Remedial Strategy

Incoll Management Pty Ltd

On behalf of
Rail Corporation NSW

Former Macdonaldtown Gasworks
Burren St
Erskineville, NSW

July 2011
JBS 40913 – 15505 Revision 8
JBS Environmental Pty Ltd

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List of Abbreviations

A list of the common abbreviations used throughout this report is provided below.

- As Arsenic
- B(a)P Benzo (a) pyrene
- BTEX Benzene, Toluene, Ethylbenzene and Xylenes
- Cd Cadmium
- Cr Chromium
- Cu Copper
- DECCW NSW Department of Environment, Climate Change and Water
- DoP NSW Department of Planning
- DP Deposited Plan
- DQO Data Quality Objectives
- EMP Environmental Management Plan
- EPA New South Wales Environment Protection Authority
- Hg Mercury
- HIL Health Based Investigation Level
- LOR Limit of Reporting
- MAH Monocyclic Aromatic Hydrocarbon
- Ni Nickel
- NoW NSW Office of Water
- OCP Organochlorine Pesticide
- PAH Polycyclic Aromatic Hydrocarbons
- Pb Lead
- PIL Phytotoxicity Based Investigation Level
- PCB Polychlorinated Biphenyls
- PQL Practical Quantitation Limit
- QA/QC Quality Assurance/Quality Control
- RPD Relative Percentage Difference
- RWVP Remediation Validation Work Plan
- SAR Site Audit Report
- SAS Site Audit Statement
- TPH Total Petroleum Hydrocarbons (C_6-C_9 and C_{10}-C_{36})
- Zn Zinc

Executive Summary

Introduction

JBS Environmental Pty Ltd was engaged by Incoll Management Pty Ltd (Incoll) on behalf of the Rail Corporation NSW Environmental Projects Unit (RailCorp) to prepare a Remedial Strategy for the proposed remediation of the former Macdonaldtown gasworks, located at Burren Street, Erskineville, NSW. The site is identified as part Lot 50 in Deposited Plan 1001467 and occupies an approximate area of 7750 m^2.

Background

Several contamination investigations have been completed at, or near, the site which have identified soil and groundwater contamination caused by historic site activities. In August 2000 the Site was declared by the NSW Environment Protection Authority (EPA) to pose a Significant Risk of Harm (SRoH) to human health and the environment. Remediation works will be required on the site to remove and /or manage the source of contamination and to render the site suitable for ongoing industrial land use.

A Remedial Action Plan (RAP) was prepared for the site and documented in '*Remedial Action Plan, Former Macdonaldtown Gasworks, Burren Street, Erskineville*, (CH2M Hill 2007). A Site Audit Report (SAR) was subsequently prepared on the RAP by ENSR Aecom and documented in '*Site Audit Report on Remedial Action Plan, Former Macdonaldtown Gasworks Site, Burren Street, Erskineville, NSW*, (ENSR Aecom 2008) which concluded that, in the opinion of the appointed Site Auditor, ''...*the remediation approach presented in the RAP could be implemented ...in order for the site to be made suitable for the future use for rail-related activities*''.

An Environmental Assessment (EA) is being prepared for submission to gain approval for the remedial works under Part 3A (Major Infrastructure and Other Projects) of the *Environmental Planning and Assessment Act 1979*. Consideration as part of the EA process, of the full range of project impacts (*e.g.* on the heritage significant items present on site, and to residents in the surrounding area), has determined that the range of remediation technologies specified in the RAP may not be ideally suited to the project, despite being technically feasible.

Additionally, since completion of the RAP and SAR, RailCorp has advised that a section of land contained within the Chullora Railway Workshops, located on Worth Street, Chullora, NSW is available for treatment of soil excavated from the site.

Objectives

Further to the RAP prepared for the site, the objectives of this Remedial Strategy document are to:

- refine the consideration of available/suitable remediation methodologies, based on additional information obtained since the completion of the RAP and SAR;
- outline RailCorp's requirements for each identified likely applicable methodology;
- facilitate a thorough assessment of available remedial options; and
- provide additional site and contaminant data to commence detailed remediation planning.

Consideration of RAP and Additional Remedial Options

A re-assessment was undertaken of the preferred remedial methods provided in the RAP and consideration was also given to alternate remedial methods that could be applied to the site. The re-assessment was primarily based on newly available information on the likely project constraints and requirements, commissioned as part of the EA process.

As part of the assessment of possible options, *in-situ* chemical oxidation and thermal treatment, listed in the preferred remedial methods in the RAP, were determined to not be appropriate for the project. *Ex-situ* remediation of material by thermal treatment, while being technically suitable, was ultimately assessed to be cost prohibitive given the anticipated volume requiring treatment. Remediation of impacted areas by i*n-situ* chemical oxidation was originally considered given the lesser need for widescale site disturbance, but was ultimately considered to be poorly suited to the tight clay and shale subsurface present, and also poorly suited to remediation of free tar impacted source zones as identified on the site.

Based on the range and distribution of contamination present, the assessment concluded that no single remedial method provided a solution that was cost effective, timely and appropriate to the site as a whole. Rather, based on the characteristics of the material encountered, the assessment identified four methods that could be used in combination on the site. The four applicable methods comprising the remedial strategy are summarised in **Table 1** below, along with the corresponding suitable materials.

Table 1: Summary of remedial strategy and suitable materials

Remediation Method	Likely Suitable Materials
Excavation and off-site disposal of untreated material	Most cost effective on material unlikely to achieve validation criteria through treatment in a timely manner AND classed as 'Restricted Solid Waste' or lower for off-site disposal
Excavation and treatment of material for on-site reuse	Most cost effective on material likely to achieve validation criteria through treatment in a timely manner. Onsite treatment method = bioremediation
Excavation and treatment of material for off-site disposal	Most cost effective on material unlikely to achieve validation criteria through treatment in a timely manner AND classed as 'Restricted Solid Waste' or higher for off-site disposal. Material may be treated on site or off site. Onsite treatment method = bioremediation, Off-site treatment method = cement stabilisation
In-situ capping of impacted material	Only acceptable where excavations have reached their practicable extent

The two treatment methods considered most appropriate for the project are bioremediation and cement stabilisation. Based on the anticipated quantities of material and indicative program of works, the configuration of treatment works will involve bioremediation of material on the Macdonaldtown site and cement stabilisation works on the off-site treatment area.

Pre Remediation Documents and Requirements

Implementation of the remedial strategy will also require endorsement of the site specific leachability criteria documented in '*Derivation of Site Specific Leachability Criteria – Former Macdonaldtown gasworks, Burren Street, Erskineville, NSW*' JBS Environmental Pty Ltd, by the appointed Site Auditor.

Additionally, prior to the commencement of remedial works, the following documents will require completion:

- Structural Engineers assessment of retaining structures required around Southern Gasholder;
- Geotechnical specification for treated material to be reused on site;
- Dilapidation Studies on adjacent structures as required;
- A Remedial Health and Safety Management Plan (RHSMP); and
- A Remedial Works Validation Plan (RWVP).

1 Introduction

1.1 Introduction

JBS Environmental Pty Ltd (JBS) was engaged by Incoll Management Pty Ltd (Incoll) on behalf of the Rail Corporation NSW Environmental Projects Unit (RailCorp) to prepare a Remedial Strategy, as prescribed in this document, for the proposed remediation of the former Macdonaldtown Gasworks, located at Burren St, Erskineville, NSW (the site).

Several contamination investigations have been completed at or near the site, which have identified soil and groundwater contamination caused by historic site activities. In August 2000 the Site was declared by the NSW Environment Protection Authority (EPA) to pose a Significant Risk of Harm (SRoH) to human health and the environment. Remediation works will be required on the site to remove and /or manage the source of contamination and to render the site suitable for ongoing industrial land use.

A Remedial Action Plan (RAP) was prepared for the site and documented in '*Remedial Action Plan, Former Macdonaldtown Gasworks, Burren Street, Erskineville*, (CH2M Hill, 2007). A Site Audit Report (SAR) was subsequently prepared on the RAP by ENSR Aecom and documented in '*Site Audit Report on Remedial Action Plan, Former Macdonaldtown Gasworks Site, Burren Street, Erskineville, NSW*, (ENSR Aecom, 2008) which concluded that, in the opinion of the appointed Site Auditor, ''*...the remediation approach presented in the RAP could be implemented ...in order for the site to be made suitable for the future use for rail-related activities''*.

An Environmental Assessment (EA) has been prepared for the remedial works under Part 3A (Major Infrastructure and Other Projects) of the *Environmental Planning and Assessment Act 1979*. Consideration as part of the EA process of the full range of project impacts (*e.g*. on the heritage significant items present on site, and to residents in the surrounding area), has determined that the range of remediation technologies specified in the RAP may not be ideally suited to the project, despite being technically feasible.

Additionally, since completion of the RAP and SAR, RailCorp has advised that a section of land contained within the Chullora Railway Workshops, located on Worth Street, Chullora, NSW is available for treatment of soil excavated from the site.

1.2 Objectives

In light of these additional project considerations, this Remedial Strategy document has been prepared to:

- refine the consideration of available/suitable remediation methodologies, based on additional information obtained since the completion of the RAP and SAR;
- outline RailCorp's requirements for each identified likely applicable methodology;
- facilitate a thorough assessment of available remedial options; and
- provide additional site and contamination data to commence detailed remediation planning.

This Remedial Strategy document provides a brief summary of the characterisation of site contamination as presented in previous investigations completed on the site. Additionally, this document contains the results of additional field investigations conducted by JBS to facilitate planning for remediation of the site, including a water treatment trial; pump tests

on shallow wells; assessment of clay content in soils; analysis of samples for leachable concentrations of contaminants; and a cement stabilisation trial.

1.3 Structure of the Document

This document has been prepared as an addendum to the RAP (CH2M Hill, 2007) prepared for the site. It should be read in conjunction with the RAP. For ease of use and to avoid unnecessary repetition, where no change is proposed to the strategy, reference is made to the relevant section in the original RAP. The purpose of this document is only to provide further information on the options for remediation of the site, and is not intended to address all the requirements of a RAP as specified in '*Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*' (NSW EPA, 1997).

This document is structured as follows:

- Section 2 provides a brief summary of site details and the contamination status;
- Section 3 details RailCorp's objectives for the remediation and required environmental performance and details the geotechnical, heritage and other major constraints of the project;
- Section 4 summarises the remediation approach recommended in the Remedial Action Plan prepared for the site, assessment of other credible options and a revised remedial strategy incorporating these additional options;
- Section 5 summarises the Remediation Acceptance Criteria to be adopted as part of the revised remediation strategy and the validation sampling plan where deviations from the RAP specified program may be acceptable;
- Section 6 details works required prior to the commencement of remediation;
- Section 7 summarises the pre-treatment requirements for remedial works;
- Section 8 details the consideration for management of perched groundwater in fill and use of a Water Treatment System during the remediation works;
- Section 9 details considerations for treatment of soil;
- Section 10 details considerations of off-site disposal of untreated and treated soil; and
- Section 11 details the anticipated remedial timeframe.

2 Summary of Site Information

On the basis of the complete environmental data set available for the site, a site conceptual model has been prepared and is summarised in the following sections. Full details on site description, history and previous results are provided in previous reports.

Figures showing site location, area and sampling locations are provided as **Figures 1** to **5**.

2.1 Geology

Review of the Sydney Geological Series Sheet 9130 (C. Herbert, 1999) indicates that the geological formation underlying the Site is the Wianamatta Group Ashfield Shale comprising black to dark-grey shale and laminite.

Previous investigations on the site as reported in CH2M Hill (2007b) have identified three general soil types on the site including fill materials, natural soils and tar impacted fill and natural soils. Each is described in more detail following.

2.1.1 Fill Material

Based on the findings of previous investigations as reported in CH2M Hill (2007b), the fill materials identified at the Site have been grouped as follows:

- Ash and Coke Gravels – observed across the majority of the Site in surface and near surface layers from ground level to approximately 0.5 m depth;
- Reworked Clays – observed in subsurface layers in some site areas between 0.5m depth to approximately 1.5 m depth. This material was observed in the majority of areas as general filling;
- Sands and Gravels – observed in subsurface layers in some site areas between 0.5m depth to approximately 1.5 m depth. This material was observed in the North East, South Central and Gas Purifier areas;
- Gravelly Sand and Clay with Minor Ash – observed in surface and subsurface layers in some site areas from ground level to approximately 3.5 m depth. This material was predominantly observed in the South West area of the Site as general filling; and
- Gravel, Sand and Demolition Wastes – observed in the fill embankment of the Retaining Wall and inside the annulus of the Northern Gasholder. This material was observed to mainly consist of sandy gravels and some ash gravels. It also consisted of demolition wastes and rubble including bricks, metal pipes, tiles, fibrous cement sheeting and Asbestos Containing Material (ACM) and other building rubble in a gravely sand matrix.

2.1.2 Natural Soil

Based on the findings of previous investigations as reported in CH2M Hill (2007b), the natural soil materials identified at the Site have been grouped as follows:

- Silty Clay – observed generally from between 1.5 m depth to approximately 2.5 m depth. This material exists across the majority of Site areas. This horizon was predominantly a saturated zone, which sustained the perched groundwater system;
- Red/Grey Mottled Clay – observed generally from between 2.5 m depth to approximately 4.0-6.0 m depth. The soil profile is consistent with a Red

Podzolic soil, being moderately to highly plastic, stiff to very stiff, moist and mottled red/grey; and

- Weathered Shale – observed underlying the natural clay. This material grades from extremely weathered to moderately weathered at depths of up to 10 m depth. At depths beyond 6 m, fracturing of the material is common.

2.1.3 Tar Impacted Fill Material and Natural Soils

A number of areas of fill/natural soil materials were observed to be impacted by tar and were summarised in CH2M Hill (2007b). The tar impacts have been categorised as follows:

- Soil/fill impacted by free tar – consisting of soil and fill materials impacted to a high degree with black ooze, highly odorous, liquor type material;
- Tarry soils – consisting of soil and fill materials with minor tar impacts and moderate odours; and
- Dark Stained Impacts – this material was observed as dark brown to black staining in the deep soils and Weathered Shale within the soil pores and shale fractures zones underneath the Southern Gasholder. This material was also moderately odorous.

