		time)	management plan that no more than 150 m^2 of material should be exposed to the atmosphere. A one metre length of one metre high windrow will contain approximately 0.5m^3 of soil and have an exposed surface area of 1.4m^3

Notes: 1 actual volumes will depend of dimensions of available area

10.5 Treatment Rates

Table 10.2 presents possible treatment rates achievable based on discussions with remediation contractors. It is noted that the rate at which material can be treated either on the Macdonaldtown or Chullora sites, will be entirely dependent the manner in which treatment is undertaken, including the method adopted, plant utilised and site configuration.

Table 10.2 – Indicative Estimated Treatment Rates

Process	Likely treatment rate	Comments/ Assumptions
Treatment by Cement Stabilisation	1000 T per day[1], can be streamlined to achieve up to 1400 T per day	Daily excavation rates are unlikely to match treatment of 1000 tonnes per day. Considerations should be given to either use of smaller mixing plants in line with excavation rates, or if large daily treatment volumes are planned whether sufficient space exists for pre-treatment stockpiling and post treatment curing
Treatment by bioremediation	500 m^3 per 3 weeks (average)[2,3]	Bioremediation may not be applicable to all contaminants requiring remediation

Notes: 1 achieved using semi-trailer sized mixing plant
2 assumes maximum volume possible stored on treated site, staggered such that all 500 m^3 is subject to daily exposure, with no more than 150m^2 uncovered at any one time.
3 treatment rates will vary if bioremediation to be completed within tented enclosure.

11 Considerations for Material Disposal

Table 8.1 includes summary of the range of materials likely to require management during the remediation program. Materials anticipated to be classed as Restricted Solid Waste or General Solid Waste will be suitable for direct disposal to appropriately licensed landfills.

As no landfills within NSW are currently licensed to dispose of Hazardous Waste, should these materials require off site disposal, the following will be required:

- treatment to achieve a lower Waste Classification prior to disposal (to a landfill licensed to receive treated material of that class of treated material); or
- delivery to an off-site facility licensed to store the material, prior to treatment for disposal to an appropriately licensed landfill.

The requirements of treatment and disposal to landfill are discussed in the Sections below.

11.1 Treatment Using Bioremediation

The objective of pre-treatment of materials classed as 'Hazardous Waste' by bioremediation would be to reduce the classification to Restricted Solid Waste or General Solid Waste. As the method should reduce contaminant mass, successful treatment should allow for unrestricted disposal of the material at an appropriately licensed landfill.

11.2 Treatment Using Cement Stabilisation

If material is to be pre-treated using cement stabilisation, the works will require completion in accordance with the DECC '*Immobilisation Technical Note 1 - Process Equipment for Treatment of Contaminated Soil and Sludge Waste*.' A copy of this document is provided in **Appendix E**.

If the material is to be disposed to landfill following cement stabilisation, disposal must be in accordance with the requirements of NSW EPA IA 2005/14, specifically that:

- The treated waste can only be disposed of at a landfill that has '*currently operating leachate management systems*' and which are licensed by DECCW to receive that particular class of waste;
- The landfill licence allows the site to receive '*waste subject to immobilisation approvals with this type of disposal restriction*';
- If the total concentration in the waste exceeds either the Specific Contaminant Concentration (SCC)2 or SCC3 values (Waste Classification Guidelines 2009), the landfill monitors leachate and groundwater for PAHs or B(a)P; and
- The landfill must be advised in writing that the material has been treated and classified in accordance with the requirements of IA #2005/14.

If material is to be treated by cement stabilisation for disposal to landfill in accordance with IA2005/14, all the requirements of this general immobilisation approval must be satisfied, including, but not limited to:

- Ensuring the proposed location of cement stabilisation is lawfully able to treat the waste, and in consultation with RailCorp, obtaining an permits or licences deemed necessary for the works;
- Providing notification to the DECCW of the intention to treat and dispose of material in accordance with IA2005/14 at least 28 days prior to the commencement of these works;
- Use of calcium or magnesium oxide based cement;
- Ratio of reagent to untreated waste must not exceed 2:1; and
- The UCS of the treated waste must be measured in accordance with NSW Roads and Traffic Authority (RTA) Test Method T131 of T116. The use of equivalent methods will require receipt of written approval from DECCW.

Furthermore if material is to be treated by cement stabilisation, the works will require completion in accordance with the DECC Immobilisation Technical Note 1 - *Process Equipment for Treatment of Contaminated Soil and Sludge Waste*. A copy of this document is provided as **Appendix E.**

It is noted that the conditions listed in IA 2005/14 preclude use of the approval on materials containing Total PAH concentrations in excess of 13 000 mg/kg or B(a)P concentrations in excess of 500 mg/kg. Review of historical site data indicates that the total concentrations in three samples analysed from the site exceeded these limits, specifically:

- free tar impacted clay at MG08/1.5 m (Total PAH 15 237 mg/kg);
- two pipe contents samples labelled as 'RP' and 'Service Pipe' and described as coal tar material sampled from a pipe (Total PAH of 20 890 mg/kg and 26 805.3 mg/kg);

The last two samples are likely to represent the concentrations in free tar present in residual underground infrastructure. This material is likely to be disposed off site as liquid waste (as described in **Section 8**), and is unlikely to require treatment for stabilisation.

The sample collected from MG08 represents clay material heavily impacted by free tar. Review of the borelog for this location indicates that the material sampled at 1.5 m was a thin band of impacted soil. When considered in isolation this thin band of soil is unsuitable for treatment by cement stabilisation, and may require transfer to a licensed off-site storage site (discussed further in **Section 11**). However, given that the great majority of all other soil samples analysed from the site contained total PAH concentrations less than half of the MG08/1.5 m concentration, it is considered unlikely that when this area is bulk excavated and handled during treatment that PAH concentrations consistently in excess of 13,000 mg/kg would be detected.

10.2 Treatment Using Bioremediation

No bioremediation trials were undertaken as part of the pre-remedial investigations. However bioremediation has been demonstrated as an effective remediation technology on former gasworks sites when used in conjunction with other technologies. Use of bioremediation wherever possible, as an auxiliary process in the proposed works, has the potential to realise significant cost savings and reductions in the volume of material disposed to landfill.

12 Indicative Program

The anticipated program for the remediation works is summarised in **Table 12.1.** The proposed program is based on the following assumptions:

- Excavation of 350 m^3 of soil on average per day from the site to the designated Chullora Treatment Area or directly to landfill over an initial three month period;
- Treatment of excavated soil as received, and for a further month after all remedial excavations completed at Macdonaldtown; and
- Site reinstatement occurring once validation of excavations completed, and continuing for a further three months after completion of treatment works.

The actual time required for completion will be dependent on the specifics of the remedial option adopted and time required for any additional administrative requirements specified by RailCorp.

Table 12.1 – Anticipated Program of Remediation Works

	Month Number																								
Stage	**1**	**2**	**3**	**4**	**5**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Pre-Remedial works[1]																										
Planning and site Establishment																										
Excavation of Contaminated soil (up to 23 000 m^3)																										
Validation of excavations, review of interim results by RailCorp + Site Auditor																										
Disposal to landfill of untreated material (estimate up to 5300 m3)																										
Treatment of soils by stabilization (assume up to 9800 m^3)																										
Treatment of soils by bioremediation (assume 50% of up to 5300 m^3)																										
Reinstatement to pre remediation levels[3]																										
Post remediation studies and monitoring[3]																										

Notes: 1 includes time for site preparation of project site specific management plans including occupation health and safety
2 includes all heritage surveys, vegetations management plans and structural surveys required
3 includes landscaping and revegetation, completion of validation reports and post remediation EMP for the site
4 duration of groundwater monitoring to be determined in the post remediation EMP for the site

13 Limitations

This report has been prepared for use by the client who commissioned the works in accordance with the project brief only and has been based in part on information obtained from other parties. The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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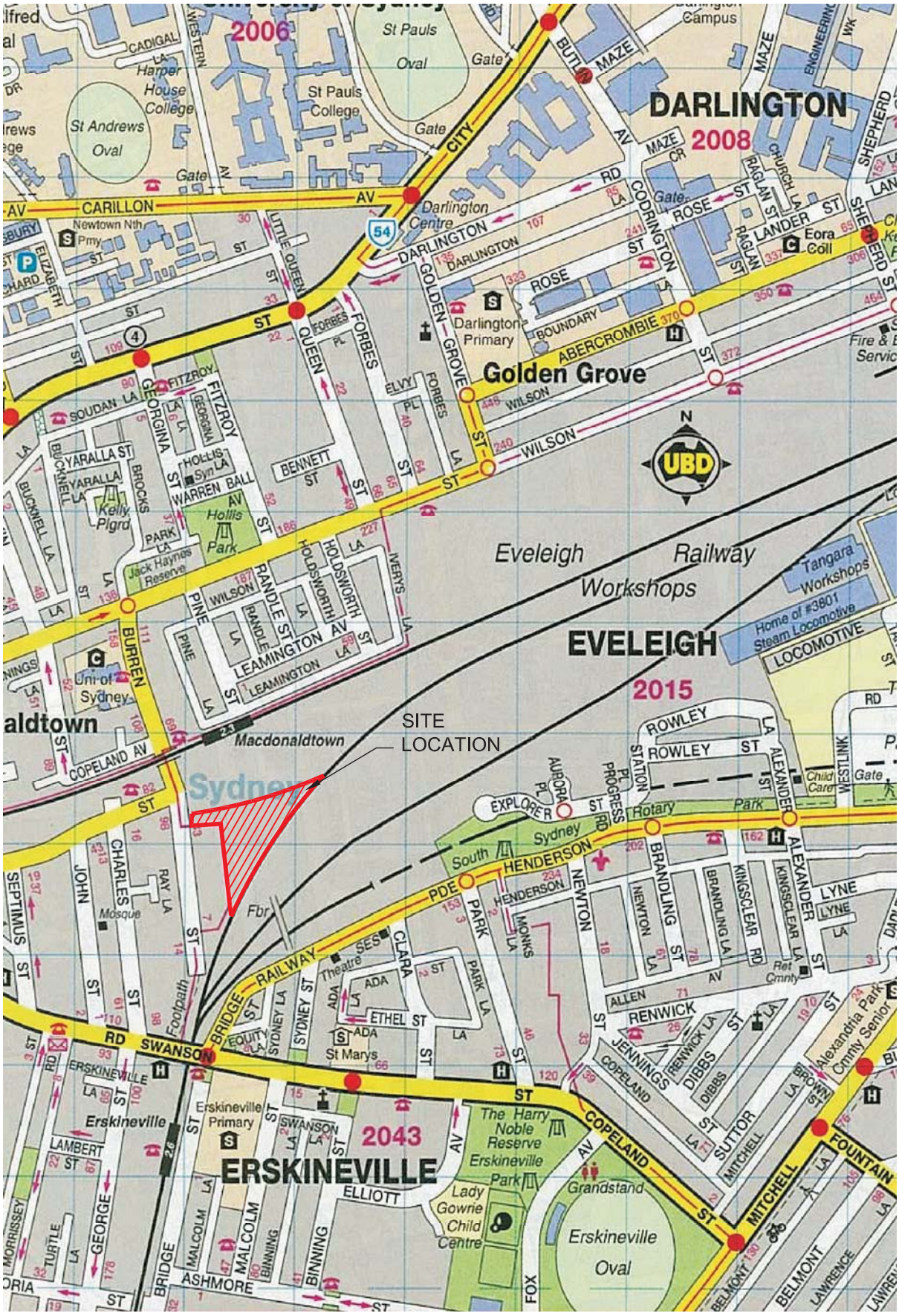
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements and site history, not on sampling and analysis of all media at all locations for all potential contaminants.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS Environmental Pty Ltd reserves the right to review the report in the context of the additional information.

