noise impact from construction sites. The most appropriate criteria to be applied to noise from construction vehicles are found in the DEC's Environmental Criteria for Road Traffic Noise.

Construction activities with the potential to cause vibration can be assessed with respect to the following criteria:

- Damage Criteria - German Standard DIN 4150 Part 3 1999 and British Standard BS 7385 Part 2 1993; and

- Human Comfort Criteria – Australian Standard 2670 Part 2 1990 and British Standard BS 6472 1992.

Property condition surveys should be undertaken for those properties where there may be a risk of cosmetic damage as a result of construction works. Property condition surveys should be undertaken on buildings/structures/roads within 50m radius from the edge of the "designated works' and any heritage listed buildings and other sensitive structures within 150m of the edge of the "designated works'. This should also include an assessment of the adjacent rail tracks.

The remedial action will be performed in such a way as to minimise unnecessary noise and vibration. Regulatory limits for noise and vibration will be strictly adhered by applying the following controls:

- Construction Hours - works should be mainly carried out within standard construction hours of 7am until 6pm Monday to Friday and 8am until 1pm on Saturday. It is possible that working hours may change depending on the outcome of community liaison and/or development approval conditions.
- Deliveries - will be carried out generally within standard construction hours (delivery of oversized loads may be required to occur outside of standard working hours). Loading and unloading will be carried out at the greatest possible distance to sensitive receivers.
- Quietest Suitable Equipment - Plant and equipment will be selected to minimise noise emission, whilst maintaining efficiency of function. Mufflers and all noise control equipment will be maintained in good order. Trucks will not use exhaust brakes on site wherever possible.
- Truck Noise (off site) - Trucks will not queue up outside residential areas prior to the 7am start time. All regular trucks are to have mufflers and other noise control equipment in good working order. Trucking routes will use main roads where feasible.
- Site Layout and Site Access - Where possible, plant will be orientated to direct noise away from sensitive receivers. Site sheds, materials and stockpiles will be used to increase acoustic shielding where feasible. Site access roads will be located as far as possible from noise sensitive areas.
- Noise Monitoring - During construction, noise monitoring at nearest affected residences will be carried out at least on a weekly basis.
- Temporary Hoarding – A contingency measure to control excessive noise should consider the installation of temporary hoarding (refer to Table 8.1).
- Vibration Monitoring and Management - Vibration monitoring will be carried out where vibration intensive activities (e.g. vibratory compaction, piling works and excavation) are required to be carried out within the established buffer zones, or where there is considered to be a risk that levels may exceed the relevant structural damage criteria. This will include carrying out vibration measurements at the commencement of these specific work tasks, limiting the duration of the vibration works and scheduling times of the work to minimise disruption to receivers.

- Community Liaison - A program of community liaison and complaint response will be implemented. Site induction training will include a noise awareness component.

8.8.4 Management of Visual Aspect

The receptors to visual aspects include the residents of the Burren Street properties along the western boundary and the rail passengers travelling through the adjoining rail corridor on the southeast boundary.

The visual impact is based on the expected size of the excavation required to remove the contaminated soils and the increase in construction activity.

Construction of an odour tent to control odour emissions should also be utilized to manage the visual impact that the excavation presents to the local residents or train passengers.

Maximum retention of vegetation along site boundaries should be considered to provide screening of the remediation site.

8.9 General Contingency Plan

The conditions encountered during remedial works can be uncertain. A set of typical issues and proposed corrective actions associated with a remediation program is provided in Table 8-1.

Table 8-1 Remedial Works Contingency Planning

Potential Issue	Proposed Corrective Action
Identification of a suitable treatment site	Reassess preferred remedial option (or combination of options) for onsite treatment. Those requirements provided in Section 8.3.7 should be used as a guide to accommodate onsite treatment or identify alternate treatment sites.
Under estimation of material volumes	Assess the need to identify a larger alternate treatment site or a secondary site (i.e. two off site treatment areas). Assess the need to undertake supplementary sampling or discriminatory classification sampling to lower uncertainty of volume estimates. Discuss and explore additional funding mechanism if required.
Unexpected finding of free tar impacts in the vicinity of the Southern Gasholder	Explore the opportunity to dismantle the Southern Gasholder structure and remediate impacts below the ground surface, then reassemble the structure on the Site post-remediation. Assess the need to review groundwater remediation strategies and additional strategies for soils (i.e. insitu techniques) considering heritage status of the gasholder.
Soil treatment option is ineffective.	Consider and assess, from trials, the additional treatment and funding required. Consider disposal of treated material with higher contamination content (i.e. as Industrial or Hazardous wastes).
Unmanageable mud in excavation zone	Improve drainage collection system; add geotextile/gravel in problem areas; strip off mud/slurry materials.
Excessive stormwater	Minimise active contaminated work area; improve stormwater diversion.
Excessive dust	Use water sprays; stop dust-generating activity until better dust control can be achieved or apply interim capping systems.
Excessively wet materials	Stockpile and dewater on site or add absorbents.
Excessive noise	Noise barrier (hoarding) installation. Augment muffler systems on excavation machinery or haulage trucks.
Excessive vibration	Reassess vehicle movement routes and speeds. Static roll backfilled areas requiring compaction.
Ineffective odour controls	Alternative control method will be assessed and applied. Controls should include masking agents (Anotec, AirRepair), chemical additives (Biosolve) or containment materials (foam, HDPE covers).
Equipment failures	Maintain spare equipment or parts; keep rental options available or shut down affected operations until repairs are made.