Soil/fill impacted by free tar was reported by CH2M Hill (2007b) to be predominately associated with former gasworks infrastructure, which include the:

- Tar Wells – shallow subsurface and deep natural soils immediately adjacent to these two structures;
- Northern Gasholder – deep natural soils immediately adjacent to the brick base annulus; and
- Old gasworks pipework – inside pipes and immediately adjacent fill/natural soils.

Tarry soils are present in localised areas, and given free tar have not migrated significant distances from gasworks infrastructure, there appears to be spatial separation between former gasworks infrastructure and tarry soils. Notably there is a layer of highly impacted soils (free tar impacts) surrounding these structures followed by less impacted tarry soils. Tarry soils are located in the following areas:

- Tar Wells, Northern Gasholder and Gas Purifier – soil and fill surrounding these source areas in surface/subsurface fill and deeper natural soils;
- Retort – fill and deep soil across the majority of this area;
- Gas Purifier – Sandy fill and deeper soils; and
- Localised impacted fill – observed in one localised pocket in the Northeast Area.

Dark stained impacts were also reported in CH2M Hill (2007b) to be associated with deep soils below the base of the annulus of the southern gasholder. The dark stained impacts were considered likely to be secondary sources within the strata in localised areas associated with the Southern Gasholder.

2.2 Hydrogeology

The groundwater system in the proximity of the site was reported in CH2M Hill (2007b) as existing as a shallow perched groundwater layer and a deep bedrock layer. The shallow groundwater exists within fill materials and silty clay above the natural clay (as shallow as

1m below ground surface), and the deeper groundwater exists within the Ashfield Shale bedrock under semi-confinement.

The groundwater flow direction was reported in CH2M Hill (2007b) to be toward the south/southeast for both shallow and deep groundwater systems. However, it was considered that flows were likely to be influenced by underground structures, including the gasholders annuli and underground waste pits and services associated with gasworks sites. It is possible there may be some interconnectivity between the shallow and deep groundwater systems given the similar direction of flow gradient.

Flow velocities within the shallow groundwater were estimated in CH2M Hill (2007b) to be 6.2-13.7 m/year, while within the deep groundwater are 12.2-36.5 m/year. However, these values do not correlate with the lateral extent of the plume, given that gasworks operations began over 100 years ago. With respect to estimated flow velocities for shallow groundwater it is noted that this layer is likely to be a local layer only and, based on review of test pit logs, flow characteristics are likely controlled by layers of high permeability (*i.e.* gravel, sand or poorly compacted materials) interdispersed between predominantly clay fill.

Based on the results of laboratory analysis of groundwater samples collected from on site and off site wells, the SKM (2006) report stated that:

''*The shallow plume appears to begin near the northern boundary of the Former Cleaning Shed and Gasworks areas and extend in a south-west direction of some 75m. The data indicate that the down-gradient edge of the plume is located at the East Hills Line at the southern edge of the site boundary. The lateral extent of the plume appears to be confined in the west to the sewer main located adjacent to the rear boundary of the residential properties, while to* [sic] *the plume is estimated to extend 50m to the east of the former tank area.*

The extent of the middle to heavy-end hydrocarbon plume in the deeper aquifer appears to be larger than the shallow aquifer. While the northern, eastern and western boundaries of the plume are similar to the shallow plume, the down-gradient extent of the plume appears to cover a distance of some 160m from the former tar tank area, with its edge near the southern boundary of railway land along Railway Parade. The data indicate that the deep aquifer plume is located entirely on railway owned [sic] *land.''*

Based on the assumption that the gasworks operations commenced more than 100 years ago, the RAP (CH2M Hill, 2007) notes that the flow velocity values provided in SKM (2006) do not correlate with the measured lateral extent of the plume (reported in the above quotation to extend 75m downgradient and 50m laterally in shallow groundwater, and 160 m downgradient in deep groundwater). It is also noted that the SKM (2006) report acknowledges the same point that, based on the measured extent of the shallow and deep groundwater plumes migrating from the site, the permeability rates estimated from slug tests appear to be an order of magnitude greater than actual rates as suggested by the dimensions of the plume. No explanation was provided for the difference in these permeability rates.

3 Remediation Objectives and Requirements

3.1 Overview

The RAP (CH2M Hill 2007) states that RailCorp wish to remediate the Site such that the following long term objectives can be met, including:

- Removal of the health risks to future site users;
- Removal of the risks to environmental receptors; and
- Allow the beneficial use of the Site for rail related activities.

3.2 Regulations and Approvals

Approval for the remedial works are being sought under Part 3A (Major Infrastructure and Other Project) of the *Environmental Planning and Assessment Act 1979*. Adherence must be made to any requirements placed on the works as part of that Approval.

3.3 RAP and SAR

The remedial works must be undertaken in accordance with the requirements of the RAP (CH2M Hill, 2007) and SAR (ENSR Aecom, 2008) prepared for the site.

3.4 Specific RailCorp Requirements

3.4.1 Requirements Near Site Boundaries

RailCorp has indicated the following requirements with regard to excavations near site boundaries:

- The recommendations for structural retentions along the western site boundary, to be specified by the RailCorp appointed Structural Engineer, must be implemented. Use of batters along this boundary may restrict the removal of impacted material, and is considered inadequate at this end of the site given its proximity to both the former Northern Gasholder source area and the neighbouring Burren Street residences; and
- Temporary batters, constructed in accordance with the recommendation provide in the Geotechnical Report, may be used along the northern, eastern and southern boundaries, provided it will not restrict the progress of excavations or adversely impact structures on adjacent properties.

3.4.2 Operational Environmental and Safety Requirements

Any remediation approach undertaken at the site must satisfy the requirements of RailCorp's environmental and safety policies.

RailCorp's Environmental Policy requires commitment to:

- Minimising use of natural resources;
- Adhering to the principles of ecologically sustainable development;
- Complying with applicable environmental legislation and regulations;
- Effectively managing environmental impacts; and
- Implementing environmental risk management at operational and strategic levels to minimise environmental impacts.

RailCorp's Safety Policy requires commitment to:

- Provide employees, contractors and labour-hire employees a safe environment from injury and workplace-related illnesses; and

- Manage risks proactively to minimise incidents.

Remediation methods applicable to the site are discussed in further detail in **Section 5**, and **Table 5.2** includes the environmental performance requirements of each remediation option to comply with RailCorp's environmental and safety policies.

3.4.3 Closure Requirements

Macdonaldtown

At the completion of remediation works RailCorp's long term objectives for the site should be met. The site should be in a condition such that a Site Audit Statement (SAS) can be prepared declaring the site suitable for commercial/industrial land use. Any Environmental Management Plan (EMP) required to achieve the long term objectives, and preparation of the SAS, should limit the commitments placed on RailCorp in terms of the scope of on-going works and restrictions on future use. RailCorp must be consulted prior to finalising the requirements of any EMP for the site.

At the completion of remedial works, a network of monitoring wells is also required on the site, sufficient to enable the completion of a program of Monitored Natural Attenuation (MNA) on the site. MNA will be undertaken in accordance with Section 10.3 of the RAP (CH2M Hill 2007) or an Auditor endorsed Groundwater Management Plan for the site.

Chullora

A baseline assessment of the treatment area to be used within the Chullora Railway Workshops must be completed prior to commencement comprising investigation of the potential chemicals of concern (PCOC) in soil and groundwater in accordance with relevant guidelines. The scope of the groundwater investigation as part of the baseline assessment should be appropriate to the nature of the proposed treatment works and their likelihood to result in contamination reaching the water table. At the completion of works, the treatment area must be restored to its pre-treatment works condition. A post treatment assessment of the area, of the same scope as the baseline assessment, will therefore be required to demonstrate that no adverse impacts have occurred or to determine the scale of restoration works.

3.5 Heritage Requirements

Archaeological assessment was undertaken on the site by City Plan Heritage and documented in the report '*Macdonaldtown Gasworks Archaeological Test Excavation Report for RailCorp*' August 2010 Ch10-009. The recommendations of the report pertinent to the remediation works include:

- machine excavation around the State heritage listed Southern Gasholder, is to be adequately planned and supervised to avoid any damage to the structure;
- in the Northern Gasholder – providing the bricks forming the annulus are not contaminated, where possible, the bricks should remain *in-situ*. Should removal of the bricks be required to remediate contamination, the removal is to be undertaken with care, so that if possible, the bricks can be cleaned and reinstated. Archaeological monitoring to record the removal, the depth of the annulus and its general construction details should be undertaken during excavation and removal of the annulus. Archival recording of the top of the annulus should be carried out prior to any removal - with minimal excavation recommended. If the bricks need to be removed and cannot be reused, the northern gasholder should be represented in some similar form;

- Prior to full scale remediation works an archaeological excavation in the area of the Retort House should be carried out for evidence of the retorts. This would entail machine stripping, hand excavation and recording of the uncovered features to Heritage Branch standards; and
- Prior to full scale remediation works, an archaeological excavation in the area probably containing the footprint of the superintendent's residence should be carried out to record the structural layout of the building. This would entail machine stripping, some hand excavation and recording of the uncovered features to Heritage Branch standards.

3.6 Geotechnical Requirements

Geotechnical testing was undertaken on the site by Pells Sullivan Meynink (PSM) and documented in the draft report '*Macdonaldtown Gasworks Remediation Project Geotechnical Investigation*' July 2010 PSM1444.R1. A summary of recommendations relevant to the completion of the bulk of excavation works is provided below, however, the original report should be referred to for full detail on earthworks and reinstatement requirements.

The report noted that excavation of fill on the site can be undertaken using conventional earth moving equipment, while rock hammers may be required for excavation of shale. **Table 3.1** summarises the recommendations made in relation to acceptable temporary batter slope angles.

Table 3.1: Recommended Temporary Batter Slope Angles

Distance between crest and structure	Geotechnical unit	Maximum batter height		
		<4 m	<6 m	<8 m
More than the batter height	Fill	1H:1V	1.5H:1V	2H:1V
	Residual clay	1H:1V	1H:1V	1.5H:1V
Less than the batter height	Fill	2H:1V	2H:1V	2.5H:1V
	Residual clay	2H:1V	2H:1V	2H:1V

The report also noted that:

''*Temporary batters where structures are located within 1.0 m of the crest should be inspected by a suitably qualified geotechnical engineer during excavation.*

Staging of construction to limit the plan extent of the excavation may be able to be adopted to result in localised steeper batter slopes. If such steeper slopes are required additional specific advice should be sought.''

The remediation works will need to ensure these slopes are maintained at all times. It is noted that the areas of identified contamination may extend below 8 m, and may also extend up to the site boundary. Provision should therefore be made for the installation of retaining structures to support the walls of the excavation in these areas.

The report also states that fill material present on the site, from a geotechnical perspective only, may be developed ''...*to allow placement of the majority of the excavated and remediated material as engineered fill*''. Should treated material satisfy contaminant requirements for reuse on site, it will be necessary to demonstrate that the treated material is suitable from a geotechnical perspective for use as engineered fill on land to be used for railway purposes.

The design of the remedial works should also take into consideration any advice provided from the appointed Structural Engineer in relation to requirements for ground stabilisation prior to and during excavation, particularly in the vicinity of the gasholders and underground services on the site.

3.7 Air Emissions Requirements

An assessment of air quality impacts was undertaken by JBS and is documented in the report titled '*Air Quality Assessment, Remediation of Former Macdonaldtown Gasworks*', Revision F, Reference 40913- 15136, dated August 2011 (JBS 2011a).

A summary of recommendations relevant to the completion of the bulk of excavation works on the Macdonaldtown site is provided below in **Table 3.2**, however, the original report should be referred to for full detail on requirements of dust and odour suppression and monitoring:

Table 3.2 Summary of Required Air Quality Controls

Site Area / Activity	Proposed Air Quality Control
Surface soil Excavations	Reduction of exposed *in-situ* materials to 400m^2 Dust suppression by hourly watering of all surfaces
Retaining Wall fill materials	Reduction of exposed *in-situ* materials to 25m^2 Dust suppression by hourly watering of all surfaces
Former gasworks area	Enclosure of excavations works, minimum required extent of enclosure shown on **Figure 7** Treatment of enclosure emissions prior to discharge.
Soil treatment - bioremediation	Enclosure of treatment works Treatment of enclosure emissions prior to discharge
Haulage Road use	Dust suppression by hourly watering of all surfaces
Groundwater	Relocation of water treatment plant to central section of the site as far removed from the Burren Street site frontage as possible, recommended location shown on **Figure 7** Enclosure of any areas used for splash filling of water treatment plant Ventilation from water treatment plant to be filtered Prevention of groundwater accumulating within excavations on the site. This may be achieved by pumping water out of the excavations as it infiltrates or if possible by pumping groundwater from adjacent wells

An assessment of air quality impacts on the alternate treatment site was also undertaken by JBS and is documented in the report titled '*Air Quality Assessment, Remediation of Former Macdonaldtown Gasworks – Chullora Material Receipt Facility*', Revision F, Reference 40913- 15137, dated June August (JBS 2011b).

The recommendations provided in JBS (2011b) relevant to the completion of soil treatment works, were that:

- All soil treatment works on the site be undertaken within temporary enclosure, including the storage of soils over the curing period, and that it be operated under negative pressure conditions to enable extraction and treatment of air emissions from the enclosure; and
- ''*The extent of exposed coal tar impacted soils is to be minimised to a surface area of 150m^2. Other coal tar impacted soils stockpiled / bioremediated on the site are to be covered to prevent odour emissions*''.

The original report should be referred to for full detail on requirements of dust and odour suppression and monitoring.