Figures



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0 500m

Approximate scale

Figure 1 **Site Location (Macdonaldtown)**

CH2M Hill (2007)
Note- All locations shown are approximate only

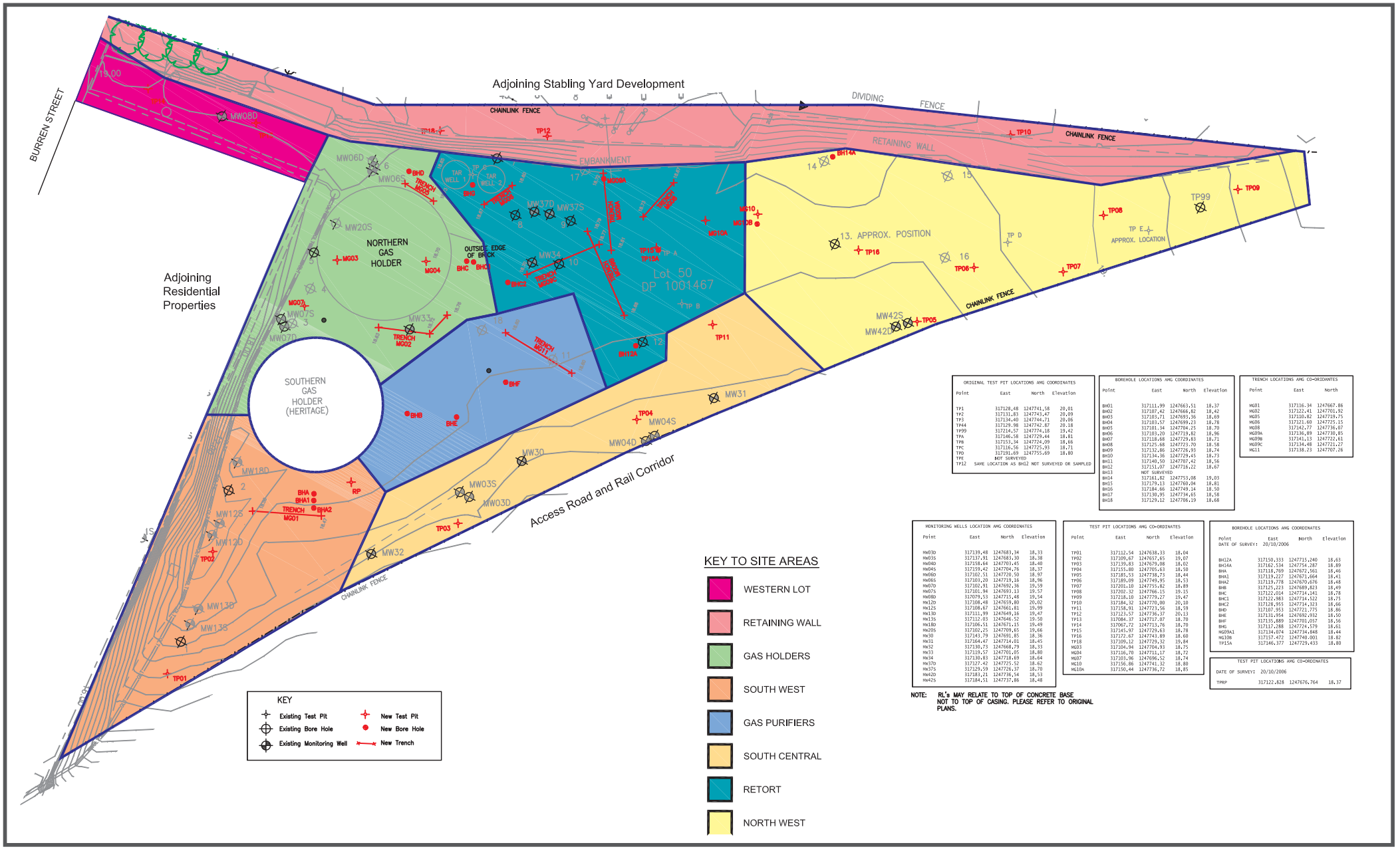
JBS ENVIRONMENTAL

0 100m

Approximate scale

Figure 2 **Current Macdonaldtown Site Plan**

CH2M Hill (2007)
Note- All locations shown are approximate only



ORIGINAL TEST PIT LOCATIONS AMG COORDINATES

Point	East	North	Elevation
TP1	317128.48	1247741.58	20.01
TP2	317131.83	1247743.47	20.09
TP3	317134.40	1247744.71	20.06
TP44	317129.98	1247742.87	20.18
TP99	317214.57	1247774.16	19.42
TP4	317146.58	1247729.44	18.81
TP8	317153.34	1247724.09	18.66
TPC	317116.56	1247725.93	18.71
TPD	317191.69	1247755.69	18.80
TPE	NOT SURVEYED		
TP12	SAME LOCATION AS BH12 NOT SURVEYED OR SAMPLED		

BOREHOLE LOCATIONS AMG COORDINATES

Point	East	North	Elevation
BH01	317111.99	1247663.51	18.37
BH02	317107.42	1247666.82	18.42
BH03	317103.71	1247693.36	18.69
BH04	317103.57	1247699.23	18.78
BH05	317101.34	1247704.25	18.70
BH06	317103.20	1247719.82	18.96
BH07	317118.68	1247729.83	18.71
BH08	317125.68	1247723.70	18.58
BH09	317132.86	1247726.93	18.74
BH10	317134.36	1247729.45	18.73
BH11	317140.50	1247707.42	18.56
BH12	317151.07	1247716.22	18.67
BH13	NOT SURVEYED		
BH14	317161.82	1247753.08	19.03
BH15	317179.13	1247760.04	18.81
BH16	317184.66	1247749.14	18.50
BH17	317130.95	1247734.65	18.58
BH18	317129.12	1247706.19	18.68

TRENCH LOCATIONS AMG CO-ORDINATES

Point	East	North
MG01	317116.34	1247667.86
MG02	317122.41	1247701.92
MG05	317110.82	1247719.75
MG06	317121.60	1247725.15
MG08	317142.77	1247736.07
MG09A	317136.89	1247730.85
MG09B	317141.13	1247722.61
MG09C	317134.48	1247721.27
MG11	317138.23	1247707.26

MONITORING WELLS LOCATION AMG COORDINATES

Point	East	North	Elevation
MW03D	317139.48	1247683.34	18.33
MW03S	317137.91	1247683.30	18.38
MW04D	317158.64	1247703.45	18.40
MW04S	317159.42	1247704.76	18.37
MW06D	317102.51	1247720.50	18.97
MW06S	317103.20	1247719.16	18.96
MW07D	317102.91	1247692.36	19.59
MW07S	317101.94	1247693.13	19.57
MW08D	317079.53	1247715.48	19.54
MW12D	317108.48	1247659.80	20.02
MW12S	317108.67	1247661.81	19.99
MW13D	317111.99	1247649.16	19.67
MW13S	317112.03	1247646.52	19.50
MW18D	317106.51	1247671.15	19.49
MW20S	317102.25	1247709.65	19.66
MW30	317143.79	1247691.85	18.36
MW31	317164.47	1247714.01	18.45
MW32	317130.73	1247668.79	18.33
MW33	317119.57	1247701.05	18.80
MW34	317130.83	1247718.69	18.64
MW37D	317127.42	1247725.52	18.62
MW37S	317129.59	1247726.37	18.70
MW42D	317183.21	1247736.54	18.53
MW42S	317184.51	1247737.86	18.48

TEST PIT LOCATIONS AMG CO-ORDINATES

Point	East	North	Elevation
TP01	317112.54	1247638.33	18.04
TP02	317109.67	1247657.65	19.07
TP03	317139.83	1247679.08	18.02
TP04	317155.80	1247705.63	18.50
TP05	317185.53	1247738.73	18.44
TP06	317189.09	1247749.95	18.53
TP07	317201.10	1247755.82	18.89
TP08	317202.32	1247766.15	19.15
TP09	317218.10	1247779.27	19.47
TP10	317184.32	1247770.00	20.10
TP11	317158.91	1247723.56	18.59
TP12	317123.57	1247736.37	20.13
TP13	317084.37	1247717.07	18.70
TP14	317067.72	1247713.76	18.70
TP15	317145.97	1247729.63	18.78
TP16	317172.67	1247743.89	18.60
TP18	317109.12	1247729.32	19.84
MG03	317104.94	1247704.93	18.75
MG04	317116.70	1247711.17	18.72
MG07	317103.96	1247696.52	18.74
MG10	317156.86	1247741.32	18.80
MG10A	317150.44	1247736.72	18.85

BOREHOLE LOCATIONS AMG COORDINATES

Point	East	North	Elevation
DATE OF SURVEY: 20/10/2006			
BH12A	317150.333	1247715.240	18.63
BH14A	317162.534	1247754.287	18.89
BHA	317118.769	1247672.161	18.46
BHA1	317119.227	1247671.664	18.41
BHA2	317119.778	1247670.676	18.48
BHB	317125.223	1247689.823	18.49
BHC	317122.014	1247714.141	18.78
BHC1	317122.983	1247714.522	18.75
BHC2	317128.955	1247714.323	18.66
BHD	317107.953	1247721.775	18.86
BHE	317131.954	1247692.932	18.50
BHF	317135.689	1247701.057	18.56
BHG	317117.288	1247724.579	18.61
MG09A1	317134.074	1247734.848	18.44
MG10B	317157.472	1247740.001	18.82
TP15A	317146.377	1247729.433	18.80

TEST PIT LOCATIONS AMG CO-ORDINATES

Point	East	North	Elevation
DATE OF SURVEY: 20/10/2006			
TPRP	317122.828	1247676.764	18.37

NOTE: RL's MAY RELATE TO TOP OF CONCRETE BASE NOT TO TOP OF CASING. PLEASE REFER TO ORIGINAL PLANS.