9 Site Validation

This section presents the procedures and protocol to validate the site remediation. Prior to any site validation work being conducted at the remediation site, a Sampling Plan should be developed to document the data quality objectives (DQOs), sampling program, sampling methods, analytical suites and other field procedures.

9.1 Excavated Areas

9.1.1 Sampling Pattern for Excavation Surfaces

A systematic sampling pattern should be employed to validate any exposed surface after excavation. Samples will be collected based on:

- an evenly spaced grid of 8.5m.

This sampling pattern provides a sample density that is based on the 95% probability of detecting a circular contamination hotspot of 10m in diameter. This approach will be followed for all excavation floor areas.

Wall surfaces of an excavation will be sampled every 10 lineal metres and at vertical depths corresponding to the depth based criteria outlined in **Section 4**. Sampling of wall surfaces will be collected between each of the following depth intervals:

- 0.0m to 1.5m;
- 1.5m to 2.5m;
- 2.5m to 4.0m;
- 4.0m to 8.0m; and
- Every 2.0m below 8.0m depth.

Consideration should be given to material types to ensure that samples representative of each fill/soil type are collected during validation.

9.2 Waste Classification

9.2.1 Untreated Material

Untreated material will be stockpiled according to the material type and sampled for waste classification for off site disposal. Stockpiled untreated material will be sampled at the following frequency:

- one (1) sample every 100m^3 or part there of for each material type.

9.2.2 Treated Material

Treated material will be stockpiled according to the material type and sampled for waste classification for off site disposal. Stockpiled treated material will be sampled at the following frequency:

- 1 per 25m^3 for batches less than 1,000m^3 (up to 40 primary samples); and
- 1 per 50 m^3 for batches over 1,000 m^3 (at least 20 samples).

9.2.3 Liquid Wastes

Liquid wastes should be sampled to obtain representative concentrations of chemicals in the waste and subsequently given a waste classification prior to removal from the Site.

9.3 Imported Material

All material imported to the Site should be Virgin Natural Excavated Material (VENM). The determination of VENM follows the definition provided in NSW EPA, 1999, which defines a VENM material that is:

- excavated from areas that are not contaminated, as a result of industrial, commercial, mining or agricultural activities, with manufactured chemicals and that does not contain sulphidic ores or soils;
- supplied from a known and trusted VENM source, such as a quarry; and
- not mixed with, or comprises, anthropogenic components, e.g. concrete timber, building rubble, hazardous building materials.

Samples will be collected from imported materials at the following sampling frequency to verify the VENM status:

- 1 (one) sample every 100m^3 for imported volumes up to 1,000m^3, with a minimum number of 5 (five) samples collected per source site; and
- 1 (one) sample every 250m^3 for imported volumes greater than to 1,000m^3, with a minimum number of 5 (five) samples collected per source site.

9.3.1 Backfilling

The backfilling of formed excavation will be conducted in a manner that follows the procedures outlined in **Section 8.7**. Validation of backfilling procedures will be achieved by ensuring that the requirements of those procedures are fully satisfied. This includes documentation that certifies:

- Australian Standards methods were followed (were required);
- Appropriate materials were used for backfilling;
- Compaction standards were achieved (i.e. density tests indicate that required densities were achieved); and
- Appropriate gradients were achieved.

9.4 Beneficial Re-Use of Excavated Material

Material that is excavated and transported off the Site (i.e. for treatment) should not be imported back onto the Site, given the implications of importing potential waste materials.

Material that is suitable for beneficial re-use will need to satisfy the following criteria:

- must originate and remain on the Site;
- does not show visual impacts of tar;

- neutral leach (SPLP) analysis data meets the adopted criteria in Table 9.1, to indicate potential concentrations at the site boundary for contaminants of concern in groundwater;
- meets either the generic or risk-based criteria for soils defined in Table 4.1 at those specified depths; and
- meets the geotechnical requirements for compaction.