4 Remedial Strategy Refinement

4.1 Extent of Soil Remediation and Strategy Proposed In RAP

The anticipated extent of remediation as specified in CH2M Hill (2007) is reproduced in **Table 4.1** following. Active remediation was considered by CH2M Hill to be only required for the free tar and impacted fill and soils on site. Requirements for groundwater remediation were discussed in Section 5.6 of the RAP. Reference should be made to **Figures 3** and **4** for the location of each nominated remediation area.

The proposed remediation is a source removal approach, with the intention that the excavation of source material in each area be completed to the extent practicable. Where heritage or geotechnical constraints are encountered such that the practicable limit is unable to remove the full extent of source material, then an *in-situ* management strategy may be implemented in these areas subject to endorsement by RailCorp and the Site Auditor. Areas where such constraints may be encountered include soil at depth in the vicinity of both the western site boundary and the former northern gasholder. Any strategy to contain source material in-situ will need to be compliant with the requirements of '*Guidelines for the Assessment of On-site Containment of Contaminated Soil*' (Australian and New Zealand Environment and Conservation Council, 1999).

The extent of remediation proposed was considered sufficient to protect the health of the future site users by removing or controlling the identified unacceptable health risks.

The contaminants that were considered to drive the health risks were the known carcinogens including benzene and B(a)P. These contaminants were considered to have a direct relationship to the tar source material and the ash/coke surface fill. Therefore, remediation of the tar sources and the ash/coke fill was proposed to mitigate the health risks these contaminants pose to the receptors. This is intended to mitigate the risks by reducing the potential for direct exposure.

Remediation of the tar sources (*e.g.* those accumulated in the Northern Gasholder annulus and the Tar Wells) and remediation of tarry impacted soils (*e.g*. from within the Retort and Gas Purifier areas) was also considered necessary to protect the environmental values of the site groundwater by a reduction in contaminant mass.

Table 4.1: Summary of Remedial Extent and Strategy (as adapted from Table 5.1, CH2M Hill, 2007)

Remediation Area	Impacted Area	Estimated Volume (m^3)	Description	RAP Preferred Remedial Approach
Tar wells	Base annulus and immediate area	1000	Soil / fill impacted by free tar	Stabilisation for off-site disposal
	Tar well contents	100	Tar sludge	Off-site disposal as liquid waste with pre-treatment as required to improve handling
Northern gasholder	Base annulus and immediate area	2100	Soil / fill impacted by free tar	Stabilisation for off-site-disposal to landfill, with pre-treatment as required to improve handling
	Gasholder contents	640	Impacted water	Off-site disposal as liquid waste
		320	Tar sludge	Off-site disposal as liquid waste with pre-treatment as required to improve

Remediation Area	Impacted Area	Estimated Volume (m^3)	Description	RAP Preferred Remedial Approach
				handling
	Buried wastes inside annulus	1900	Demolition materials	Off-site disposal as' Asbestos/Industrial'[1] (*i.e.* with pre-treatment to remove free tar or oversize component)
Former gasworks area	Shallow fill / soils	9225	Tarry soils – fill and natural clays	Stabilisation for off-site-disposal to landfill, with pre-treatment as required to improve handling
	Deeper soils	2375	Tarry soils – natural clays and weathered shales	Stabilisation for off-site-disposal to landfill, with pre-treatment as required to improve handling
	TP16 Hotspot	115	Tarry soils – fill and natural clays	Stabilisation for off-site-disposal to landfill, with pre-treatment as required to improve handling
Site surfaces		2950	Ash and coke gravels	Off-site disposal to landfill
Retaining wall		1765	Gravel sand and demolition wastes	Off-site disposal to landfill. With processing (*i.e.* segregating oversized component) recycling or beneficial reuse may also be an option
Hotspots	BH14	100	Fill and natural clays	Off-site disposal to landfill
	MW13s	140	Fill	Offsite disposal to landfill
	MW04s	100	Fill and natural clays	Off-site disposal to landfill
Pipework	Varying across site	Unknown	Tar / scrap metal	Treatment to remove tar from pipework. Tar to be disposed to landfill, scrap metal possibly disposed to landfill as demolition waste

4.2 Additional Remediation Options Consideration

Further to several detailed studies on the implementation of the RAP, it was decided that based on the range and volume of materials requiring remediation on the site, the proposed strategy should incorporate alternate options for remediating the site to those provided in the RAP. JBS was requested to review the potential for the following additional treatment/management options to be incorporated into the remedial approach for the site:

- Excavation of soil for ex-situ treatment by bioremediation for on site reuse; and
- *In-situ* capping of impacted materials.

An assessment of the technical and overall suitability was undertaken for the additional options listed above, and is summarised in **Table 4.2**.

[1] Asbestos Contaminated Special Waste or Restricted Solid Waste under DECC 2008

Each of the possible remedial options has been assessed for each of the three contamination issues requiring assessment on the site, namely:

- Free tar present in disused infrastructure, in fill, soils and shale underlying the site;
- Ash and tar materials considered to be acting as source material for unacceptable levels of groundwater contamination; and
- Asbestos impact potentially contained throughout fill materials on the site

Table 4.2 also includes assessment of two of the four remedial methods preferred in the RAP (CH2M Hill 2007), specifically:

- excavation and off-site disposal of soil without treatment; and
- excavation and off-site stabilisation of soil for off site disposal.

No further consideration was made of chemical oxidation of material and thermal treatment for off site disposal, despite their inclusion as preferred methods in the RAP (CH2M Hill, 2007). Chemical oxidation was considered unsuited to the particular contaminants of concern, and to the low permeability of the soil and rock units underlying the site. Thermal desorption was considered technically feasible, but less suitable, given the proximity of sensitive land uses to the site (and potential off site treatment location), and likely costs for the low volume of material to be treated.

4.3 Revised Remedial Strategy

Based on the additional data and review of other likely remedial methodologies, the remedial strategy for the site is presented in the following flowchart (**Flowchart 4.1**) and summarised in **Table 4.3**.

Table 4.3: Summary of Remedial Strategy and Suitable Materials

Remediation Method	Likely Suitable Materials
Excavation and off-site disposal of untreated material	Most cost effective on material unlikely to achieve validation criteria through treatment in a timely manner AND classed as 'Restricted Solid Waste' or lower for off-site disposal
Excavation and treatment of material for on-site reuse	Most cost effective on material likely to achieve validation criteria through treatment in a timely manner. Onsite treatment method = bioremediation
Excavation and treatment of material for off-site disposal	Most cost effective on material unlikely to achieve validation criteria through treatment in a timely manner AND classed as 'Restricted Solid Waste' or higher for off-site disposal. Material may be treated on site or off site. Onsite treatment method = bioremediation, Off-site treatment method = cement stabilisation
In-situ capping of impacted material	Only acceptable where excavations have reached their practicable extent

Further consideration each element of the Remedial Strategy is provided in **Table A**.

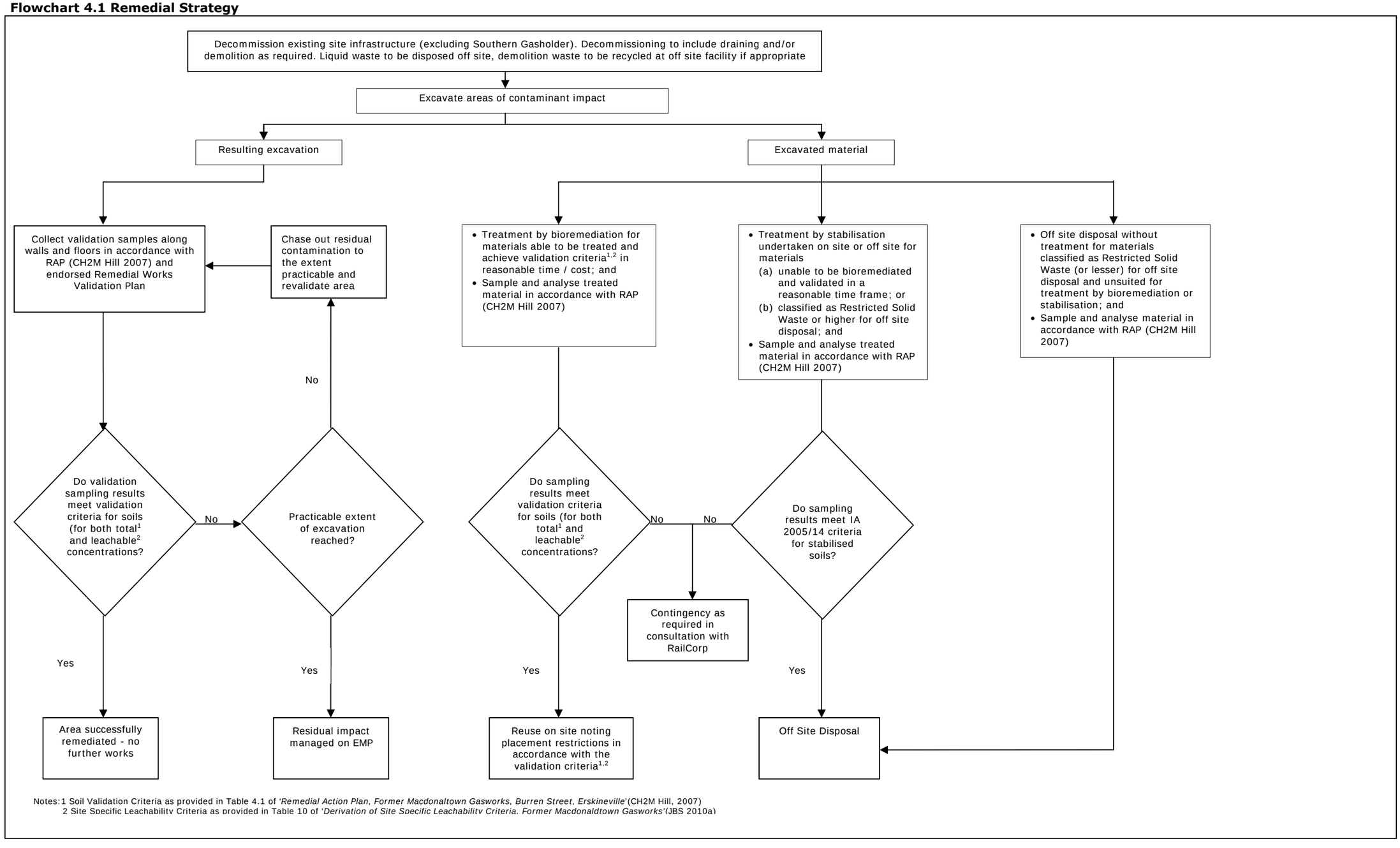
Table 4.2: Evaluation of Soil Treatment and Management Options

Consideration	Option 1 – Excavation and off site disposal of untreated material	Option 2 – Excavation and on-site treatment for on site reuse (Bioremediation)	Option 3 – Excavation and off-site treatment for off site disposal (stabilisation)	Option 4 – In-situ Capping of Impacted soils
Use of permanent solutions & alternative technologies or resource recovery technologies	Permanent solution: Yes Alternate technology: No Resource recovery technology: No	Permanent solution: Yes Alternate technology: No Resource recovery technology: Yes	Permanent solution: Yes Alternate technology: No Resource recovery technology: No	Permanent solution: Yes Alternate technology: No Resource recovery technology: No
Satisfy DECC (2006) preference for treatment as a principle element	No	Yes	Yes – although may be undertaken as off site treatment at Chullora[2]	No
Suitable materials	Only materials that are classed as Restricted Solid Waste, or lower, for off site disposal.	Only materials that are likely to be treated by bioremediation and likely to achieve validation criteria within both a reasonable time frame and cost. Unlikely to be suited to material impacted by free tar or asbestos	Only materials that are classed as Restricted Solid Waste, or higher, for off site disposal. Unlikely to be cost effective on materials classed as General Solid Waste for off site disposal	Only acceptable where excavations have been reached the practicable limits i.e. where remedial excavation cannot removal full extent of source
Ability to achieve validation	Validation able to be achieved with certainty	This option has the potential to achieve validation	This option has the potential to achieve validation	Validation able to be achieved with certainty, subject to ongoing management.
Ability for treated material to be reused on site	-	This option has the potential to produce material suitable for reuse however, heavily impacted materials may encounter treatment difficulties and potential failure of validation criteria could occur	This option has the potential to produce material suitable for reuse however, the relatively high concentrations and nature of hydrocarbons (heavy end TPH / PAHs) suggests treatment difficulties and potential failure of validation criteria relating to leachability could occur	-
OH&S considerations	OH&S issues during remediation able to be reasonably managed. Intensive odour control will be required for nearby site users	OH&S issues during remediation able to be reasonably managed. Intensive odour control will be required for nearby site users	OH&S issues during remediation able to be reasonably managed, intensive odour control will be required for nearby site users	OH&S issues able to be reasonably controlled
Timing & staging requirements	No significant time delays	Uncertain – generally extended timeframes required for bioremediation.	Uncertain – generally extended timeframes required for bioremediation. Dependent also on capacity of stabilisation system, and available area as will require 7-10 days for curing of each treatment batch	No significant delays , however program will need to factor in time for construction of capping before remediation is complete
Geotechnical requirements	Water table reduction in fill required and stabilisation of Southern Gasholder and any other structures to be retained required (common to all options)			
Cost effectiveness	Upfront costs: low	Upfront costs: moderate	Upfront costs: low	Upfront costs: moderate
	Water Treatment Costs (common to all potential options: uncertain will also depend on costs, if any, for disposal of groundwater generated during dewatering)			
	Long Term Costs: High, given large areas of the site where material would be classed as Hazardous Waste, Restricted Solid Waste or Special Waste for off-site disposal	Long Term Costs: Uncertain – will be dependent on treatment timeframes	Long Term Costs: Moderate	Long Term Costs: low, however party responsible for on-going management will maintain the liability associated with human health and environmental incidents linked to breach of the containment area
	Total Costs: Comparatively High	Total Costs: Uncertain, but likely to be less than disposal of treated material to landfilll	Total Costs: Uncertain , but likely to be less than disposal of untreated material to landfill	Total Costs: comparatively low Presence of containment area may reduce value of the land in the future
Compliance with applicable or relevant appropriate requirements (ARARs)	Disposal site (*i.e.* Landfill) will require appropriate EPL[1] for waste disposal application to land for that class of material	If treated material to be disposed to off site: disposal site (*i.e.* Landfill) will require Immobilisation Approval from DECCW, disposal site will also need approval to receive waste	Treated material to be disposed to off site: disposal site (*i.e.* Landfill) will require appropriate EPL[1] for waste disposal application to land	The consent authority may need to accept the *in-situ* management of contaminated material and a method will need to be nominated for legal enforcement of the RAP. There will need to be a responsible party suitable to be nominated for on-going management of capping and / or containment cell, approval from Site Auditor required for strategy to determine which materials suitable to remain on site.
		If material to be treated at Chullora an EPL[1] for treatment of contaminated soil will be required for Chullora	If material to be treated at Chullora EPL[1] for treatment of contaminated soil required for Chullora	
	Water Generated During Dewatering – Trade Waste Agreement with Sydney Water if not suitable for reinjection (common to all methods)			
On-going Liability Post	None	None	None	Requires on-going management, may limit future commercial use of the site and responsibility if