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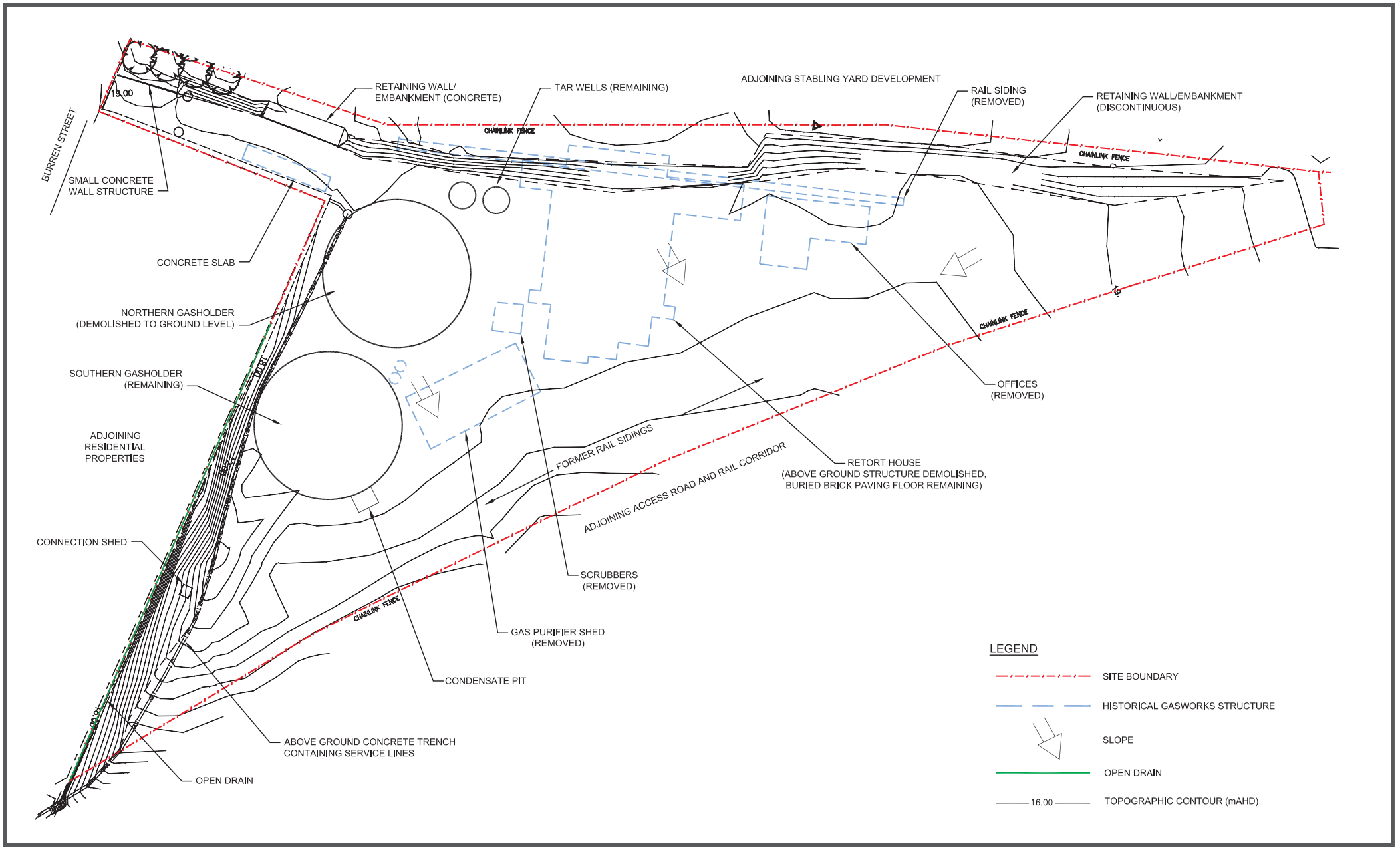
0 50m