The neutral leach (SPLP) data is required to meet the criteria in the following table. The majority of criteria are taken from ANZECC 2000, with the exception of those referenced in the table. Each criterion has been corrected to reflect the contaminant concentration at the site boundary based on a Dilution Attenuation Factor (DAF) of 20.

Table 9.1 – Neutral Leach Criteria for Beneficial Re-Use (all values in µg/L)

Analyte	Criterion Value
As (total)	480[1]
Cd	4
Cr (VI)	20
Cu	28
Hg (inorganic)	1.2
Ni	220
Pb	68
Zn	160
Benzene	19,000
Toluene	6,000 (ANZECC 1992)
Ethylbenzene	2,800 (ANZECC 1992)
o-xylene	7,000
p-xylene	4,000
Benzo(a)pyrene	1 (Dutch 2000)
Naphthalene	320
TPH (C_{10}-C_{36})	12,000 (Dutch 2000)
Phenol	6,400
Cyanide (total or free)	140

Table Notes:
(1) – ANZECC 2000 criterion for As (III) used.

For future use of the Site for rail-related activities, the physical properties of materials being considered for beneficial re-use must meet the geotechnical requirements specific for rail land, as outlined in **Section 8.7**.

An assessment of beneficial re-use must also consider aesthetic impacts of the material. For a commercial/industrial land use setting this only extends to malodorous materials as outlined in **Section 4.6**.

Materials being assessed for beneficial re-use will be stockpiled according to their visual appearance and sampled at the following frequency:

- one (1) sample every 25m^3 or part there of for each different material type.

9.5 Analysis of Validation Data

The methodology used for comparison of soil data to criteria is based on the methods referred to in the NSW EPA *Sampling Design Guidelines* (1995) and NEPC (1999) NEPM, which are:

- comparison of the 95% upper confidence limit of the arithmetic mean concentration (95% UCL values) of each contaminant to the nominated site criterion;
- No individual sample result should have a concentration that exceeds 250% of the criterion;
- A normal distribution will only be used if the coefficient of variance is not greater than 1.2; and
- The standard deviation of a sample population should not exceed 50% of the nominated criteria.

Statistical analysis must only be performed on similar materials of same the lithology.

9.6 Quality Assurance and Quality Control Program

9.6.1 Field Data Samples

Field data quality samples should be collected as part of the QA/QC program. Field data quality samples that should be collected include:

- Field Duplicates/Intra-Laboratory Duplicates at a frequency of 1/20 primary samples;
- Split Duplicates/Inter-Laboratory Duplicates at a frequency of 1/20 primary samples;
- Equipment Rinsate Blanks (not for disposable items) at a frequency of 1/piece of equipment/sampling day;
- Trip Blanks at a frequency of 1/sample batch; and
- Spiked Trip Blanks at a frequency of 1/sample batch (were volatile analysis is requested only).

The combination of Field duplicates and Split duplicates corresponds to a field QA/QC program that consist 10% of primary samples.

9.6.2 Laboratory Data Samples

The analytical laboratories undertaking the chemical analysis of samples must be accredited by the National Association of Testing Authorities (NATA) for each analytical method.

The following is a summary of the laboratory quality control samples that will be analysed by the selected laboratory and reported with the chemical analysis results:

- Method Blanks;

- Laboratory Duplicates;
- Laboratory Control Samples;
- Matrix Spikes; and
- Surrogate Spikes.

9.6.3 Data Quality Assessment

An assessment of data quality and the validity of the QA/QC program should be undertaken based on an evaluation of the Data Quality Indicators (DQIs). This assessment should be based on a nominated set of PARCC parameters (i.e. precision, accuracy, representativeness, completeness and comparability).

The DQI parameters will be required to be defined within a Sampling Plan to be developed for the remediation and validation works. Achievement of the project DQOs will be required to be assessed against the DQIs for both field and laboratory procedures.

9.7 Waste Tracking

A materials tracking system should be implemented to control and track the movement of materials on and off the Site. This system should control each of the different material handling phases that occur during the project including excavation, stockpiling, processing (screening and crushing), re-use, off site treatment and off-site disposal.

The system will track all site materials from "cradle-to-grave" and will provide detailed and accurate information about the location and quantity of all materials both on and off-site.

Waste tracking data shall be reconciled with documentation provided by waste transporters and waste receivers.