Consideration	Option 1 – Excavation and off site disposal of untreated material	Option 2 – Excavation and on-site treatment for on site reuse (Bioremediation)	Option 3 – Excavation and off-site treatment for off site disposal (stabilisation)	Option 4 – In-situ Capping of Impacted soils
Remediation				breaches occur
Protection of Human Health	Overall **Good**	Overall **Good**	Overall **Average** – may not be capable of remediating concentrations present in workable timeframe.	Overall **Good** but as no reduction in contaminant mass, method requires on-going management, may limit future commercial use of the site.
Environment & heritage	Good - reduction in contaminant mass on site Poor - consumes limited landfill resources	Good – reduces the leachable concentration of contaminants If off-site disposal required as a result of failed treatment, poor - option consumes limited landfill resources	Good - reduction in contaminant mass on site Poor - generation of green house gases during remediation Poor - if used without air emission controls then potential for odour generation during remediation Poor - need to segregate asbestos impacted material from treatment process or incorporate mitigation measures in operational procedures to prevent release /exposure to asbestos fibres during and post treatment Disposed to landfill, poor - consumes limited landfill resources	Good – isolated contaminated material from environment Poor- no reduction in contaminant mass on site therefore maintenance of isolation involves ongoing management and liability
Reputation / community	Consultation required but assume preferable as only certified clean materials will be used to reinstate site	Consultation required but assume preferable as reduces number of large vehicle movements to and from site	Consultation required but assume preferable as only certified clean materials will be used to reinstate site	Consultation required but assume preferable as less disruption to surrounding area
Conclusion	**Suited only to material impacted by low levels of contamination.** **Primary limiting factors include:** **- No licensed facilities in NSW exist to receive material classed as 'Hazardous Waste' for off site disposal** **- High cost option** **- High impact on limited landfill resources** **Not a complete solution**	**Suited only to material considered suited to achieve validation criteria by bioremediation in a reasonable timeframe.** **Primary limiting factors include:** **- bioremediation unsuited for remediation of inorganic and semi-volatile contaminants** **- Potential cost of off site disposal if validation criteria cannot be achieved after treatment** **Not a complete solution**	**May be used as the complete solution, however costs likely to be prohibitive if used on material capable of being reused on site** **Cost of undertaking treatment by stabilisation are likely to restrict the suitability of this option only to material considered unsuitable for treatment by bioremediation and/or in untreated form classed as Restricted Solid Waste, or higher, for offsite disposal**	**Acceptable only where the excavations have reached practicable limits** **The primary limiting factor is the that source removal is not achieved adopting this option** **Not a complete solution**

Notes: 1 EPL: Environment Protection Licence issued by DECCW under the *Protection of the Environment Operations Act* (1997)

Flowchart 4.1 Remedial Strategy



Notes: 1 Soil Validation Criteria as provided in Table 4.1 of '*Remedial Action Plan, Former Macdonaltown Gasworks, Burren Street, Erskineville*'(CH2M Hill, 2007)
2 Site Specific Leachability Criteria as provided in Table 10 of '*Derivation of Site Specific Leachability Criteria. Former Macdonaldtown Gasworks*'(JBS 2010a)

5 Remediation Acceptance Criteria and Validation Plan

Validation data are to be collected to verify the effectiveness of the remediation works and document the condition of the site as being suitable for the proposed future use(s).

Given the nature and extent of remediation works, validation data shall verify that:

- the identified contaminated soils (listed in **Table 5.3** of this document and Section 5 of the RAP) were effectively remediated; and
- any soils / fill materials retained on the site (including any materials excavated and treated for reuse) are suitable for on-going industrial land use.

5.1 Remediation Acceptance Criteria

The RAP (CH2M Hill, 2007) produced for the site included site specific validation criteria for total concentration in soil. The calculated values are depth dependent, based on risks to future site users associated with exposure to vapours and present for four distinct depth ranges:

- Surface (0.0m) to 1.5m below ground surface of finished site;
- 1.5 to 2.5m below ground surface of finished site;
- 2.5 to 4.0m below ground surface of finished site; and
- 4.0 to 8.0m below ground surface of finished site.

Soil validation criteria are summarised in **Table 5.1** following.

Table 5.1: Soil Validation Criteria

Analyte	Depth Range[6]			
	0-1.5m	1.5-2.5m	2.5-4.0m	4.0-8.0m
Heavy metals				
As (total)	500	-	-	-
Cd	100	-	-	-
Cr	500[1]	-	-	-
Cu	5,000	-	-	-
Hg (inorganic)	75	-	-	-
Ni	3,000	-	-	-
Zn	35,000	-	-	-
Monocyclic Aromatic Hydrocarbons				
Benzene	1[3]	1[3]	1[3]	1[3]
Toluene	1.4[2]	2.6	4	7.9
Ethylbenzene	3.1[2]	11.1	17.6	34.8
Total xylene	14[2, 3]	14[3]	14[3]	14[3]
Polycyclic Aromatic Hydrocarbons (PAHs)				
PAHs (total)	100	-	-	-
Benzo(a)pyrene	5	-[4]	-[4]	-[4]
Naphthalene	-	3.8	6.0	11.8
Acenaphthene	-	-[4]	-[4]	-[4]
Fluorene	-	-[4]	-[4]	-[4]
Pyrene	-	-[4]	-[4]	-[4]
Benzo(b)fluoranthene	-	-[4]	-[4]	-[4]
Chrysene	-	-[4]	-[4]	-[4]
Other Constituents				
Total Phenol	42,500	-	-	-
Cyanide (complex	2,500	-	-	-
Asbestos	No detection of fibres in surface soils (0.5m depth). No visible			

Note: 1. Value is for Cr(VI) and used as a conservative concentration as a preliminary screening value for chromium.

2. Criteria for toluene, ethylbenzene and xylenes at 0-1.5m are ecological health based.

3. Risk based values are lower than laboratory analytical limits of reporting (LORs) and health investigation levels (HILs), therefore less conservative HILs applied to all depths.

4. Not of concern. Based on the outcomes of vapour fate and transport modelling reported in CH2M Hill (2007b) the contaminant was considered to have a low vapour potential at the nominated soil temperature of 15°C.

5. Adopted criteria in CH2M Hill (2007b) on the basis of Australian Contaminated land Consultants Association (2002) 'Asbestos in Soils – Code of Practice'

6. Depth ranges provided in metres below ground level in RAP (CH2M Hill 2007), these will need to be converted to levels relative the required finished ground surface.

Given that the revised strategy allows for material to be reused onsite, site specific leachability criteria were derived in the JBS letter '*Derivation of Site Specific Leachability Criteria – Former Macdonaldtown gasworks, Burren Street, Erskineville, NSW'* Reference JBS 40913-15501, provided as **Appendix B.**

The site specific leachability criteria were derived based on the relevant criteria for protection of groundwater resources in the area, but also incorporating a dilution attenuation factor (DAF) to account for dilution of contaminated groundwater that occurs at the receiving water body, as it becomes mixed with groundwater discharged from the remainder of the catchment. A DAF value of 16.6 was determined for the site, and the resulting site specific leachability criteria for the main contaminants of concern are provided in **Table 5.2** below. The complete list of site specific leachability criteria is presented in **Appendix B**.

Table 5.2: Site Specific Leachability RAC (all units in µg/L)

Contaminant	Limit of Reporting	Site Specific Criteria for assessment for leachable concentrations in soil[1]
HEAVY METALS		
Arsenic (III/V)	0.1	38.2 / 74.7
Cadmium	0.1	11.6
Chromium (III)		166
Chromium (VI)	0.1	73
Copper	0.1	21.6
Lead	0.1	73
Manganese	1	1328
Mercury	0.05	1.76
Nickel	1	1162
Zinc	1	249
POLYCYCLIC AROMATIC HYDRCAOCARBONS		
Benzo(a)Pyrene	0.1	1.7
Naphthalene	0.1	1162
Phenanthrene	0.1	10.3
Anthracene	0.1	0.2
Fluoranthene	0.1	1.7

[1] Adopted criteria – 16.6x ANZECC/ARMCANZ 2000 trigger values, 16.6 x the LOR was adopted where ANZECC/ARMCANZ 2000 trigger values are unlikely to be achieved readily by the laboratories

The values presented in **Table 5.2** were derived to be protective of downgradient receptors in the event that contamination leaches out of subsurface soils, infiltrates the water table and migrates off site (**Appendix B**). They are considered to be the upper limits of allowable leachabilities on site. The actual quality of shallow groundwater on the site (**Table 8.2**), is much better than the upper limits set for leachability. Given that the remediation strategy prescribed will ultimately remove the bulk of contaminant mass from the subsurface it is therefore considered unlikely that

the leachability of material in validated areas of the site, or material to be reinstated after treatment will reach the upper limits provided in **Table 5.2**.

5.2 Validation of Soil Remediation Works

The proposed soil validation sampling and analytical program for the revised remedial strategy is outlined in **Table 5.3**. Validation requirements for material to be imported onto site have been included for completeness, noting that the specified testing requirements will need to be undertaken on the material at its source location and prior to arrival on site.

Table 5.3: Soil Validation Sampling Program

Item	Sampling Frequency			Analytes
	Excavation floors	Excavation Walls (from each distinct horizon / material type)	Sampling Density	
Remediation Excavation (consistent with RAP)	1 sample per 8.5 m square grid centres	1 sample per 10 lineal metres / 10 m – at depths of between 0 and 1.5m, 1.5 and 2.5m, 2.5 and 4.0m, 4.0 and 8.0m and every 2m below 8.0m depth	N/A	8 metals BTEX PAHs Phenols Cyanide Asbestos
Treated materials prior to off-site disposal or on-site reuse (ALTERNATE TO RAP)	N/A	N/A	7 samples per treatment batch up to 1000 m^3 + 1 additional sample per 200m^3 (or part thereof) in excess of 1000m^3	8 metals BTEX PAHs Phenols
				BTEX (gw leach)[1] PAH (gw leach) [1] Heavy metals (gw leach) [1]
Impacted material to be retained in-situ under newly installed site capping	Confirmatory sampling on 8.5 m square grid centres. Samples analysed at 1.0 m intervals to a depth of 1 m below observed depth of impact			8 metals BTEX (total and GW leach) PAHs (total and GW leach) Phenols Cyanide Asbestos
Imported material for reinstatement[2]: - VENM, ENM soil or material generated and certified under an approved DECCW resource recovery exemption and approved for use by DECCW[2] (ALTERNATE TO RAP)	N/A	N/A	Minimum 10 samples per source site to enable calculation of 95%UCL_{avg} concentrations	8 metals TPH/BTEX PAHs OCPs/PCBs (for VENM only) Asbestos Foreign material (ENM only) pH (ENM only) VCH (ENM only)
			For recovered materials testing should be in accordance with the requirements of the relevant exemption	

Notes: 1 leachability testing shall be undertaken on treated materials using site specific groundwater to simulate likely potential risks to groundwater.

2 All imported material must be tested and validated at the source location prior to receipt at the Macdonaldtown Gasworks site.

3 any material generated under an approved DECCW resource recovery exemption to be imported to site must be demonstrated as complying with all the requirements of that exemption and must be approved for use in reinstating the site in writing by DECCW.

It is noted that TPH is not included in the analytical suite specified for validation samples, despite the inclusion of petroleum hydrocarbons in the '*principal chemicals of interest at gasworks sites*' in DEC (2005) '*Information for the assessment of former gasworks sites*'. Imray and Langley (Enhealth, 2001)[2] mention the difficulties in the risk assessment of mixtures such as TPH and refer to two approaches used in a hybrid framework for assessing TPH by The Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG,

[2] Health-based Soil Investigation Levels, Imray, P. and Langley, A., enHealth (enHealth, 2001).

1997). The first approach investigates the presence of indicator chemicals which are carcinogenic substances such as benzene and PAHs, which if detected require assessment using contaminant specific health investigation levels. The second stage involves assessment against criteria for well defined TPH fractions, which have been derived for $>C_{16}$-C_{35} aromatics, $>C_{16}$-C_{35} aliphatics and $>C_{35}$ aliphatics in soil. The analytical suite for the validation program is based on the first approach, i.e. assessing the specific compounds likely to present an unacceptable risk, rather than the TPH mixture itself. This is considered appropriate for the site as the extensive historical dataset indicates that elevated TPH concentrations were primarily comprise of either PAH or BTEX compounds. Conversely TPH concentrations were generally below the detection limit in samples where PAH or BTEX concentrations were low.

Sampling Rationale

The sampling and analytical regime presented in **Table 5.3** is based on the following rationale:

- The wall sampling frequency is based on what is considered to be an adequately conservative lineal frequency capable of detecting residual contamination and being representative of residual materials;
- Treated material sampling frequencies for on site reuse or off-site disposal are designed to ensure reliable 95%UCL_{avg} concentrations are derived; and
- Imported material sampling frequencies exceed the minimum 1 composite sample requirement outlined in EPA 1995, and is based on having sufficient data to generate reliable 95%UCL_{avg} concentrations. Procedure B (EPA 1995) will also be used to confirm that an appropriate number of samples have been obtained from each source type / material type to enable comparison against the appropriate criteria.