Approximate scale

Figure 3 **Site Areas**

CH2M Hill (2007)
Note- All locations shown are approximate only



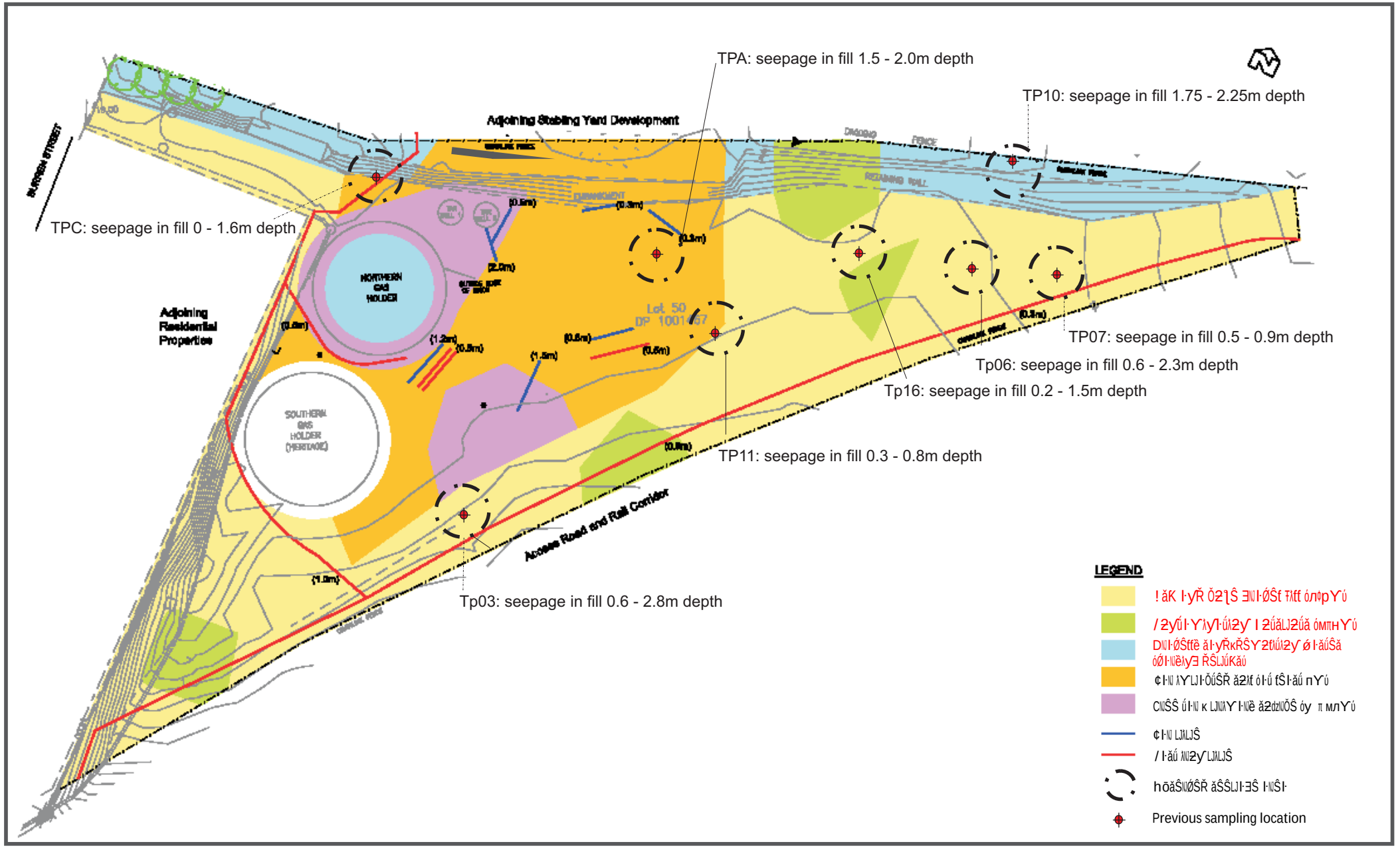
JBS ENVIRONMENTAL

0 50m

Approximate scale

Figure 4 **Location of Historical Gasworks Infrastructure**

CH2M Hill (2007)
Note- All locations shown are approximate only

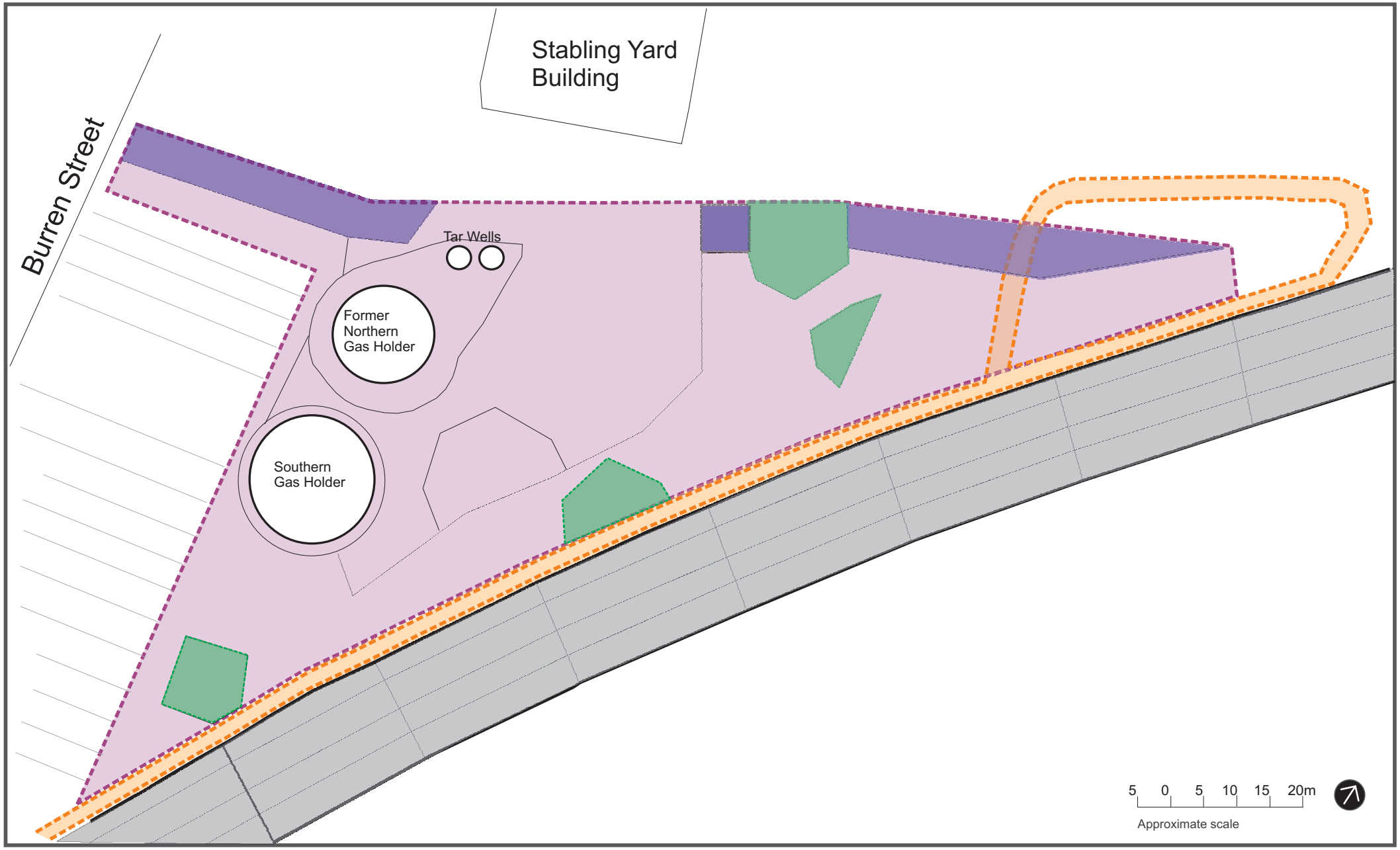


0 50m

Approximate scale

Figure 5 Remediation Areas and Locations of Observed Seepage

CH2M Hill (2007)
Note- All locations shown are approximate only



Site Boundary

Task 1A - assessment of blue area for suitability to remain on site

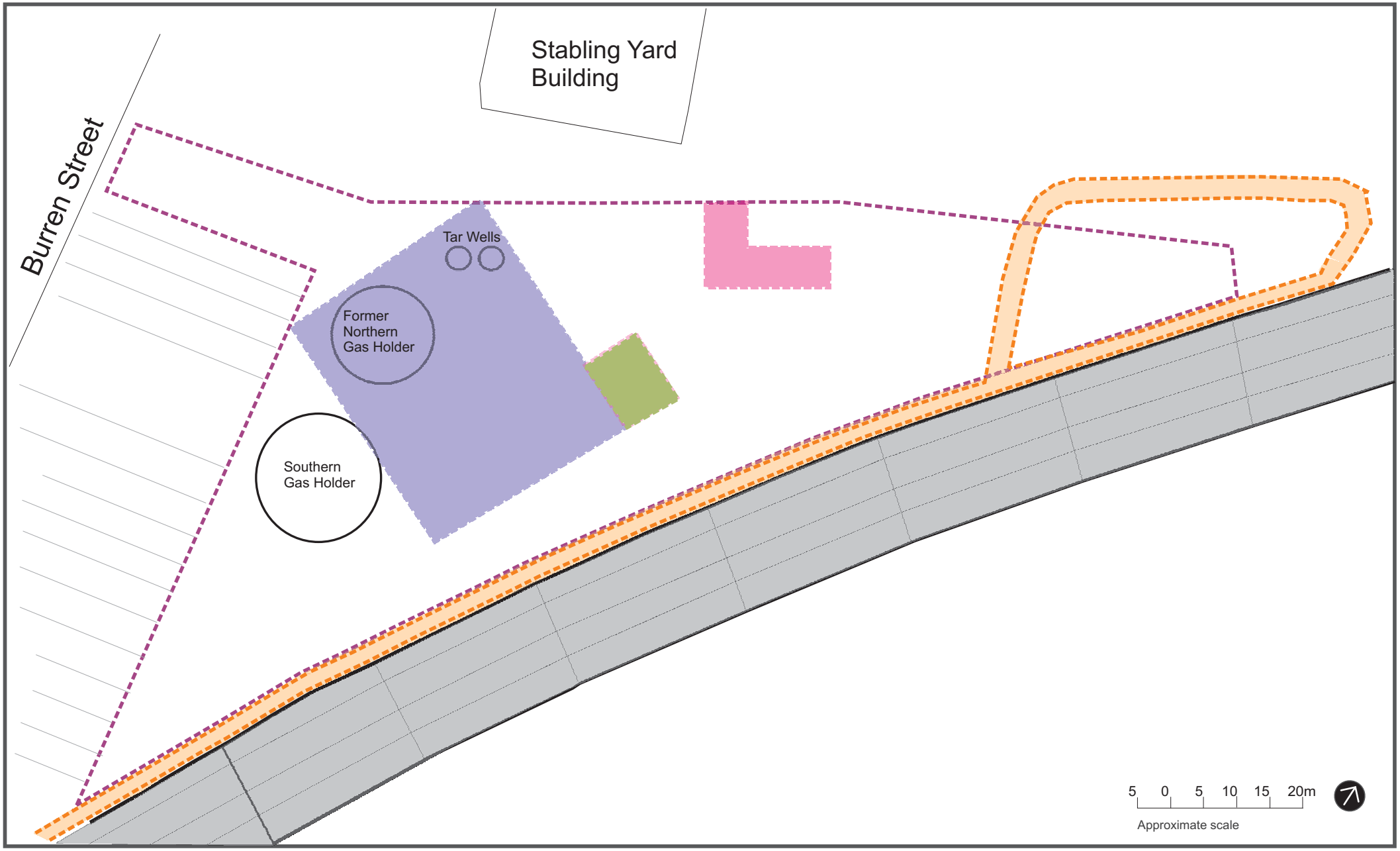
Task 1B - installation of access road turning circle

Task 1C - strip off top 0.5 of fill (for remediation by cement stabilisation)

Task 1D - Excavate and validate hotspots (for remediation by cement stabilisation)

Figure 6 **Former Macdonaldtown Gasworks - Remediation Stage One Works**

As adapted from Figure 4 CH2M Hill 2007



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- Site Boundary
- Temporary Enclosure
- Air Emissions Treatment System
- Water Treatment System
- Site Access Road
- Water Treatment System

Figure 7 **Macdonaldtown Remediation Proposed Site Setup**

As adapted from Figure 4 CH2M Hill 2007

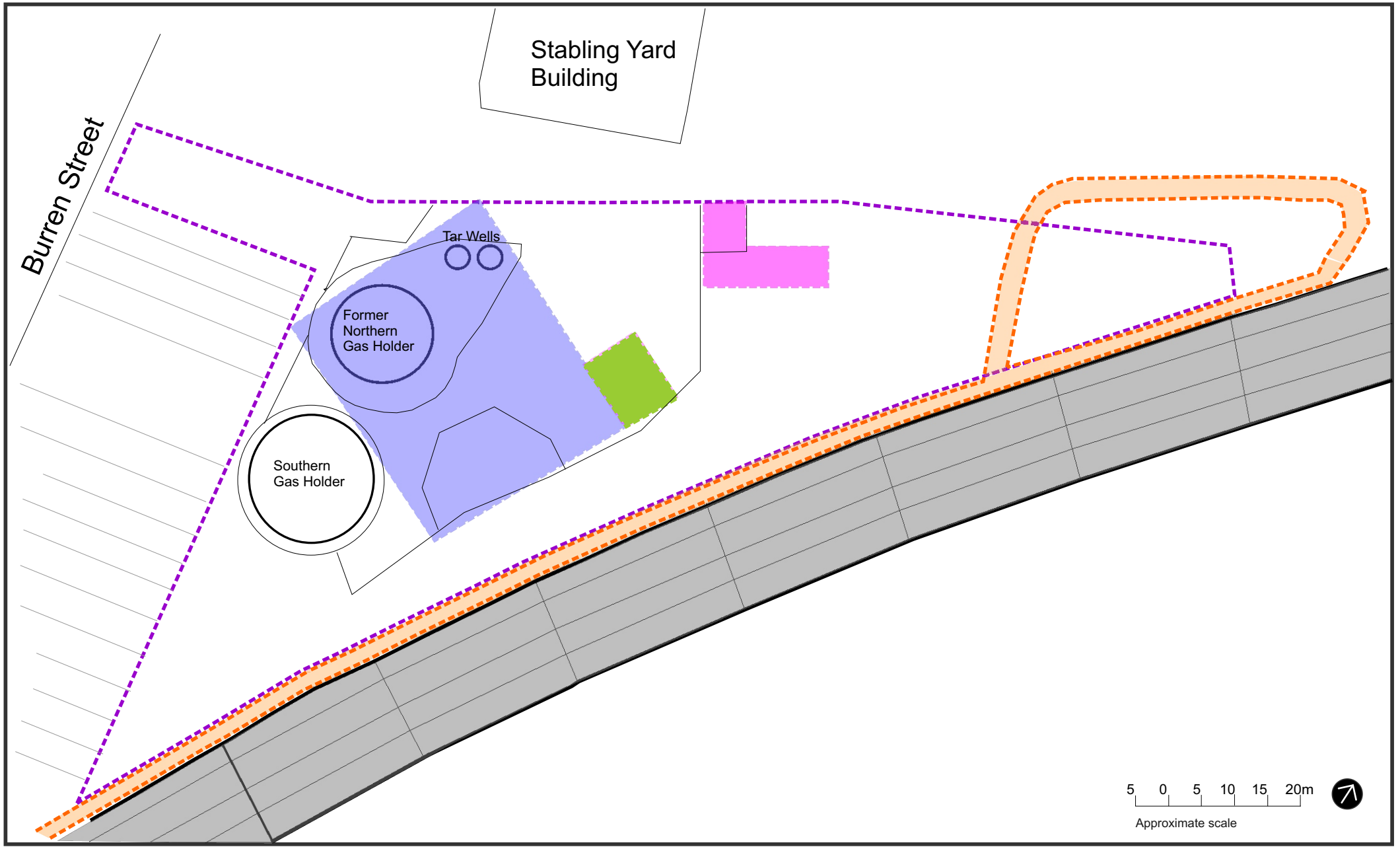
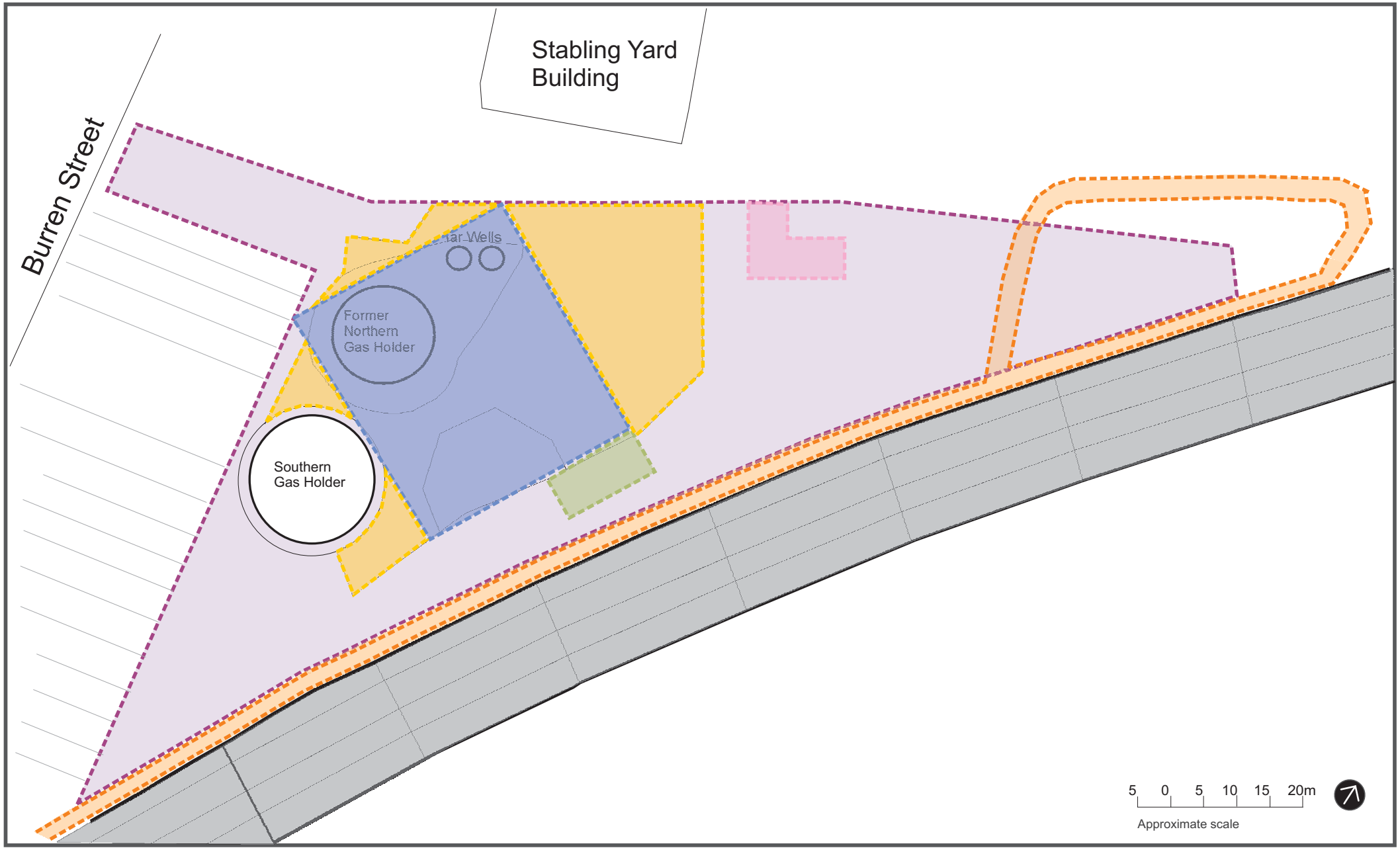