9.8 Validation Report

The validation report will be prepared in accordance with NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*, and to meet requirements of the NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme*. The validation report will include the following:

- Details on the implementation of the RAP;
- Verification of regulatory compliance;
- A clear statement on whether the Site is considered suitable for its intended land use and whether it is considered to present an unacceptable risk to human health and the environment;
- Details of the long term EMP; and
- Any limitations, assumptions and uncertainties relevant to the conclusions of the report.

10 Long-Term Management

The preferred remedial strategy will involve an ongoing monitoring and management commitment for the Site. An EMP should be developed after the completion of the remediation to account for potential ongoing risks to future Site users from residual contamination, management of the Southern Gasholder heritage structure and management of groundwater contamination.

10.1 Site Users

The EMP will document the potential exposure risks posed by post-remediation residual contamination, and provide detailed procedures for undertaking works where risks may be encountered (i.e. an exposure pathway is completed). An example is providing specific procedures for undertaking subsurface excavations. A permit and sign off protocol will enable those responsible for implementing the EMP to ensure all requirements of the EMP have been met for particular work tasks.

The EMP will include details on the locations of contamination marker layers (if installed) and information on maintaining Site security.

The EMP should also provide information that details specific limitations and controls on-Site activities. Of particular importance is prohibiting the construction of basements on the Site, prohibiting the use of groundwater and controlling extracted groundwater (i.e. from dewatered trenches) from discharging from the Site.

10.2 Protecting Heritage Items

The EMP will provide information specific to the limitations on redevelopment potential in the vicinity of the Southern Gasholder, based on the heritage value of this structure and the requirement to protect its stability and fabric. The limitation should also extend to the western site boundary embankment, where aesthetic impacts (noise, visual) to neighbouring residents may need to be minimized.

The EMP should detail necessary requirements to maintain the Southern Gasholder and the embankment area, particularly in regard to:

- landscaping and aesthetic considerations;
- signage to notify site users of the heritage value;
- maintaining a 'buffer zone' around the structure to minimise potential damage; and
- prohibition of the use of heavy machinery and undertaking excavations in the buffer zone.

It is understood that a landscape design plan will be prepared prior to Site remediation, which should address some of the requirements above.

10.3 Groundwater Management

A groundwater management plan (GMP) will form part of the EMP to address risks from ongoing groundwater contamination. The GMP should detail the ongoing monitoring required to assess whether the Site remedial action (i.e. source removal to the extent practicable) is achieving the management goals for groundwater. Further,

the GMP is to provide an approach that enables cessation of groundwater monitoring based on evaluation of results over a certain period of time following commencement of monitoring. The following sections provide an overview of the proposed groundwater monitoring requirements.

10.3.1 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) will form part of the remedial strategy for the Site, and provides the basis for assessing the success of the Site remediation goals relating to groundwater protection by source removal. This approach will be implemented to monitor the concentration of residual compounds (primarily PAH, and BTEX) remaining in the groundwater beneath Site following remediation.

Limited data obtained by CH2M HILL (2000) indicated there was the potential for natural attenuation of hydrocarbon compounds in both the shallow groundwater and the deep shale groundwater, based on reported concentrations of natural attenuation parameters, sulfate, nitrate, dissolved oxygen, ferrous iron and methane.

A summary of previous data is presented in the following table.

Table 10.1 – Summary of Natural Attenuation Parameters Data

	Sulfate	Nitrate	Dissolved Oxygen	Ferrous Iron	Methane
Shallow Groundwater					
Mean (CH2M HILL, 2000)	151	0.476	2.03	30.8	943.3
Mean (CH2M HILL, 2001)	-	-	3.7	-	-
Mean (SKM, 2006)	-	-	7.43	-	-
Deep Shale Groundwater					
Mean (CH2M HILL, 2000)	613.3	0.012	2.8	18.7	50.67
Mean (CH2M HILL, 2001)	-	-	2.35	-	-
Mean (SKM, 2006)	-	-	8.14	-	-

All values in mg/L
(-) not tested.

The natural attenuation processes that are likely to be occurring at the former gasworks Site would include processes such as biodegradation, dispersion, sorption and volatilization. Biodegradation mechanisms may occur under both aerobic and anaerobic conditions including respiration (oxygen reduction), denitrification, iron (ferric) reduction, sulfagenesis, and methanogenisis.

Dispersion of the contaminants may be considered low given the low permeability and adsorptive affect of the clay and shale lithology. However, given the age of the Site operations (i.e. over 100 years) and the prominent fracturing of the weathered shale, dispersion has occurred from the source zones, particularly for contaminants with high to moderate solubility. This mechanism may be the result of preferential groundwater pathway flow through shale fracture. Dispersion is evident given the plume in the deep shale extends up to 125m, for light fraction hydrocarbons, and 160m, for middle to heavy fraction hydrocarbons, from the Site.