Sampling Methodology and Data Quality

Should remain consistent with the requirements of the Section 9 of RAP (CH2M Hill, 2007)

5.3 Application of RAC

The following rules apply to use of RAC in material to be retained on site:

1. For impacted material to be retained *in-situ* due to heritage or geotechnical restrictions on the extent of excavation – soils in the area to be retained on site must be sampled and analysed at the frequency specified in **Section 5.3**, which includes both total and leachable concentrations. Leachable concentrations in all samples must comply with the RAC provided in **Table 5.2** due to the potential for contaminant migration. Consultation should be undertaken with RailCorp/Site Auditor on a case by case basis to determine whether these materials are also required to comply with the RAC for total concentrations at specific locations. Where samples fail to meet these criteria a contingency strategy may be required subject to RailCorp/Site Auditor endorsement prior to implementation. Contingency options may include management by capping and ongoing monitoring;
2. For material used to reinstate the site following treatment by bioremediation- each treated batch is to be sampled and analysed at the frequency specified in **Section 5.3.** Leachable concentrations in all samples must comply with the RAC provided in **Table 5.2,** AND total concentrations in all samples must be compliant with RAC (specified in **Table 5.1,** as adapted from the RAP, CH2M Hill, 2007).

Where samples fail to meet these criteria a contingency strategy may be required subject to RailCorp/Site Auditor endorsement prior to implementation. Contingency options may include extending the period of remediation, cement stabilisation or disposal to landfill without further treatment; and

3. For material to be treated by cement stabilisation – as this material will require waste classification for off site disposal, each treated batch is to be sampled and analysed in accordance with the requirements of IA 2005/14**.** Leachable concentrations should be assessed against Specific Contaminant Concentration (SCC) values provided in Waste Classification Guidelines (DECC 2009), AND compliance with the additional criteria listed in **Table 5.4** must be demonstrated. Where samples fail to meet these criteria a contingency strategy may be required and will require RailCorp/Site Auditor endorsement prior to implementation. Contingency options may include retreating of soils to achieve compressive strength or disposal to landfill;

Table 5.4: Soil Criteria (units as specified)

Property	Requirement (IA 2005/14, NSW EPA)[1]
Maximum allowable concentrations in **untreated** material	PAHs – 13 000 mg.kg^{-1} B(a)P – 500 mg.kg^{-1} Non-halogenated phenols – 2000 mg.kg^{-1} Total Cyanide 4000 mg.kg^{-1}
Reagent used for stabilisation	Calcium or Magnesium Oxide
Maximum allowable stabilisation ratio	2:1 (*i.e.* by mass, 2 parts reagent to 1 part untreated soil)
Unconfined compressive strength (UCS)	1 MPa as the 95% lower confidence limit value (as assessed by AS1012.9-1999)

Notes: 1. *General Approval of the Immobilisation of Contaminants in Waste'* (NSW EPA 2005), Approval Number 2005/14 - *Coal Tar Waste from former Gasworks Sites*.

5.4 Groundwater Management

No active groundwater remediation is proposed in the RAP (CH2M Hill, 2007). The Monitored Natural Attenuation (MNA) approach is proposed to monitor the concentrations of residual compounds in groundwater following the completion of soil.

It will, therefore, be necessary as part of the soil remediation works to install new groundwater monitoring well on the site in accordance with Section 10.3.3 of the RAP (CH2M Hill, 2007), or any future RailCorp and Auditor endorsed Groundwater Management Plan produced for the site.

Additionally any perched groundwater drained out of the fill material and shallow soil to enable excavation of the areas to be remediated will require treatment prior to off site disposal. Further discussion of the treatment of perched water generated during excavation works is provided in **Section 7**.

6 Pre-Remedial Documentation

A number of pre-remedial studies, plans and approvals are likely to be required for implementation of the RAP (CH2M Hill 2007) and this Remedial Strategies document. These are summarised following.

6.1 Pre-Remedial Studies

The following pre-remedial studies should be completed prior to the detailed consideration and design of remediation works:

6.1.1 Geotechnical and Dewatering Assessments

As the areas requiring remediation extend up to the site boundaries, geotechnical structural retention will be required to secure properties bordering the site. As a minimum it is considered geotechnical controls will be required along the western boundary and in the vicinity of the southern gas holder, but consideration should also be given to the need for retention along the southern and northern site boundaries.

Geotechnical assessment may also be required on treated material proposed for reuse on the site and for disposal to landfill.

Where not included in the existing geotechnical report[3] then detailed geotechnical assessments will be required to provide geotechnical parameters for retaining structure design.

Structural engineer design of shoring will be required based on the geotechnical parameters.

Each of the studies shall be undertaken by qualified geotechnical and structural engineers.

6.2 Pre Remediation Works Plans

6.2.1 Remediation Health and Safety Management Plan (RHSMP)

Several potential health and safety hazards are anticipated to be present during the course of the remediation works. These relate to physical hazard posed by the completion of a large scale demolition and earthworks project and chemical hazards associated with the contaminated soils and groundwater underlying the site. A Remediation Health and safety Plan (RHSMP) will be required prior to the commencement of works. As a minimum the RHSMP will need to detail the following items:

- Assessment of potential hazards posed by works including detailed descriptions of potential toxicological impacts from contaminants present in soil and groundwater underlying the site;
- Stipulation of measures to remove hazards (where possible);
- Procedures / controls to be put in place to control hazards where elimination is not possible;
- Any requirement for personal protective equipment to be worn by the site workforce;
- Specific consideration of the PPE and/or operational requirements for maintenance of acceptable working conditions within the proposed enclosure;

[3](PSM 2010) '*Macdonaldtown Gasworks Remediation Project Geotechnical Investigation*' PSM1444.R1

- Requirements for pre-works training of the site workforce (*i.e.* Occupational Health and Safety General Induction for all personnel, HAZWOPER training for staff potentially directly exposed to contaminants etc);
- Requirements for occupational monitoring to be completed during the remediation works; and
- Evacuation plans and directions for medical assistance / first aid.

Additional requirements for the RHSMP may be identified during the course of remediation.

6.2.2 Dilapidation Studies

There is a potential for proposed remediation works to have structural impacts on adjoining properties. Pre- and post-works dilapidation studies will be required of adjoining properties to assess for dilapidation as caused by the remediation works.

6.2.3 Remediation Works and Validation Plan (RWVP)

The requirements of this document and the RAP may be achieved by a number of methods by the successful remediation contractor. A Remediation Works and Validation Plan (RWVP) will be required prior to the commencement of works and will require endorsement by the appointed Site Auditor. As a minimum the RWVP will need to detail the following items:

- Compliance with the requirements of the RAP, the Environmental Management Plan (EMP) prepared for the site and this Remedial Strategy document will be met;
- Compliance with any additional requirements arising out of the Part 3A approval;
- The validation program (frequencies and analytical suites) to be adopted for material to remain *in-situ*;
- The validation program (frequencies and analytical suites) to be adopted for treated material to be reused on site;
- The preferred off-site disposal location(s) for material to be disposed to landfill;
- Details of the treatment methods to be adopted, both on-site and off-site;
- An indicative layout of the likely treatment operation relative to site boundaries and adjacent land uses, including the proposed infrastructure and drainage plans on both sites, and on the Chullora site waste reception and handling areas;
- Details of the baseline sampling program to be adopted on the treatment site; and
- Details of the post-treatment sampling program and the criteria to be met at the completion of off-site treatment works.

6.3 Pre-Remediation Approvals

A review of the likely scope of remediation works has been completed. The approvals identified as most likely being required include:

- Development consent as an integrated development under the *Environmental Planning and Assessment Act 1979* from City of Sydney Council prior to commencement of any demolition or excavated works associated with the remediation of the site. The works will be classified as a Category 1 remediation works under SEPP 55 'Remediation of Land';

- Should source removal during remediation require dewatering of the major water bearing zone underlying the site, then a Construction Dewatering Permit under the *Water Act 1912* will be required;
- Approval to discharge treated groundwater generated as part of the remediation works. For discharge to sewer, a Trade Waste Agreement must be entered into with Sydney Water. For discharge into stormwater approval will be required from City of Sydney Council. Approval may also be required for the reuse of treated groundwater on the site;
- An Environment Protection Licence from NSW EPA under the *Protection of the Environment Operations Act 1997* may be required where untreated soil is to be transferred off site for treatment;
- Should the stabilisation method adopted deviate from the specification provided in IA 2005/14, then a Specific Immobilisation approval will be required from the NSW DECCW as per NSW DECC (2008). It is likely that correspondence from the proposed landfill disposal location will be required confirming that the premises are licensed to receive immobilised material;
- If it is intended that material treated at Chullora is to be returned to site as treated material, then licensing by NSW EPA under the *Protection of the Environment Operations Act 1997* will be required*;*
- Where a substantial quantity of materials require removal from the site generating significant vehicle movements then approval may be required under SEPP11 'Traffic Generating Developments'; and
- WorkCover NSW must be provided with notification seven days prior to any demolition works, or asbestos removal works.

7 Site Establishment and Configuration of Operations

Limits on the area available for remediation on the Macdonaldtown site and available for treatment works on the Chullora site are likely to determine the configuration of works undertaken.

7.1 Macdonaldtown

Based on the remedial strategy summarised in **Flowchart 4.1**, a summary of the proposed scope of works on the Macdonaldtown site is presented in **Table 7.1**. **Figures 6** to **9**, nominate the anticipated remediation areas/depths and likely locations for the associated infrastructure.

Table 7.1: Summary of Remediation Works

Stage	Task	Comments
Preliminary	Project planning and licensing	-
Site Establishment I	Setup of site offices, sediment and erosion controls	-
Remediation Stage I	1A – assessment/soil sampling of northern boundary retaining wall 1B- construction of internal turning circle, vegetation removal	Blue area forming the northern boundary of the site as shown on **Figure 5** (does not include fill material within the former Northern gasholder)
	1C – excavation/validation of the top 0.5m of fill material of the entire site surface. Transfer of excavated soil to Chullora for treatment prior to disposal to landfill	Yellow areas on **Figure 5** (ash & coke gravel fill) do not have a malodorous potential. These soils will be excavated by standard excavation practice to typical depth of 0.5m. Consideration may be given to supplementary sampling through this layer prior to excavation, for comparison to remediation acceptance criteria as defined in the RAP (CH2M Hill 2007)
	1D – excavation/validation of hotspots to depths of 1-2m	Hot-spot 'A' at north-east portion of the site (**Figure 5**) in proximity of former sample location BH14; Benzene impact. Hot-spot 'B' at eastern portion of the site (**Figure 5**) in proximity of former sample location TP16; Free tar impact. Hot-spot 'C' at eastern portion of the site (**Figure 5**) in proximity of former sample location MW04 (**Figure 3**); Benzene impact. Hot-spot 'D' at south-western portion of the site (**Figure 5**) in proximity of former sample location MW13; Ash and coke impacts Excavation/validation of any other hotpot locations identified during the preceding stages
Site Establishment II	Installation of temporary enclosure, associated air extraction/treatment system and water treatment system	Proposed locations shown on **Figure 7**.
Remediation Stage II	2A- commission air and water treatment system	-
	2B – excavate/validate areas within enclosure. Transfer of excavated soil to Chullora for treatment prior to disposal to landfill	Pink and orange areas on **Figure 5** as present within the boundaries of the enclosure
	2C – reinstate enclosure excavation with imported material certified as suitable for the proposed land use and compliant with the	-

Stage	Task	Comments
	relevant legislation	
Remediation Stage III	3A – excavate/validate areas external to the enclosure. Excavated material unsuited for onsite bioremediation within enclosure to be transferred to Chullora for treatment prior to disposal to landfill	Orange areas on **Figure 5** as present external to the boundaries of the enclosure During completion of Task 3A the water treatment may require location based on the extent of chase out excavation required.
	3B –Material assessed as suitable for remediation by bioremediation to be stockpiled for treatment within enclosure	Stockpiles of material awaiting bioremediation within the enclosure will be placed in the areas designated for soil stockpiling as shown on **Figure 5** and be maintained in accordance with the EMP for the works (JBS 2011c)
	3C – reinstatement of site using imported material certified as suitable for the proposed land use and compliant with the relevant legislation	-
Disestablishment	Decommissioning of air and water treatment plants, disestablishment of enclosure and site offices	-

A program of controls for odours, gas and dust emissions from the Site and routine monitoring has been designed to mitigate the impact of the proposed works on the surrounding community and environment. Full details of the required management controls and monitoring program are provided in '*Environmental Management Plan, Demolition and Remediation, Former Macdonaldtown Gasworks, Burren Street, Erskineville, NSW*', (JBS 2011c).

The major control to be adopted is for excavation of primary source zones to be completed within an enclosed area. Use of an enclosed area was a recommendation of the Air Quality Impact Assessment (JBS 2011a) required for the control of odour and gas emissions from heavily impacted areas. **Figure 7** shows the likely position of the enclosure. The enclosure shall be a purpose built metal clad or fabric structure sufficiently sized to allow the internal operation of tippers, excavators and associated equipment as required for the stockpiling and handling of soils and any associated equipment. Openings in the enclosure shall be minimised so as to reduce potential for uncontrolled releases. A temporary purpose-built enclosure has been nominated rather than a more permanent engineered constructed building given the:

- need for remediation to occur in a large purpose built structure which can optimise use of space without limiting remediation works or requiring substantial pre-construction design and site preparation or post-remediation demolition and waste;
- need to minimise disruption to the normal operations of the adjacent Macdonaldtown Stabling Yards; and
- post-remediation concept plan for the site is for open space land absent of any new buildings.

It is anticipated that a purpose built temporary enclosure operated under negative pressure conditions that is demonstrated effective through routine monitoring (in accordance with JBS 2011c) will provide control equal to that of an engineered building.