Figure 8 **Former Macdonaldtown Gasworks - Remediation Stage 2**

As adapted from Figure 4 CH2M Hill 2007



Site Boundary

Task 3A - excavate areas of impact and assess potential for bioremediation

Potential Stockpiling areas

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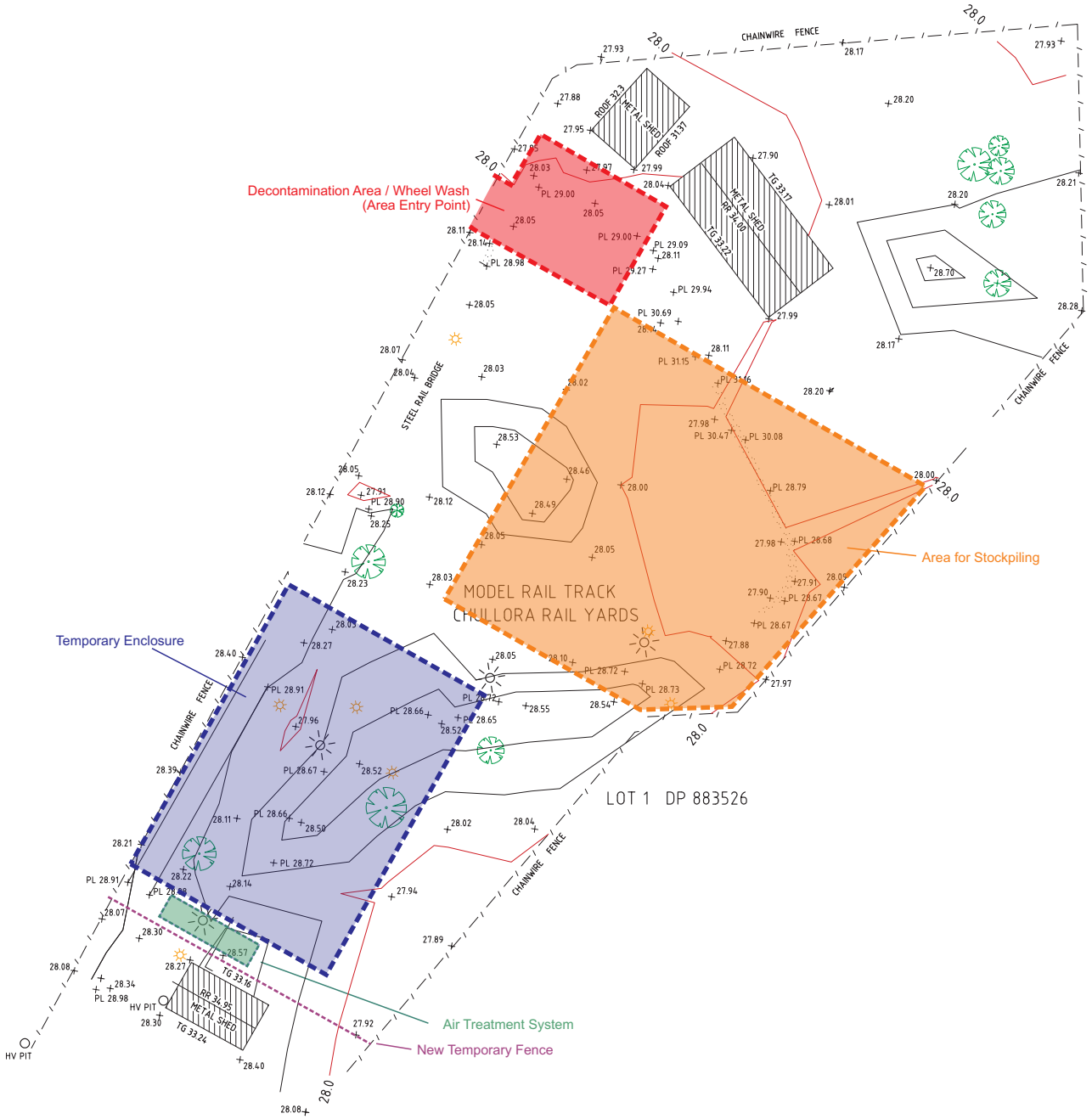
Figure 9 **Former Macdonaldtown Gasworks - Remediation Stage Three Works**

As adapted from Figure 4 CH2M Hill 2007



Source: Base Image - © 2011 Lynton Surveyors Pty Ltd - 2011C107_DET.dwg

0 7.5 15 30 m

Scale: Approximate

Datum: MGA94 Zone 56 - AHD		Doc. No: Preliminary	
A4			
A	Original Issue -	RF	19-05-2011
Rev	Description	Drn.	Date

Legend:

- New Temporary Fence
- Air Treatment System
- Temporary Enclosure
- Area for Stockpiling
- Decontamination Area / Wheel Wash

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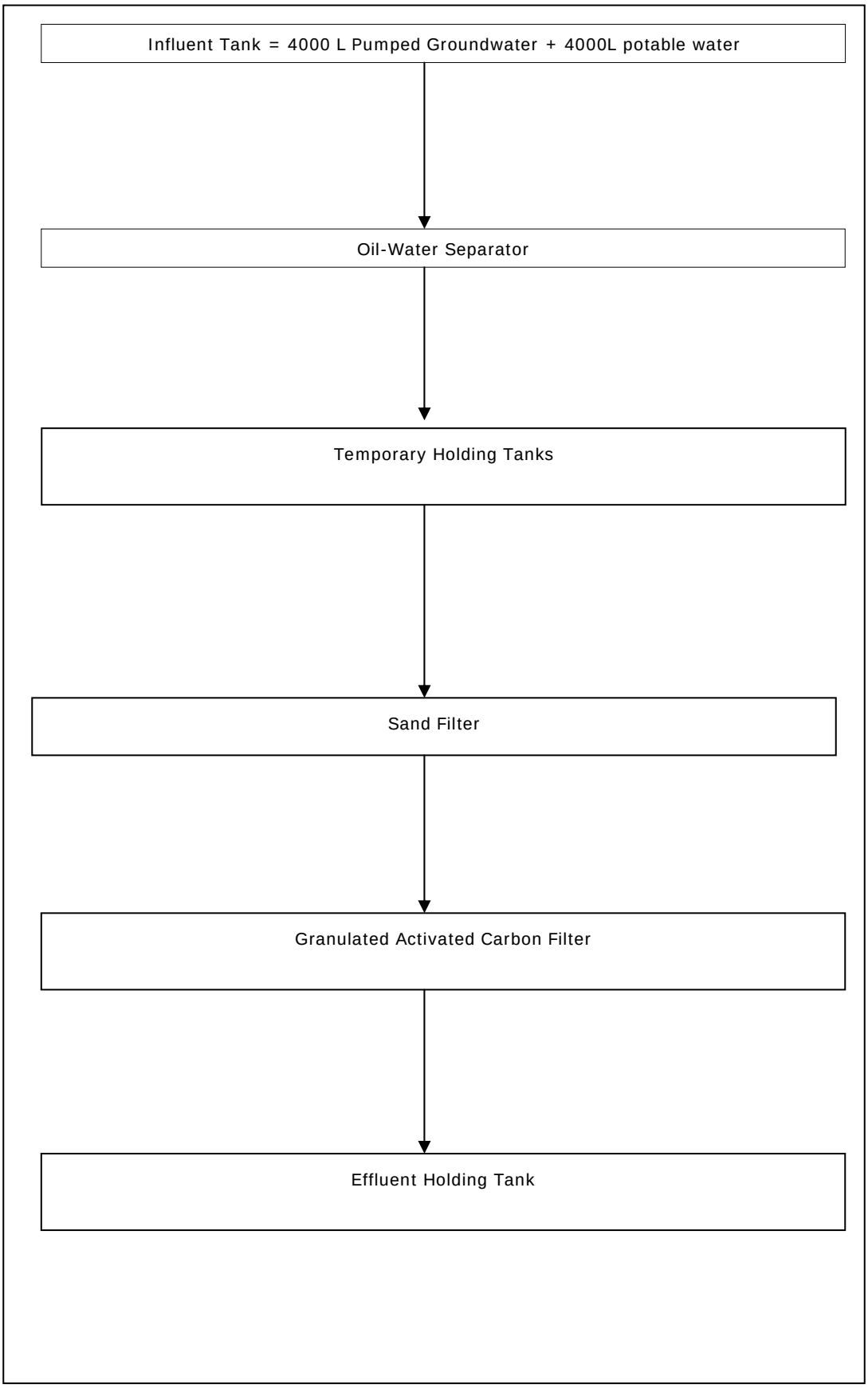
Figure 10: Proposed Setup of Treatment Area (Chullora)