The recommendations provided in '*Air Quality Assessment, Remediation of Former Macdonaldtown Gasworks*', Revision F, Reference 40913- 15136, (JBS 2011a) require that the temporary enclosure be maintained under a constant negative pressure during working

hours. To this end it will be necessary for the enclosure to be fitted with an emissions control system that will allow for controlled extraction and treatment of air.

The emissions control system will comprise two main elements:

- The collection system - which must be capable of maintaining adequate ventilation rates throughout the enclosure under negative pressure conditions. With the exception of fugitive emission that may occur when the enclosure entry points are momentarily opened and closed, the collection system must be capable of extracting emissions out of the enclosure through one central and controlled point; and
- The treatment system – external to the enclosure and must be capable of receiving and treating air extracted from within the enclosure. The treatment system should utilise granular activated carbon (GAC) filter(s) with appropriate sizing to remove potentially malodorous or harmful constituents. **Figure 7** shows the likely location of the air treatment system.

Any bioremediation proposed as part of the remediation program is to be conducted within the temporary enclosure. Spreading, turning and stockpiling of soil undergoing bioremediation within the zone of influence of the emissions control system will mitigate the potential for offensive odours to migrate beyond the boundaries of the Site. Construction of windrows or biopiles of soil for bioremediation will need to be appropriately sized as per the dimensions of the enclosure. It is proposed that bioremediation occurs after the completion of excavation works within the enclosure, therefore consideration should be given to changes in the air treatment system that may be required to accommodate likely increases in emission and particulate loading rates. In the event that increased loading rates are expected during bioremediation, re-commissioning of the air treatment system will be required. Design of the emissions control system should ensure an efficiency capable of meeting OH&S requirements for air quality within the enclosure, and/or specify requirement for personal protective equipment (PPE) requirements for the exposed workforce. Any requirements for PPE within the tent will need to be included in the RHSMP, as detailed in **Section 6.2.1**.

Based on the available dataset it is not anticipated that free tar will be encountered external to the temporary enclosure. However as a precaution, a contingency has been included in JBS (2011c) for such an occurrence and requires that the following is completed prior to the disturbance of free tar impacts external to the enclosure:

- Works in the area cease until the Remediation Consultant has determined the appropriate controls for that location, including OH& considerations for the remediation workforce;
- The free tar material remains securely covered for the duration between the first encounter with the material and the remedial excavation works. Plastic sheeting, soil, steel plates or other appropriate cover may be used for this purpose;
- Wherever possible any sampling required to characterise the free tar and adjacent material should be undertaken prior to the commencement of remedial excavations for the free tar. Appropriate disposal locations should also be confirmed prior to commencement; and
- Where free tar is encountered external to the temporary enclosure the material will need to be excavated and transported to a licensed landfill for treatment or disposal.

JBS (2011c) notes that the controls required are likely to be specific to the occurrence of the free tar, however lists the following as possible contingency actions:

- Temporary windscreens installed around the perimeter of the free tar area prior to remediation, in conjunction with wetting of the exposed surfaces during remediation; or
- Delineation of the area, relocation (and operation) of the enclosure over each occurrence, as required, once all remediation works inside the original footprint have been completed to the extent practicable.

Additionally these contingencies may also require execution in those areas within the enclosure footprint where the excavation cannot be safely extended to the point of successful validation without impacting the stability of the enclosure. This includes where the excavation begins to impinge upon allowable batter slopes, as summarised in **Section 3.6**, or past the line of temporary shoring.

Any additional infrastructure on the treatment site required by the contractor to meet the conditions of the RAP (CH2M Hill 2007), the REMP (JBS 2011c) and this Remedial Strategy document will need to be documented in the RWP to be prepared as per **Section 6.2.3**.

7.2 Chullora

A summary of the proposed scope of works on the Chullora site is presented in **Table 7.2** including likely plant required. **Figure 10** nominates the anticipated site setup.

Table 7.2: Summary of Treatment Works

Stage	Task	Comments
Preliminary	Project planning and licensing	-
Site Establishment	Conduct baseline environmental assessment of treatment site	-
	Setup of site offices, sediment and erosion controls	-
	Installation of temporary enclosure and associated air extraction/treatment system. Installation of cement stabilisation plant within the enclosure	Proposed locations shown on **Figure 10**.
Treatment	A- commission air and water treatment system B – receive materials for treatment. Onsite stockpiling until minimum treatment volume achieved	- Proposed areas for stockpiling of shown on **Figure 10** and soils in this area to be maintained in accordance with the EMP for the works (JBS 2011c)
	C – once minimum volume achieved treatment/validation of soils by cement stabilisation within the enclosure	Treated soil is to remain within the enclosure for the duration of the curing period and until validation results confirm successful stabilisation has occurred.
	D- stockpiling of treated/validated soil external to enclosure until removal off-site is possible	Any treated material removed from site to be transferred directly to a an appropriately licenced landfill for disposal. Proposed areas for stockpiling of shown on **Figure 10** and soils awaiting transfer in this area to be maintained in accordance with the EMP for the works (JBS 2011c)
Disestablishment	Decommissioning of air treatment plants, disestablishment of enclosure and site offices	-
	Conduct post works environmental assessment of treatment area	-

A program of controls for odours, gas and dust emissions from the Site and routine monitoring has been designed to mitigate the impact of the proposed works on the surrounding community and environment. Full details of the required management controls and monitoring program are provided in the EMP (JBS 2011c).

The major control to be adopted is for the treatment of impacted soil to be undertaken within an enclosed area, including storage of treated soil over the curing period. Use of an enclosed area was a recommendation of the Air Quality Impact Assessment (JBS 2011b) required for the control of odour and gas emissions from the cement stabilisation process. **Figure 10** shows the likely position of the enclosure. The enclosure shall be a purpose-built metal clad or fabric structure sufficiently sized to allow the internal operation of tippers, excavators and associated equipment as required for the stockpiling and handling of soils and any associated equipment. Openings in the enclosure shall be minimised so as to reduce potential for uncontrolled releases. A temporary purpose-built enclosure has been nominated rather than a more permanent engineered constructed building given the:

- need for treatment to occur in a large purpose built structure which can optimise use of space without limiting remediation works or requiring substantial pre-construction design and site preparation or post-remediation demolition and waste;
- need to minimise disruption to the normal operations of the adjacent Chullora Rail Yards; and
- need for the area to be restored to its original condition on completion of the treatment program.

The recommendations provided in (JBS 2011b) require that the temporary enclosure be maintained under a constant negative pressure during working hours. To this end it will be necessary for the enclosure to be fitted with an emissions control system that will allow for controlled extraction and treatment of air. The emissions control system will need to comprise a collection system and treatment system consistent with that required on the Macdonaldtown site as described in **Section 7.1**.

It is anticipated that a purpose built temporary enclosure operated under negative pressure conditions and one that is demonstrated through routine monitoring (in accordance with JBS 2011c) will provide effective control equal to that of an engineered building.

Table 7.3: Summary of Treatment Works

Stage	Description of Works	Major Equipment
-	Receipt, Stockpiling, Treatment and Disposal of Soil	Pug Mill – size to be determined 20T excavators – external to enclosure 20T excavator – internal to enclosure Air treatment system, including: - Diesel generator - Extraction Fan (2 x 1.5m diameter) - Granular activated carbon filter Semi trailers arriving and departing from site Water Truck Tipper trucks

Any additional infrastructure on the treatment site required by the contractor to meet the conditions of the RAP (CH2M Hill 2007), the REMP (JBS 2011c) and this Remedial Strategy document will need to be documented in the RWP to be prepared as per **Section 6.2.3**.

8 Pre-Treatment Requirements

Table 8.1 provides additional detail on the requirements of the various elements of the revised remedial strategy and identifies the following pre-treatment works potentially required for the remediation of site:

- Pre-treatment of tar sludge for off-site disposal by either heating or inclusion of additives such as fly ash to improve handling;
- Extraction of tar contents from gasworks pipes manually or by other methods such as using heat or chemicals;
- Lowering moisture content, crushing and/or homogenisation of fill, soil and shale impacted by free tar or displaying other tar impacts;
- Segregation of oversized materials in demolition waste and fill obtained from existing retaining walls and in the vicinity of hotspots at BH14, MW13S and MW04S;
- Removal of impacted water in below ground infrastructure on the site (Northern and Southern Gasholders, tar wells etc) and as required in areas to be excavated.

8.1 Tar Wells and Northern Gasholder

Tar sludge present in the tar wells and Northern Gasholder will most likely be removed from site by specialised vacuum trucks licensed to transport liquid waste. Under these circumstances the tar sludge may be treated *in situ* to improve handling and be pumped directly into the vacuum trucks without the need for a separate above ground treatment area. The heating or requirement for additives to enable pump out of tar sludge will be dependent on several site specific conditions at the time of remediation including volume and depth of tar sludge, proportion of soil or other inclusions, size and power of pump utilised and capability of the disposal truck to maintain the handling properties of the sludge during transport. The Contractor will be responsible for ensuring that OH&S, environmental and/or planning controls are adequately addressed for the proposed tasks.

Extraction of tar contents from gasworks pipes may be undertaken as follows:

- Where the pipes require preservation, then treatment in the form of heating or additives to mobilise and extract the contents; or
- Where the pipes need not be preserved, and assuming proper soil and water controls are in place, then it may be possible to sever the pipes into smaller sections for manual extraction of the contents.

The Contractor will be responsible for ensuring that OH&S, environmental and/or planning controls are adequately addressed for the proposed task.

8.2 Free Tar and Impacted Fill

Pre-treatment works on free tar and tar impacted fill, on either site, will need to be undertaken in a contained area to prevent the uncontrolled spread of contamination and release of vapours. As a minimum sediment and erosion controls should be provided to achieve this end. Additionally where the disturbance of tar sludge occurs outside the tented enclosure (as discussed below and in **Section 3.7**), management controls will also be required to prevent unacceptable releases of contaminants in air or odour. This may include capture of emissions and treatment if necessary.

Pre-treatment of free tar and tar impacted fill soil and bedrock may require lowering the moisture content of the material, crushing the excavated material and/or homogenisation

to enable stabilisation. The pre-treatment works are capable of completion using conventional earthmoving equipment such as excavators and backhoe loaders.

The following applies to any pre-treatment works required on materials excavated from the Northern Gasholder and tar wells further north, and all other coal tar impacted areas, (as described in the Air Quality Assessment completed for the works, JBS 2010a):

- Pre-treatment works undertaken on the Macdonaldtown site on free tar and tar impacted soils will need to be enclosed to prevent unacceptable odour impacts beyond the boundary of the site;
- Pre-treatment works undertaken within the boundaries of the designated treatment area within the Chullora Railway workshops, must ensure that no more than 150m^2 of coal tar impacted soil is uncovered at any one time. The restriction of exposed surface area of soil on the Chullora treatment site is required in order to prevent unacceptable odour impacts on the surrounding area in accordance with the Air Quality Assessment for the Chullora treatment site (JBS 2010b); and
- The clay content of soil successfully remediated through cement stabilisation generally lies between 60 and 80 % by mass. One of the three soil samples tested in the recent benchscale stabilisation trial contained a clay content of 87%, and when treated with 5, 12.5 and 20 % cement, failed to achieve the required compressive strength specified in IA 2005/14 (NSW EPA 2005) for cement stabilisation. Based on the results of the benchscale trial, it is considered that the materials containing a clay content greater than 80% are likely to occur in natural soil layers encountered at depth. Therefore it may be necessary to obtain a specific immobilisation approval from DECCW for cement stabilisation to allow a lower UCS value to be adopted for the process. Alternately some of the material capable of being treated may require homogenisation prior to treatment. Any material used in the homogenisation process to achieve the required composition in the material for treatment must be derived from the Macdonaldtown site.

Segregation of oversized particles will be required on those materials to be treated by cement stabilisation or bioremediation, and is generally completed through mechanical screening. However, consideration should be given to optimising any segregation works to minimise the amount of handling required of the coal tar impacted material prior to treatment. Consideration should be given to:

- The OH&S and PPE requirements for mechanical screening of fill potentially containing asbestos;
- Management of odour impacts;
- Off –site disposal requirements of the segregated oversized particles, which may not be suitable for disposal as building and demolition waste in accordance with DECC (2008) if impacted by free tar or other contaminants post sorting. Segregated oversized materials that as assessed as ‘impacted’ may require a waste classification for off site disposal.
- The attachment of high speed shredders on the screening plant, given that much of the fill and residual soil underlying the site is predominantly clay. The high speed shredder would be faster than a conventional shaker screen under these conditions and would simultaneously cause the break up of clay clumps in the screened material.

Requirements of the pre-treatment of impacted water from within the northern gas holder and tar wells is discussed in **Section 8.**

Table 8.1: Revised Remedial Strategy - Requirements of Pre – Treatment and Primary Treatment

Site Area	Material Type	Extent of Impact	Expected Quantity (m^3)	Remediation Method	Pre-treatment Requirements		Primary Treatment Requirements	
					Possible Pre-treatment Required	Waste Classification (subsequent to pre-treatment if required)	Primary Treatment Options	Anticipated Waste Classification Subsequent to Treatment / Immobilisation Approval
Northern gasholder	Tar Sludge	Contained within Base of Gasholder	320	Liquid Waste Disposal	Potential pre-treatment to improve handling – heating or use of additive such as fly ash	Hazardous Waste (Liquid)	-	-
	Impacted Water	Contained within Gasholder	640	Liquid Waste Disposal, disposal to sewer or on site reuse	Extraction from gasholder	Liquid Waste	Pass through on site water treatment plant	Suitable for disposal to sewer or on site beneficial reuse
	Soil / fill impacted by free tar	Base annulus and proximate soils (within pink shaded area on Figure 4 to a depth of 8m-10m)	2100	Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Potential options to improve handling if required - lowering moisture content, breakdown clay clods to expose higher surface area	Hazardous	Stabilisation or bioremediation treatment– Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste (may also be assessed for suitability for on site reuse)
	Demolition Waste	Buried inside Gasholder annulus (blue shaded area on Figure 4)	1900	Landfill disposal or Recycling	-	Special Waste (asbestos)	Segregation of free tar, asbestos containing materials and oversize particles	Hazardous Waste (free tar) Special Waste (asbestos) General Solid Waste (Non-Putrescible)
Retort and Surrounding Former Gasworks Source Areas	Shallow Tar Impacted Soil and Fill	Lateral extent of orange shaded area on Figure 4 to a depth of at least 4m	9225	Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Physical amendment to break down material with high clay content (*i.e.* lowering moisture content, breakdown clay clods to expose higher surface area) Likely alternative site for pre-treatment and remedial treatment	Hazardous or Restricted Solid Waste	Stabilisation or bioremediation treatment Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste (may also be assessed for suitability for on site reuse)
	Deep Tar Impacted Natural Soil	Lateral extent of pink shaded area on Figure 4 in the vicinity of boreholes BHE and BHF to a depth of 8m-10m	2375			Hazardous or Restricted Solid Waste		Restricted Solid Waste or General Solid Waste (may also be assessed for suitability for on site reuse)
	Tar Impacted Contamination hotspot at TP16 location	Lateral extent of green shaded area on Figure 4 to a depth of 1 m-2 m	115			Hazardous or Restricted Solid Waste		Restricted Solid Waste or General Solid Waste (may also be assessed for suitability for on site reuse)
Existing Site Surfaces	Ash/ Coke Fill	Lateral extent of shaded area on Figure 4 to a depth of at least 0.5 m	2950	Stabilisation or bioremediation treatment for onsite reuse or landfill disposal. Application of NSW DEC Immobilisation approval (Approval #1999/05)	Potential options to improve handling if required - lowering moisture content, breakdown clay clods to expose higher surface area	Hazardous	Stabilisation or bioremediation treatment Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste (may also be assessed for suitability for on site reuse)
Retaining Wall	General Fill and demolition waste	Entire Northern boundary (shaded blue on Figure 4)	1765	Landfill disposal, Beneficial Reuse or Recycling	segregation of oversize materials	General Solid Waste	-	-
Contamination Hotspots	Impacted Fill at locations BH14, MW13s and MW04s	Lateral extent shown as green shaded area on Figure 4 to a depth of 1 m-2 m	340	Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	segregation of oversize materials	Hazardous	Stabilisation or bioremediation treatment Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste
Site Wide	Old Gasworks Pipes	Varied	Unknown	Separate landfill disposal of empty pipework and tar contents	Chemical or manual extraction of tar contents, steam, or other cleaning of pipe work	Hazardous (tar) and General Soil Waste Non-Putrescible (clean pipe sections)	-	-
Site Wide	Fill and natural soil materials	NA	Unknown	Beneficial reuse, or as required: Stabilisation or bioremediation treatment for onsite reuse or landfill disposal.	segregation of oversize materials	Hazardous	Stabilisation or bioremediation treatment Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste
Deep excavations proximal to source area	Residual tar sources – subsequent to source removal	Unknown	Unknown	Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Potential options to improve handling if required - grinding to expose higher surface area	Hazardous	Stabilisation or bioremediation treatment Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste

9 Considerations for the Water Treatment System

Based on observations recorded during previous testing on the site, excavation of fill material as part of the remediation program may encounter significant volumes of perched groundwater. A water treatment system (WTS) is proposed as part of the remediation strategy to process groundwater generated either during excavation, or pumped out of the fill prior to excavation. The objective of using the WTS would be to treat the collected groundwater to an acceptable level, such that it may be discharged to stormwater, to sewer or used in operation *e.g.* as wheel wash water or for dust suppression.

9.1 Rates of water requiring treatment

Test locations encountering significant seepage in testpits are summarised in **Table 9.1** and displayed on **Figure 11.** Flow velocities within the shallow groundwater were estimated in CH2M Hill (2007) to be between 6.2 and 13.7 m/year, determined through slug tests conducted in shallow groundwater wells on the site.

Table 9.1: Summary of Observed Seepage in Fill

Test Location	Termination Depth (m BGL)	Depth Extent of Fill (m BGL)	Fill description	Depth of Apparent seepage zone (m)
TPA (CH2M Hill Phase I & II ESA 2000)	2.0 (R)	0 - 2.0	0 - 1.5: FILL, Light brown medium grained sand with some gravel, loose unconsolidated moist. 1.5 - 2.0: FILL, Free tar product migrating out of bricks seams, some clay, plastic, wet, tarry type odour.	1.5 - 2.0
TPC (CH2M Hill Phase I & II ESA 2000)	1.6 (R)	0 - 1.6	0 - 1.6: FILL, Bricks, minor clay, sand, very wet, visible hydrocarbon sheen, hydrocarbon odour, tar visible on bricks. (BRICK WALL TP EASTERN SIDE)	0 - 1.6
TP03 (CH2M Hill 2006)	4	0 - 2.8	0- 0.3: FILL gravelly Sand, brown, dark brown, dark grey, ash and crushed sandstone, ballast, clinker, ash 0.3 - 1.5: FILL gravelly Clay, firm, medium plasticity, dry, orange and grey, fine to coarse gravel, subround to subangular, ballast, coke. Water ingres at 0.6m, fast 1.5 - 2.8: FILL clayey Silt (original surface?), low plasticity, dark grey, wet	0.6 - 2.8
TP06 (CH2M Hill 2006)	2.7	0 - 2.3	0 - 0.3: FILL gravelly Sand, ash, clinker and coke, gravel subround to angular, fine to coarse grained 0.3 - 0.5 FILL sandy Clay, light brown to orange, firm, low plasticity, some clinker 0.5 - 1.4: FILL (original surface?) clayey gravel, orange/brown, medium to coarse grained, sandstone, grey-black subangular clinker GROUNDWATER INGRES AT 0.6m 1.4 - 2.3: FILL clayey Silt (original surface?) dark grey/brown, wet	0.6 - 2.3
TP07 (CH2M Hill 2006)	2.2	0.2 - 1.7	0.2 - 0.5: FILL gravelly Sand, black to dark grey, dry, ash and coke, gravel fine to medium grained, of ash, coke, clinker 0.5 - 0.9: FILL clayey Sand, brown, slightly gravelly, wet, half bricks, gravel fine to coarse grained, subround to subangular, sandstone, shale 0.9 - 1.3: FILL gravelly Clay, grey and red mottles, very firm, subangular to subround sandstone and shale 1.3 - 1.7: FILL clayey Silt (original surface?), soft	0.5 - 0.9

TP10 (CH2M Hill 2006)	4.1	0 - 3.2	0 - 0.8: FILL gravelly Sand, dark brown, dark grey or black, of ash, coke, coal, gravel medium to coarse grained, angular to subangular of same material, presence of bricks, round cobbles 0.8 - 0.95: FILL single layer of red brick 0.95 - 1.25: FILL Sand, dry medium grained, yellow sand, massive concrete boulder at 1.1 m BGS 1.25 - 1.75: FILL gravelly Clay, orange with grey mottles, dry, medium to coarse grained, subangular to subround, of shale (WATER INGRESS at 1.7m) 1.75 - 2.25: FILL sandy Gravel, grey, wet, of shale 2.25 - 3.2: FILL possibly reworked natural material, orange with grey mottles, very firm, gravel medium to coarse grained, angular shale	1.75 - 2.25
TP11 (CH2M Hill 2006)	4	0 - 3.2	0 - 0.3: FILL gravelly Sand, brown, black, dry, ash and coke, rootlets in top 0.1 m 0.3 - 0.8: clayey Sand, yellow, orange, wet 0.8 - 3.2 FILL clayey Sand, interbeded with grey and red mottles, firm clay at 0.8 - 0.9 mBGS and 1.2 - 1.3 m BGS, reworked natural material	0.3 - 0.8
TP15 (CH2M Hill 2006)	4.1	0 - 2.5	0 - 0.3: FILL gravelly Sand, loose 0.3 - 1.7 FILL ash and gravel water and free tar at 1.1m bgs at brickwork footing 1.7 - 2.5 FILL sandy Clay (original surface?), brown to green, high plasticity	1.0 - 1.7
TP16 (CH2M Hill 2006)	3.8	0 - 1.5	0 - 0.2: FILL gravelly Sand, dark grey, black, dry, ash and coke 0.2 - 1.5: FILL gravelly Sand, orange and light brown, dry, with cobbles, sandstone GROUNDWATER INGRESS at 0.2 m	0.2 - ?

Results of recent pump testing by JBS, detailed in **Appendix A**, determined the hydraulic conductivities at MW37S and MW42S, to be between 5.09 x 10^{-6} m/s and 6.65 x 10^{-6} m/s.

Anticipated inflows along the north boundary of the site based on recent pump test results may be as high as between 300 m^3 per day and 400 m^3 per day at the commencement of excavation works, based on the following conservative assumptions:

- saturated fill is present between 1 and 6 m depth across the entire site;
- continuous hydraulic connectivity in groundwater present in fill across the site; and
- excavation of fill material would require pumping along the entire northern boundary of the site (approximately 140m in length).

The PSM (2010) Geotechnical Report provides no assessment on the impact of draining the perched water table on settlement on the site and surrounding properties. Based on the water bearing zones listing in **Table 9.1** it appears that the zones containing significant volumes of perched groundwater are restricted to layers of fill. As these layers are likely to be limited to the extent of the site, the volume of inflows are anticipated to reduce over time. In the event that no reduction of inflows occurs, the remediation works should consider the impacts of settlement on the site and surrounding area.

Additionally, surface water is likely to have accumulated in underground infrastructure associated with the former gasworks including the Southern Gasholder and Tar Wells. Estimates of likely volumes of impacted water contained in subsurface structures are estimated as follows:

- Northern Gasholder – 640 m^3 (CH2M Hill, 2007);
- Southern Gasholder – 1875 m^3 (based on a diameter of 20 m and assumed depth of 6 m, filled with water); and
- Tar Wells- 50 m^3 (conservative assumption allows for half of 100 m^3 of tar well contents, reported in CH2M Hill 2007, to be filled with impacted water).

Some allowance should also be made for impacted water contained in disused service trenches, pits and pipeworks that may remain *in-situ*.

9.2 Anticipated Influent Quality and Required Effluent Quality

Table 9.2 summarises the range of contaminant concentrations detected in groundwater sampled from the site. In viewing **Table 9.2** it should be noted that the majority of groundwater generated from remedial works at the site is likely to be derived from the fill layers, where contaminant concentrations were generally less than those detected in samples of groundwater collected from the underlying natural shale.

Table 9.2: Summary of Groundwater Contamination

	Criteria	Shallow Groundwater Concentrations			Deep Groundwater Concentrations		
Analyte	**ANZECC 2000**	**Range (µg/L)**	**Location of Maximum**	**Site Area**	**Range (µg/L)**	**Location of Maximum**	**Site Area**
Electrical Conductivity	200-300[1] (µS/cm)	442 - 2010 (µS/cm)	MW35S	Central northern	717 – 3820 (µS/cm)	MW03D	Central Southern
Cd	0.2	nd - 2.6	MW13s	Southwest	nd - 1.5	MW06d	Gasholders
Cr(total)	-	nd – 15	MW04s	South Central	nd - 7	MW04d	South Central
Cu	1.4	nd – 220	MW42s	Northeast	0.001 - 208	MW42d	Northeast
Pb	3.4	nd – 174	MW42s		nd - 140	MW03d	South Central
Ni	11	nd – 10	MW04s	South Central	nd - 92	MW36d	Offsite
Zn	8	0.033 - 1,570	MW13s	Southwest	0.015 - 869	MW42d	Northeast
Cyanide (total)	7	0.02 - 0.479	MW20s	Gasholders	nd - 14.9	MW03d	South Central
Benzene	950	nd – 704	MW07s		nd - 14,000	MW03d	
Toluene	-	nd – 117	MW07s		nd - 792	MW03d	
Ethylbenzene	-	nd - 213	MW07s		nd - 317	MW03d	
Total Xylenes	550 (o & p)	nd - 417	MW07s		nd - 5,010	MW03d	
Total PAHs	16 (naphthalene)	nd - 1,677 (naphthalene 1,460)	MW07s		nd - 4,208 (naphthalene 3,840)	MW07d	Gasholders

Note: 1 typical range of EC in NSW lowland rivers as provided in ANZECC 2000 Table 3.3.3

9.3 Required Effluent Quality

Table 9.3 summarises the acceptable concentrations for disposal to sewer under an Industrial 'Trade Waste' Agreement with Sydney Water as provided in the Sydney Water Brochure '*Industrial Customers – Acceptance Standards and Charging Rates for 2010-11*'. A copy of this brochure is provided as **Appendix D**. These criteria are likely to be the required performance criteria for any WTS used on site, noting that in providing approval for discharge into sewer Sydney Water may alter allowable concentrations based on the estimated rates and TDS concentrations. All notes associated with **Table 9.3** should also be considered in determining the requirements of the systems performance.

Discussions with City of Sydney (CoS) staff indicate that should it be necessary to discharge treated groundwater to stormwater, then an application must be made to CoS demonstrating that the water to be discharged:

- Is clear (i.e. turbidity of less than 20 NTU);
- Is free of visible suspended sediment (i.e. total suspended solids concentration less than 50 mg/L);
- Has no visible oil or grease film (i.e. oil and grease less than 10 mg/L);
- Has a pH value between 6.5 and 8.5; and

- Has been assessed to not adversely impact the visual character of the receiving water body i.e. concentrations of any other contaminants of concern occur at levels which do not represent a risk to the receiving water body (i.e. Alexandra Canal).

For treated groundwater to be reused on site *e.g.* as wheelwash water or for dust suppression, compliance with the criteria provided in **Table 9.3** should be sufficient. Consideration may also be given to the use of site specific values, or modified site specific values where appropriate. The current values for site specific leachability criteria are provided in the JBS letter '*Derivation of Site Specific Leachability Criteria – Former Macdonaldtown gasworks, Burren Street, Erskineville, NSW'* Reference JBS 40913-15501, provided as **Appendix B.**

A WTS was trialled on the site, with the methods and results documented in the JBS Letter Report '*Groundwater Treatment Trial, Former Macdonaldtown Gasworks*', dated 05 August 2010 Reference 40913 - 15534. A copy of this letter is included as **Appendix C**.