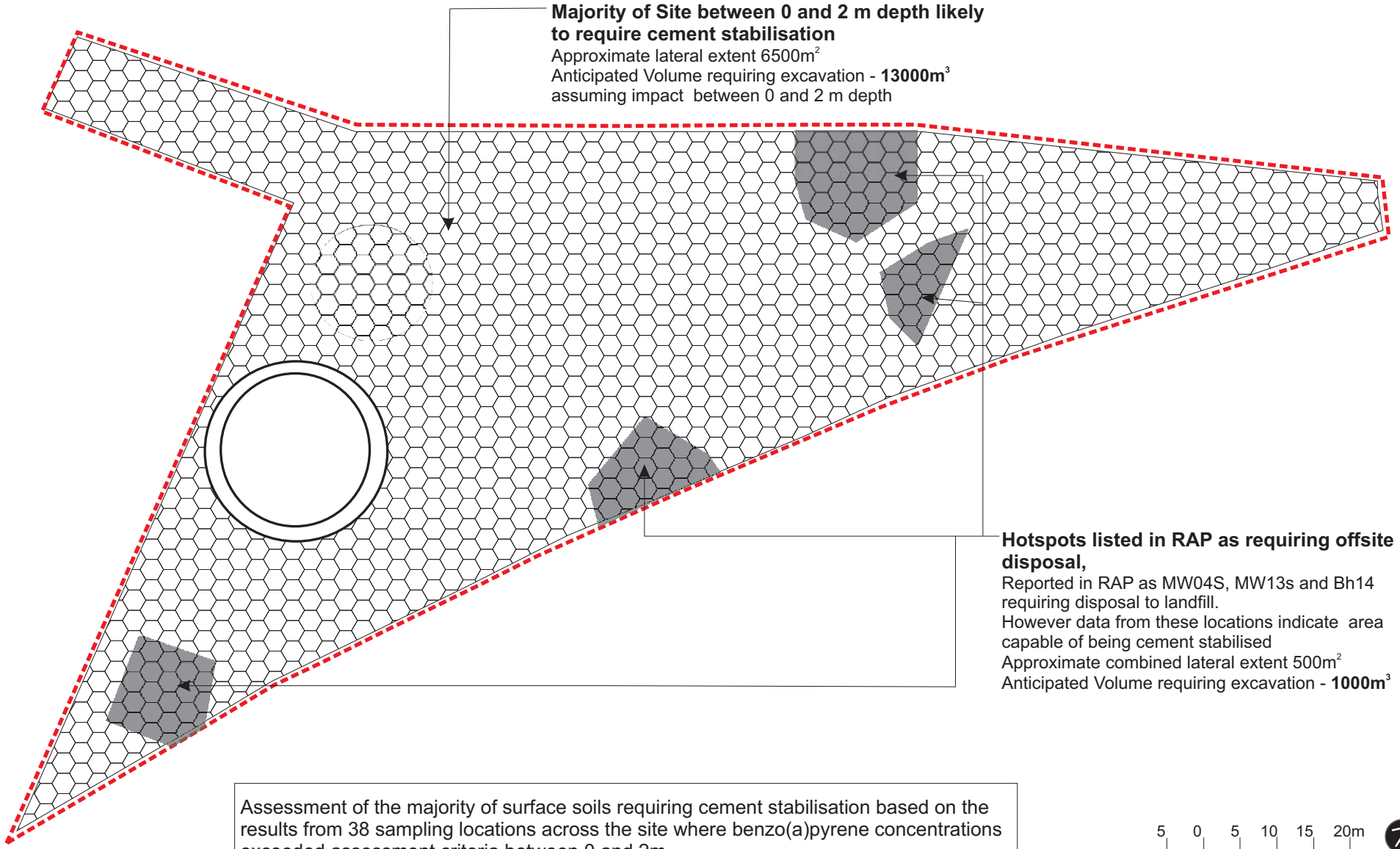
Client: Incoll Management

Project: RailCorp Macdonaldtown Approvals

Job No: 40913 File Name: 40913_02

Figure 11: Water Treatment Trial Setup and Components





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Approximate extent of impacted area (as adapted from CH2M Hill 2007)

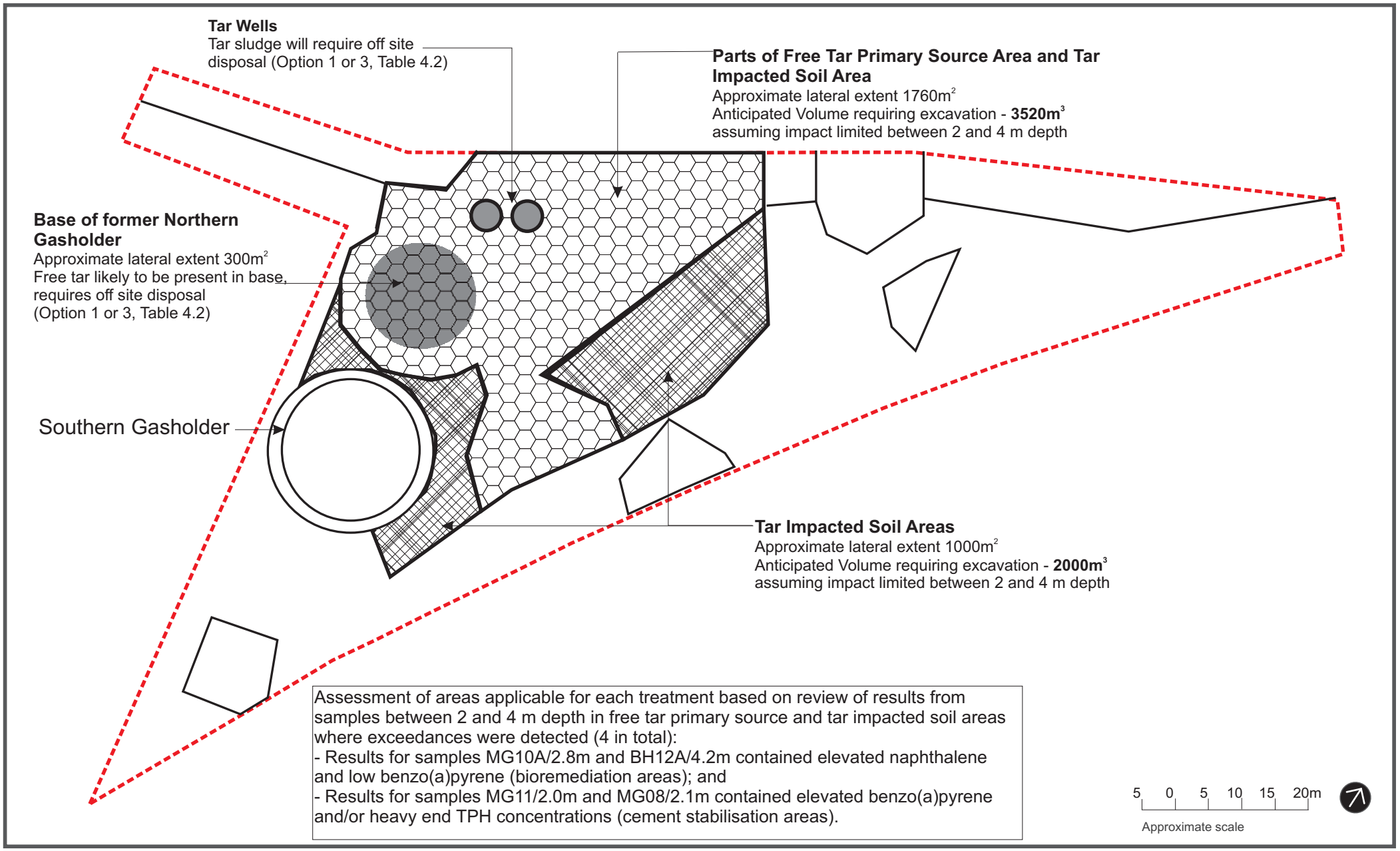
Site Boundary

Area of Impact Likely to be treatable with bioremediation

Area of Impact Likely to require cement stabilisation

Figure 12 **Areas Suited to Treatment (Between 0 and 2m depth)**

As adapted from Figure 4 CH2M Hill 2007



JBS ENVIRONMENTAL

Approximate extent of impacted area (as adapted from CH2M Hill 2007)

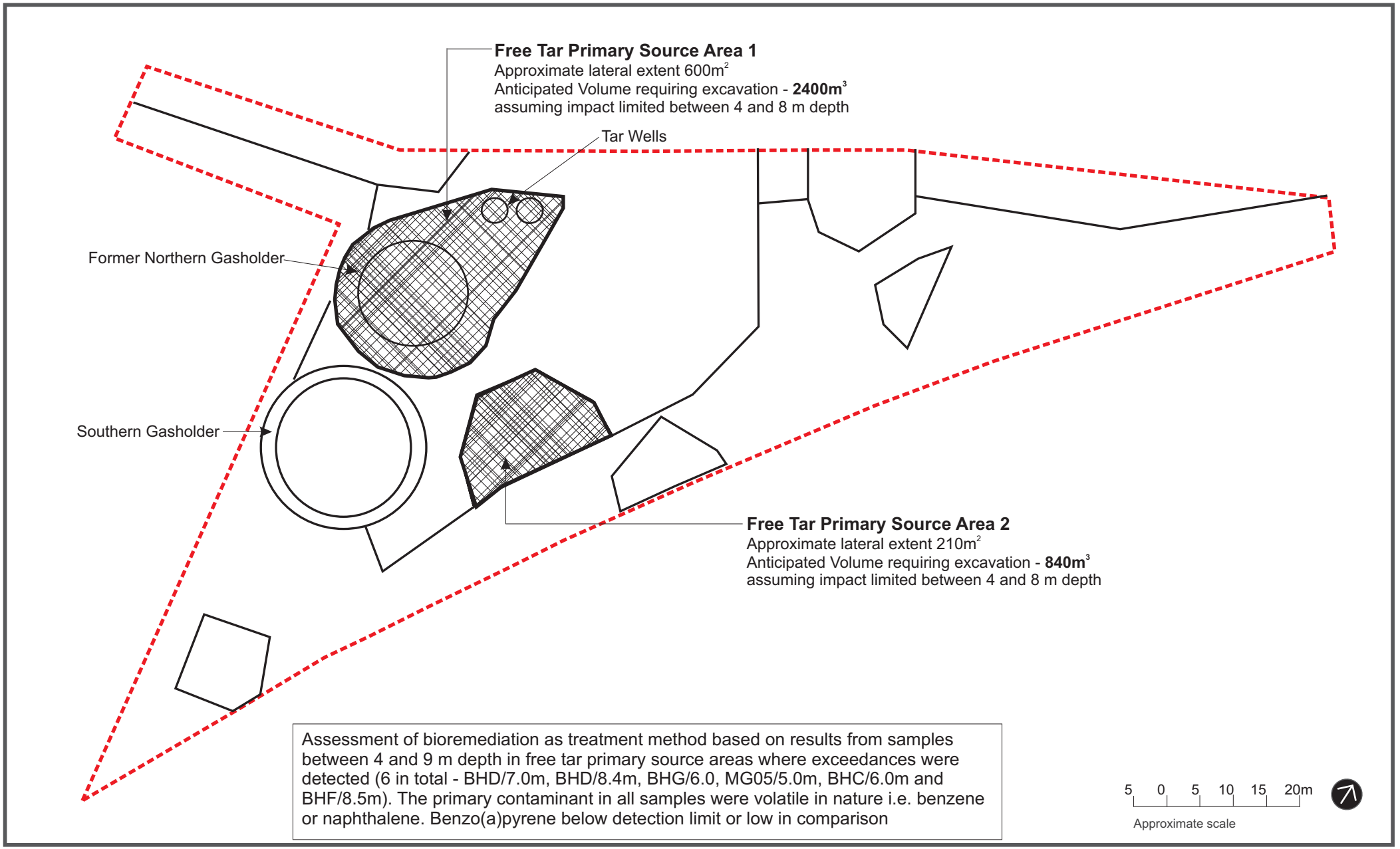
Site Boundary

Area of Impact Likely to be Subject to Treatment or Management by Options 2 or 3 in Table 4.2 (bioremediation)

Area of Impact Likely to be Subject to Treatment or Management by Option 3 in Table 4.2 (cement stabilisation)

Figure 13 **Estimated Extent of Treatment Options (Between 2 and 4m depth)**

As adapted from Figure 4 CH2M Hill 2007



JBS ENVIRONMENTAL

Approximate extent of impacted area (as adapted from CH2M Hill 2007)

Site Boundary

Area of Impact Likely to be subject to Treatment or Remediation in accordance with Option 2 or 3 in Table 4.2

Figure 14 **Estimated Extent of Treatment Options (Greater than 4m depth)**

As adapted from Figure 4 CH2M Hill 2007

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0 50m
Approximate scale

Figure 15 **Chullora Treatment Area Site Plan**

Department of Lands (2010)
Note- All locations shown are approximate only

Tables

Table A: Revised Remedial Strategy – Areas, Extents and Likely Treatment Requirements

Site Area	Material Type	Extent of Impact	Expected Quantity (m^3)	Contaminants (Maximum reported concentration)	Primary Treatment		Licencing Requirements
					Treatment Options (1,2, 3 or 4 from Table 4.2)	Anticipated Waste Classification Subsequent to Treatment / Immobilisation Approval	
Northern gasholder	Tar Sludge	Contained within Base of Gasholder	320	Benzo(a)pyrene (595 mg/kg) Total PAHs (26 805.3 mg/kg) TPH C6-C9 (3770 mg/kg) TPH C10-C14 (1 180 000 mg/kg) Benzene (814 mg/kg) Ethylbenzene (254 mg/kg) Total Xylenes (3170 mg/kg)	Option 1: Liquid Waste Disposal	-	No premises based licence required for on-site handling Licenced Liquid Waste contractor required for transport and ultimate treatment/disposal of free tar
	Impacted Water	Contained within Gasholder	640	Naphthalene (1 460 µg/L) Total PAHs (1 6774 µg/L) TPH C6-C9 (2170 µg/L) TPH C10-C14 (9495 µg/L) Benzene (704 µg/L) Ethylbenzene (213 µg/L) Toluene (117 µg/L) Total Xylenes (417 µg/L))	Option 1: Liquid Waste Disposal; or disposal to sewer or on site reuse	Suitable for disposal to sewer or on site beneficial reuse	Disposal to sewer requires trade waste agreement with Sydney Water
	Soil / fill impacted by free tar	Base annulus and proximate soils (within pink shaded area on Figure 5 to a depth of 8m-10m)	2100	Benzo(a)pyrene (17.6 mg/kg) Total PAHs (1906.4 mg/kg) TPH C6-C9 (559 mg/kg) TPH C10-C14 (8760 mg/kg) Benzene (5.4 mg/kg) Ethylbenzene (40.8 mg/kg) Total Xylenes (246.7 mg/kg)	Options 2 or 3: Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by 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)	For treatment - Cement stabilisation may be undertaken in accordance with NSW DEC general immobilisation approval (Approval #2005/14), Deviations from this method may require a specific immobilisation approval to be obtained from DECCW For off-site disposal – landfill receiving treated material must: - be licensed the class of waste the treated material is assessed as; - have an operational leachate collection system - monitor leachate and groundwater on site for B(a)P and Total PAHs
	Demolition Waste	Buried inside Gasholder annulus (blue shaded area on Figure 5)	1900	Benzo(a)pyrene (17.6 mg/kg) Total PAHs (1906.4 mg/kg) TPH C6-C9 (559 mg/kg) TPH C10-C14 (8760 mg/kg) Benzene (5.4 mg/kg) Ethylbenzene (40.8) Total Xylenes (246.7) Asbestos present	Landfill disposal or Recycling	Hazardous Waste (free tar)	No premises based licence required for on-site handling Licensed Liquid Waste contractor required for transport and ultimate treatment/disposal of free tar
						Special Waste (asbestos)	For site removal works – if more than 10m^2 of ACM encountered, works must be undertaken by a licencedAS1 contractor For off-site disposal – landfill must be licensed to received asbestos waste
						General Solid Waste (Non-Putrescible)	For off-site disposal – landfill must be licensed to received General Solid Waste (non-putrescible) For recycling – premises must be licenced for appropriate waste recovery category
Retort and Surrounding Former Gasworks Source Areas	Shallow Tar Impacted Soil and Fill	Lateral extent of orange shaded area on Figure 5 to a depth of at least 4m	9225	Benzo(a)pyrene (444 mg/kg) Total PAHs (15 237.6 mg/kg) TPH C6-C9 (51 mg/kg) TPH C10-C14 (435 100 mg/kg) Benzene (0.3 mg/kg) Ethylbenzene (12.3 mg/kg) Total Xylenes (10.6 mg/kg)	Options 2 or 3: Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by 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)	For treatment - Cement stabilisation may be undertaken in accordance with NSW DEC general immobilisation approval (Approval #2005/14), Deviations from this method may require a specific immobilisation approval to be obtained from DECCW For off-site disposal – landfill receiving treated material must: - be licensed to receive the class of waste the treated material is assessed as; - have an operational leachate collection system - monitor leachate and groundwater on site for B(a)P and Total PAHs
	Deep Tar Impacted Natural Soil	Lateral extent of pink shaded area on Figure 5 in the vicinity of boreholes BHE and BHF to a depth of 8m-10m	2375	Benzo(a)pyrene (13.9 mg/kg) Total PAHs (515.6 mg/kg) TPH C6-C9 (228 mg/kg) TPH C10-C14 (5350 mg/kg) Benzene (20 mg/kg) Ethylbenzene (8.3 mg/kg) Total Xylenes (94.9 mg/kg)		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 5 to a depth of 1m-2m	115	Benzo(a)pyrene (39.4 mg/kg) Total PAHs (425.1 mg/kg) TPH C6-C9 (166 mg/kg) TPH C10-C14 (7640 mg/kg) Benzene (3.1 mg/kg) Ethylbenzene (6.4 mg/kg) Total Xylenes (61.2 mg/kg)		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 5 to a depth of at least 0.5 m	2950	Benzo(a)pyrene (39 mg/kg at BH13) Total PAHs (413.2mg/kg at BH13) TPH C10-C14 (7100 mg/kg at BH13) Lead (2140 mg/kg at VP01 surface)	Options 2 or 3: Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by 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)	For treatment - Cement stabilisation may be undertaken in accordance with NSW DEC general immobilisation approval (Approval #2005/14), Deviations from this method may require a specific immobilisation approval to be obtained from DECCW For off-site disposal – landfill receiving treated material must: - be licensed to accept the class of waste the treated material is assessed as; - have an operational leachate collection system - monitor leachate and groundwater on site for B(a)P and Total PAHs
Retaining Wall	General Fill and demolition waste	Entire Northern boundary (shaded blue on Figure 5)	1765	Benzo(a)pyrene 150 mg/kg) Total PAHs (2472.4 mg/kg) Benzene (15.0 mg/kg) Total Xylenes (1.7 mg/kg)	Landfill disposal, Beneficial Reuse or Recycling	-	For removal works – if more than 10 m^2 of ACM encountered, works must be undertaken by a licenced AS1 contractor For off-site disposal – landfill must be licensed to received General Solid Waste (non-putrecible) and /or Special Waste (Asbestos Waste)

Site Area	Material Type	Extent of Impact	Expected Quantity (m^3)	Contaminants (Maximum reported concentration)	Primary Treatment		Licencing Requirements
					Treatment Options (1,2, 3 or 4 from Table 4.2)	Anticipated Waste Classification Subsequent to Treatment / Immobilisation Approval	
							as appropriate For recycling – premises must be licenced for appropriate waste recovery category
Contamination Hotspots	Impacted Fill at locations BH14, MW13s and MW04s	Lateral extent shown as green shaded area on Figure 5 to a depth of 1 m-2 m	340	At BH14: Benzo(a)pyrene (5 mg/kg) Benzene (4.6 mg/kg) Total Xylenes (48 mg/kg) At MW13: Naphthalene Benzo(a)pyrene (34.9 mg/kg) Total PAHs (346 mg/kg) TPH C10-C14 (6444 mg/kg) At MW04: Benzene (4 mg/kg)	Options 2 or 3: Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation or Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste	For treatment - Cement stabilisation may be undertaken in accordance with NSW DEC general immobilisation approval (Approval #2005/14), Deviations from this method may require a specific immobilisation approval to be obtained from DECCW For off-site disposal – landfill receiving treated material must: - be licensed to receive to accept the class of waste the treated material is assessed as; - have an operational leachate collection system - monitor leachate and groundwater on site for B(a)P and Total PAHs
Site Wide	Old Gasworks Pipes	varied	Unknown	Benzo(a)pyrene (595 mg/kg) Total PAHs (26 805.3 mg/kg) TPH C6-C9 (3770 mg/kg) TPH C10-C14 (1180 000 mg/kg) Benzene (814 mg/kg) Ethylbenzene (254 mg/kg) Total Xylenes (3170 mg/kg)	Option 1: Separate landfill disposal of empty pipework and tar contents	-	No premises based licence required for on-site handling Licenced Liquid Waste contractor required for transport and ultimate treatment/disposal of free tar
Site Wide	Fill and natural soil materials	NA	Unknown	unknown	Option 2 or 3: Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation or Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste	For treatment - Cement stabilisation may be undertaken in accordance with NSW DEC general immobilisation approval (Approval #2005/14), Deviations from this method may require a specific immobilisation approval to be obtained from DECCW For off-site disposal – landfill receiving treated material must: - be licensed to accept the class of waste the treated material is assessed as; - have an operational leachate collection system - monitor leachate and groundwater on site for B(a)P and Total PAHs
Deep excavations proximate to source area	Residual tar sources – subsequent to source removal	Unknown	Unknown	Unknown	Option 2 or 3: Treatment by bioremediation treatment for onsite reuse or landfill disposal OR Treatment by stabilisation or Stabilisation to apply NSW DEC immobilisation approval (Approval #2005/14)	Restricted Solid Waste or General Solid Waste	For treatment - Cement stabilisation may be undertaken in accordance with NSW DEC general immobilisation approval (Approval #2005/14), Deviations from this method may require a specific immobilisation approval to be obtained from DECCW For off-site disposal – landfill receiving treated material must: - be licensed to accept the class of waste the treated material is assessed as; - have an operational leachate collection system - monitor leachate and groundwater on site for B(a)P and Total PAHs

Appendix A

Pre-Remedial Investigations

A1 Pre-Remedial Investigations -Methods

The short list of most remedial options applicable to the site has been determined as follows:

- Excavation and off-site disposal to landfill of all material containing contaminant concentrations above the site acceptance criteria;
- Excavation and treatment of all possible material containing contaminants concentrations above the site acceptance criteria, for either:
    - off-site disposal to landfill; or
    - on site reuse.
- Assessment of leachability and contaminant source zones on the site. Excavation of all accessible source zone materials and treatment, as required, for off-site site disposal to landfill and/or on-site reuse. Capping and on-site management of impacted areas assessed to be either:
    - inaccessible due to heritage or geotechnical constraints; and/or
    - outside of source zones and not posing an unacceptable risk to groundwater migrating offsite.