Overall it was noted that samples of the treatment system effluent were reported to contain very low concentrations of all contaminants of concern at the site. The average concentration of all WTS effluent samples is included in **Table 9.3**, and indicates that with the exception of arsenic, the concentrations in treated water samples complies with the relevant 'Trade Waste' acceptance criteria where available, noting, however, that the full suite of analytes listed in **Table 9.3** was beyond the scope of the trial. With respect to arsenic it was considered that used of an acid washed granular activated carbon (GAC) filter could result in arsenic concentrations within acceptable limits.

Notwithstanding this difference, it appears that the WTS used in the treatment trial could be scaled up for use in the remediation process to enable discharge of treated groundwater to sewer. While the specifics of the system to be used during the remediation program will require on site refinement based on the actual groundwater quality and quantity encountered, the details of the successfully implemented trial system are summarised in the following sections.

It is also noted that when applying for the trade waste agreement, justification should be provided for not undertaking analysis for the full suite of analytes listed in **Table 9.3**, rather a reduced testing suite should be recommended comprising the contaminants of concern at the site i.e. PAHs, heavy metals and water quality parameters and others as required based on the site historical groundwater data.

Table 9.3: Summary of WTS Performance Criteria (all concentrations in mg/L)

Contaminant	DISPOSAL TO SEWER – Trade Waste Acceptance Criteria[1,3,4,18]
Acetaldehyde	5
Acetone	400
Aluminium	100
Ammonia	100[5]
Arsenic	1
Barium	5
Biological Oxygen Demand (soluble)	100[17]
Boron	100
Bromine	5
Cadmium	1
Chlorinated Phenolics	0.05[8]
Chlorine	10
Chromium	3[9]
Cobalt	5
Copper	5
Cyanide	1[10]
Fluoride	20[6]
Formaldehyde	30
General pesticides (excludes OC and OP)	0.1[11]
Herbicides and defoliants	0.1
Iron	50
Lead	2
Lithium (Specified Systems only)	10[12]
Manganese	10
Mercaptans	1
Mercury	0.03
Methyl Ethyl Ketone	100
Molybdenum	100
Nickel	3
Organoarsenic compounds	0.1
pH	7 to 10
Petroleum Hydrocarbons (flammable)	10[20, 13,16]
Benzene	0.1[7]
Toluene	0.5
Ethylbenzene	1
Xylene	1
Phenolic Compounds	1[8]
Polynuclear aromatic hydrocarbons	5
Benzo(a)pyrene	-
Naphthalene	-
Phenanthrene	-
Anthracene	-
Fluoranthene	-
Propionaldehyde	5
Selenium (total)	5
Silver	5
Sulphide	5
Sulphite	50
Temperature	38°C
Thiosulphate	300
Tin	10
Total Dissolved Solids	500[14,18]
Uranium	10
Volatile halocarbons	1[15, 19]
Chloroform	0.1
Perchloroethylene	0.3
Trichloroethylene	0.1
Zinc	5

Notes: **BOLD** exceeds performance criteria

1 All concentrations in mg/L

2 LOR: limit of reporting

3 Sydney Water will introduce acceptance standards for a substance on a sub-system specific basis as determined by:

- how much the receiving system can transport and treat
- how corroded the sub-system is
- how sewage treatment products will be used.

4. Discrete oil, fat or grease must not be discharged.
5. Where ammonia is present with other nitrogenous compounds, the amount of nitrogen in the ammonia is deducted from the Total nitrogen as measured by Total Kjeldahl Nitrogen, before calculating the charge for nitrogen.
6. Fluoride, phosphorus and nitrogen limits don't apply where the customer's sewerage system is connected to a sewage treatment plant that discharges to the ocean.
7. Acceptance standards also apply to concentrations of ammonia, benzene, bromine, chlorine, cyanide, formaldehyde, petroleum hydrocarbons, sulphide and volatile halocarbons in discrete samples.
8. Sydney Water will determine acceptance standards for individual chlorinated phenolics on a catchment basis, following pollution reduction targets set by the DECCW NSW for the sewage treatment plant effluent. The concentration limit is a guide only and we may set lower limits for individual chlorinated phenolic compounds.
9. Sydney Water do not allow discharge from comfort air conditioning cooling towers and evaporative condensers using products containing hexavalent chromium (chromate) or organometallic algicides, if the blow down (or 'bleed-off') is connected to the sewer. Comfort cooling towers are defined as cooling towers dedicated to heating, ventilation, air-conditioning or refrigeration systems.
10. Cyanide is defined as labile cyanide amenable to alkaline chlorination. This includes free cyanide as well as those complex cyanides that are particularly dissociable, almost wholly, or in a large degree, and therefore potentially toxic in low concentrations.
11. Sydney Water will not consent to any discharge of organochlorine pesticides (including chlordane, dieldrin and heptachlor), or organophosphorus pesticides (including chlorpyrifos, diazinon and malathion) into the sewerage system.
12. The limit for lithium applies only to the Rouse Hill sewage catchment.
13. Where flammable and/or explosive substances may be present, the customer must demonstrate to us that there is no possibility of explosions or fires in the sewerage system. We will discuss limits and charges with individual customers, before a trade waste agreement is negotiated. The flammability of the discharge must never exceed five per cent of the Lower Explosive Limit (LEL) of hexane at 25 0C. In some cases a customer may be required to install an LEL meter.
14. Sydney Water will determine acceptance standards for total dissolved solids on a catchment-specific basis. A limit of 500 mg/L may apply to customers discharging to an inland sewage treatment plant or to a sewage treatment plant that is part of a designated reuse system. Acceptance standards will only apply to those customers discharging in excess of 100kg/d of total dissolved solids (TDS) or greater than one per cent of the total catchment TDS load (whichever is the lesser).
15. Analysis of volatile halocarbons must at a minimum include methylene chloride, chloroform, trichloroethylene and perchloroethylene.
16. This substance is made up of several substances including benzene, toluene, ethylbenzene, (m+p)-xylene and o-xylene.
17. As at 1 July 2010, the limit for soluble BOD applies only to the Smithfield sewage and SPS 67 catchments, due to corrosion.
18. This is a guide only. Exact allowable levels are determined on a system-specific basis.
19. Charges will apply for total volatile halocarbons
20. Charges will apply for total petroleum hydrocarbons (flammable)

9.4 Details of Trialled WTS

The following WTS was trialled on site:

- Equalization/storage – initial influent collection tanks to allow consistent loading to the WTP under variable conditions in the collection system and to optimize the size of the treatment system;
- Pre-treatment System – comprising an oil/water separator to remove any free oily materials prior to treatment;
- Filtration System comprising;
  - Bag filters – to remove particulate matter and to protect the downstream filtration processes;
  - Activated Carbon Filters – to remove dissolved organics and some inorganic components;
- Ancillary tanks, pumps, control and monitoring equipment.

A process flow diagram of the treatment system is presented in **Figure 11.**

Consideration should be given to the inclusion of influent tanks in the full scale system used for the remediation works given inflow rates from the fill layers are likely to vary across the site and over the duration of the works.

Influent into the system was restricted to 72 litres / min using a control valve. The flow rate adopted was equivalent to a contact time with the carbon filter of 8 minutes.

With the exception of arsenic, the effluent water generated by the system was generally compliant with ANZECC/ARMCANZ 2000 95% trigger values. The result of the trial indicated that arsenic concentrations increased following contact with the activated carbon filter. It was considered that this impact can readily be minimised by the selection of acid washed GAC filter for use in the operational WTP.

9.5 WTS Waste

A number of waste streams will be generated through use of a WTS and planning for the remediation works must consider the disposal requirements for these materials as follows.

- Free oil removed in the oil/water separator will require collection, most likely to be discharge to a 'drum' collection system. Any drums should be used and stored within a containment area to collect any spills. The collection system will be equipped with a level switch to advise the operator when the drums are full and require disposal, or systems shall be in place such that overflow of the drums does not occur;
- The filter bags in the sand bag filter system will have to be replaced and disposed of once the filters become filled with sediment. Testing of the filter bag was not conducted as part of the water treatment trial. It is possible that these filter bags are classified as a hazardous waste due to the presence of hydrocarbons and/or metals, and will require appropriate disposal to landfill; and
- The activated carbon filter media will become fully loaded over time and require disposal. The replacement frequency will depend on the contaminant load in the water for treatment. In adopting a sustainable approach to the works it is recommended that where possible the spent activated carbon media be returned to the supplier for regeneration, rather than disposal.

Appropriate disposal of wastes generated by the WTS may require sampling and analysis to determine the appropriate disposal location.

10 Considerations for Treatment of Contaminated Material

The revised remedial strategy for the site incorporates options for managing material containing exceedances of the acceptance criteria, including soil treatment by cement stabilisation (at Chullora) or bioremediation (on site).

One of two objectives exist for the inclusion of this option:

1. Treating coal tar contaminated material such that a reduced waste classification may be achieved for disposal off site to landfill, in accordance with NSW EPA '*General Immobilisation of Contaminants in Waste – Coal tar Contaminated Waste From Former Gasworks Sites*' approval number 2005/14 (IA 2005/14). Excavated material that requires off site disposal as Hazardous Waste will need to be treated in this manner. The Contractor may choose to similarly treat material that requires off site disposal as Restricted Solid Waste should their cost benefit analysis indicate worthwhile savings can be achieved in the project timeline or budget; or
2. Treating coal tar contaminated material such that it can be reused on site. This will require demonstration of the following for the material undergoing treatment by bioremediation on site – compliance with the site specific total concentrations (as provided in Table 4.1 of the RAP) AND the material does not pose a risk to groundwater migrating off-site and is compliant with the site specific leachability criteria for the site.

Figures 12, 13 and **14** provide an estimate of the areas suited to treatment by cement stabilisation or bioremediation. Each figure relates to a particular soil depth interval. The areas and values provided in **Figures 12** to **14** should be viewed as indicative only and have been based on an assessment of the available historical data, including borelogs describing the prevalence of free tar impacts in soil and fill. Actual conditions encountered during bulk excavation of the site may vary.

Furthermore the volume of material suited to each treatment option after excavation will be heavily influenced by the methods adopted and strict implementation of site controls to prevent cross contamination.

10.1 Treatment Using Cement Stabilisation (Chullora)

In the benchscale immobilisation trial conducted by JBS (**Appendix A**) the results indicated that two of the three materials tested were capable of achieving the required UCS value of 1 MPa (NSW EPA 2005) with a minimum addition of 12.5% cement. The other parameters tested in these materials also showed full compliance with the requirements of IA 2005/14, and under this order would be suitable for off site disposal to landfill as General Solid Waste. The third material failed to meet the required UCS value even with 20% cement addition, and was assessed to be not stabilised. The failure was assumed to be related to the clay content of this material, which was noted to be 87% and well above the general range of 60% to 80% material considered suitable for cement stabilisation. As all other parameters in the failed material showed full compliance with the requirements of IA 2005/14, the stabilisation issue may be overcome by using an increased ratio of cement in the treatment process provided the mixing ratio provided in IA2004/14 Condition 1.3 is note exceeded.

It is noted that bioremediation will not be applicable to all excavated source materials from the site. Bioremediation should only be undertaken on material impacted by volatile contaminants, i.e. areas of the site impacted with heavy metal contamination cannot be bioremediated. Additionally where excavated material requires remediation of PAHs the decision to bioremediate should consider the form of the contamination and proportion of individual compounds present, noting that:

- Bioremediation of material impacted by free tar is unlikely to be practicable; and
- Bioremediation is applicable to material impacted with lighter end PAHs such as naphthalene, while bioremediation of the heavy end PAHs may not at all be possible in a reasonable timeframe or may require the application of additives for breakdown.

The effectiveness of the bioremediation process will also be dependent on the layout of the bioremediation area and the frequency of turning adopted.

10.3 Off Site Treatment

Given the proximity of the Macdonaldtown site to residents, and likely space restrictions during excavation of contaminated soils, an alternate site has been identified by RailCorp for ex-situ treatment of soils. Approval is being sought for treatment to occur on an approximate 2 ha parcel of land contained within the RailCorp owned Chullora Railway Workshops, located on Worth Street, Chullora, NSW. A plan showing the likely maximum area to be made available for treatment works is provided as **Figure 15.** Material treated off site must be disposed to an appropriately licensed facility.

10.4 Storage Volume

Storage volumes for Macdonaldtown have not been estimated given the inherent variability in how remedial excavations may be staged.

The volume of material capable of being stored and or treated within the designated area at Chullora will depend on several project specific factors including the treatment method to be adopted, the area required for truck loading areas, plant and supplies, and the size of the allocated area for treatment.

To aid with planning for the site **Table 10.1** provides indicative estimates of volumes of material that can be handled on the Chullora site. Each process has been assessed individually *i.e.* volume of soil if all treatment area use for either storage, curing of stabilised material or bioremediation windrows. The values assume minimal area only is required for truck loading, supply and plant storage. The approximate volume of material treatable is likely to be easily estimated by determining what percentage of the site is to be used for each task.

Table 10..1 – Estimated Volume of Material Capable of being stored in Chullora Treatment Area

Process	Area Occupied	Indicative Volume capable of storage on site at one time	Comments/ Assumptions
Storage	0.5 ha[1]	8,250 m^3	Stockpile max 5 m high, 10m wide, in 5 rows running lengthwise across area
Treated Stabilised soil – layed out for curing period	0.5 ha[1]	2,500 m^3	Treated soil placed in 0.5m high blocks for curing
Soil in wind rows for bioremediation	0.5 ha[1]	1250 m^3 (storage on site at any one time) approximately 50 m^3 uncovered (i.e. being treated at any one	Soil for bioremediation place in 1 m high windrows in 8 rows running lengthwise across site. Assumes that the maximum number of rows that can be uncovered at any one time should be consistent with the requirements of the air quality