Based on the available dataset there were several items that required additional information to enable design of a remedial strategy. The following gaps /areas requiring resolution were identified:

- Can tar impacted soils be stabilised, and if so what pre-treatment works may be required? Specifically, it is noted that while the RAP recommends that much of the impacted material be remediated by stabilisation or thermal treatment for off-site treatment, no assessment has been undertaken on the potential applicability of either treatment method. As the stabilisation of soil is likely to be the more cost effective treatment method of the two specified, it was considered prudent to run a bench scale trial of the required methodology, in accordance with NSW EPA (2005), to verify its suitability for application at the site;

- If it can be demonstrated that tar impacted soils can be stabilised, what is the suitability the stabilised material to be retained on site? Specifically what are the maximum leachable concentrations of the contaminants of concern (COC) in soil that will not have an adverse impact on the surrounding environment? Results of the bench scale trial could be used to assess the maximum leachable concentrations in soils (treated or untreated) that can be retained on site. These concentrations, incorporating factors of dilution that may occur as leached contamination mixes with groundwater, and fate and transport modelling on the mixed water, could be incorporated into the remedial strategy as clean-up criteria;

- What are the quantities of water likely to be generated during dewatering of the site for remediation? Previous investigations of the site have reported that contaminated soil is present at depths below the level of the perched water table in fill. Additionally, significant volumes of seepage have occurred in test pits excavated into the site. Efficient completion of the proposed remediation will therefore, require dewatering of fill materials in areas requiring remediation;

- What on site technologies will be suited to treatment of water generated during dewatering? Water samples collected from the perched water table in fill were reported to contain elevated concentrations of TPH and PAHs that would preclude reinjection of this water down-gradient of the dewatering area. An on site

treatment plant may be capable of reducing TPH and PAH concentrations in this water such that reinjection or disposal to sewer, as part of a trade waste agreement with Sydney Water, may be applicable. A pilot trial of possible treatment technologies was required to finalise the required approach;

A2 Scope of Works

In order to address the uncertainties listed in the previous Section, the following scope of work was completed at the site:

- Derivation of site specific assessment criteria for leachable concentrations that are considered suitable for the protection of environmental values;
- Assessment of the suitability of impacted material at the site to be remediated by stabilisation, through:
    - the excavation of testpits and sampling of impacted material. representative of that at the site;
    - bench scale treatment of cement stabilisation on impacted material; and
    - analysis of treated material for leachable concentrations and unconfined compressive strength (UCS).
- Further characterisation of leachable contaminant concentrations through the collection and analysis of up to nine samples of impacted fill or soil from potential source areas;
- Assessment of the expected rate of dewatering required on site by completion of short interval pump tests at representative locations across the site; and
- Assessment of suitable disposal locations for water generated during dewatering and required treatment, if any, by:
    - Completion of a water treatment trial on water collected during the pump tests. Three treatment technologies are to be trialled, namely an oil/water separator, a sand filter and a granulated activated carbon (GAC) filter; and
    - Collection and analysis of samples of influent and effluent from each treatment method.

The methods and results of the pre-remediation testing program developed to address these data gaps are detailed in the subsequent sections.

A.3 Derivation of Site Specific Leachability Criteria

In preparing the revised remediation strategy for the site, it is proposed that both the total and leachable concentrations of the contaminants of concern are assessed in treated material prior to determining its suitability for on site reuse.

Determination of acceptable total concentrations in treated material is expected to be straightforward and based on human health related investigation levels for commercial land use.

Site specific leachability criteria were derived by the site specific criteria in the JBS letter '*Derivation of Site Specific Leachability Criteria – Former Macdonaldtown gasworks, Burren Street, Erskineville, NSW*' Reference JBS 40913-1550, 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 site are provided in **Table A3.1** below.

Full details of the DAF and criteria derivation methods are provided in **Appendix B**.

Table A3.1: Site Specific Leachability Assessment Criteria (all units in µg/L)

Contaminant	Limit of Reporting	Aquatic Ecosystems[1]	Site Specific Criteria for assessment for leachable concentrations in soil[3]
Arsenic (III/V)	0.1	2.3[2] / 4.5[2, 5]	36.8
Cadmium	0.1	0.7[1]	11.36
Chromium (III)	1	10	160
Chromium (VI)	0.1	4.4	70.4
Copper	0.1	1.3	20.8
Lead	0.1	4.4	70.4
Manganese	1	80[2]	1280
Mercury	0.05	0.1[1]	1.76
Nickel	1	70	1120
Zinc	1	15	240
VOLATILE ORGANIC COMPOUNDS			
Benzene		500	8000
Toluene		180[2]	2880
Ethylbenzene		5[2]	80
Xylene (M+O+P)		625[2]	10000
Styrene		1600	25600
Phenols		400	6400
POLYCYCLIC AROMATIC HYDRCAOCARBONS			
Benzo(a)Pyrene	0.1	0.1[2]	1.6
Naphthalene	0.1	70	1162
Phenanthrene	0.1	0.6[2]	9.6
Anthracene	0.1	0.01[2]	0.16
Fluoranthene	0.1	0.1[2]	1.6

[1] 95% protection levels (marine ecosystems) have been used. When these levels fail to protect key test species, the 99% protection levels were used - ANZECC/ARMCANZ (2000). The 99% protection levels have been adopted in line with recommendations in Section 8.3.7 of ANZECC/ARMCANZ 2000.
[2] Insufficient data to derive a reliable trigger value. In these instances, reference has been made to low reliability trigger levels contained in ANZECC/ARMCANZ (2000).
[3] Adopted criteria – 16x ANZECC/ARMCANZ 2000 trigger values, which is equivalent to 16.6x the LOR where applicable
[4] Where no ANZECC/ARMCANZ 2000 trigger values, LOR used prior to applying dilution attenuation factor of 16

A.4 Sampling and Analysis Plan

Data Quality Objectives (DQOs) were developed for the remainder of the pre-remedial assessment works, as discussed in the following sections.

A4.1 State the Problem

RailCorp are committed to undertaking remediation works on the former Macdonaldtown Gasworks site. Contamination has been identified on the site consisting of free tar present in the abandoned gasworks infrastructure (tar wells, retort pipes etc.) and elevated concentrations of lead, B(a)P, Total PAH, TPH C_6-C_9, TPH C_{10}-C_{36} and BTEX compounds in soils present from the surface to depths in excess of 10 m below ground level (bgl). Samples of groundwater collected from both the perched water table present in fill and from the bedrock aquifer underlying the site were reported to contain elevated concentrations of heavy metals, B(a)P, Total PAH, TPH C_6-C_9, TPH C_{10}-C_{36} and BTEX. In accordance with the land use zoning, the objective of the proposed remediation program would be to render the site suitable for commercial land use with no unacceptable risk to the environment.

The pre-remedial assessment works were conducted to provide additional detail on the likely manner in which remediation is to be undertaken.

The team at JBS utilised for the project comprised:

- Andrew Lau – Principal Contaminated Land, was the Project Director, responsible for client liaison and program design;
- Matthew Parkinson – Principal Contaminated Land, provided specialist technical input to program design and assessment of results;
- Sumi Dorairaj – Senior Environmental Consultant, was the Project Manager responsible for client liaison, site work planning and design, health and safety management, site work co-ordination, subcontractor management and reporting; and
- Tim Davis – Senior Field Scientist, was responsible for completion of site works including subcontractor management, health and safety management and reporting.

The conceptual site model, prior to the completion of the pre-remedial assessment works, has been summarised in **Sections 2** of the main body of this report.

A4.2 Identify the Decision

The following decisions were made:

- For impacted material that remains *in-situ*, or that has been remediated through stabilisation, what are the maximum leachable concentrations of COC that present no additional risk to future users or to the surrounding environment via groundwater?
- For the coal tar impacted fill or soil to be remediated, what proportion (by mass) of calcium or magnesium based oxide cement must be added during treatment for immobilisation to be successful in reducing the leachable concentrations to acceptable levels?
- For the coal tar impacted fill or soil to be remediated, what proportion (by mass) of calcium or magnesium based oxide cement must be added during treatment to satisfy the requirements for disposal under the DECCW General Approval of the

Immobilisation of Contaminants in Waste 2005/14 (Coal Tar Wastes from Former Gas Works sites)?

- What are conservative and reasonable estimates of the dewatering rates that will be required on site during remediation of fill and/or soil?
- Out of an oil/water separator, sand filter and granular activated carbon (GAC) filter, which technology (or combination thereof) is best suited to treat the water generated on site during dewatering?

A4.3 Identify Inputs to the Decision

Inputs to the decisions were:

- A site conceptual model provided in the RAP(CH2M Hill, 2007);
- Existing groundwater data consisting of gauging, survey and limited analysis of groundwater samples;
- Soil environmental data collected by soil sampling and analysis;
- Stabilisation trial data comprising treated soil analysis and geotechnical strength testing for a range of treatment conditions;
- Groundwater pump test results from a representative number of wells on site consisting of gauging and pumping rate results to allow estimate rates of inflow into excavations;
- Treated groundwater environmental data generated by processing the water generated during the pump test through a trial scale water treatment plant, with sampling and analysis of recovered effluent;
- Soil criteria to be selected on the site based on a range of potential environmental values as defined by assessment criteria prepared in **Section A7.2**;
- Waste assessment criteria specified for Non-Liquid Waste in '*Waste Classification Guidelines, Part 1: Classifying Waste'* (DECC, 2009) and also the '*General Approval of the Immobilisation of Contaminants in Waste*' (NSW EPA 2005);
- Groundwater criteria selected on the site to be protective of current and potential future environmental values permitted under the site zoning, as defined by assessment criteria prepared in **Section A7.4**;
- Confirmation that data generated by sample analysis are of a sufficient quality to allow reliable comparison to assessment criteria as undertaken by assessment of quality assurance / quality control as per the data quality indicators established in **Section 6.4**; and
- Qualitative assessment of remediation methods commenced in **Section A9.**

A4.4 Define the Study Boundaries

The conditions to which the decisions applied and within which data were collected are summarised following:

- The lateral boundaries of the site are consistent with the boundaries of Part Lot 50 in Deposited Plan 1004167 that comprises the site;
- Risk goals as required to be met for on-going industrial use of the site and the future user populations that may be potentially impacted by contaminated material retained on the former Macdonaldtown gasworks site;

- Future site occupants and occupants in the proximity of the site, who have been assumed to be potentially exposed to groundwater present in the upper-most water bearing zone only; and
- Background groundwater quality was collected from the hydraulically upgradient boundary of the site, interpreted as being the western boundary of the former gasworks site.

A4.5 Develop a Decision Rule

The requirements for future remedial Strategy with respect to fill/soil stabilisation and groundwater treatment were proposed to be assessed by:

- Comparison of environmental data, from untreated and treated soil or fill, to criteria provided for the off site disposal of waste as available within '*General Approval of the Immobilisation of Contaminants in Waste*' (NSW EPA 2005), Approval Number 2005/14 - *Coal Tar Waste from Former Gasworks Sites*;
- Comparison of environmental data, from treated water and leachable concentrations in stabilised soil, to criteria provided for the protection of ecological ecosystems as available within:
    - 95% protection values for marine water ecosystems provided in ANZECC/ARMCANZ (2000) 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality';
    - Dutch intervention levels provided for TPH to Netherlands Ministry of Housing, Spatial Planning and Environment (2000) 'Circular on target values and intervention values for soil remediation'; and
    - Site specific leachability criteria as provided in **Appendix B**;

  as assessed at the location of the nearest potentially impacted marine ecosystems, *i.e.* Alexandra Canal.

A4.6 Specify Limits of Decision Error

There are two types of decision error identified in AS4482.1-2005 'Guide to the investigation and sampling of sites with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds'. These include:

a) Deciding that the site is acceptable when it actually is not; and

b) Deciding that the site is unacceptable when it is.

Limits are required to be set on each type of error presented here. AS4482.1-2005 nominates that a 5% probability of (a) and 20% probability of (b). These were adopted for this investigation.

To assess the usability of the data prior to making decisions, the data were assessed against pre-determined Data Quality Indicators (DQIs) for precision, accuracy, representativeness, completeness and comparability. The acceptable limit on decision error is 100% compliance with DQIs.

The pre-determined Data Quality Indicators (DQIs) established for the project are discussed below in relation to precision, accuracy, representativeness, comparability and completeness (PARCC parameters), and are shown in **Table A4.1**.

- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is

assessed by calculating the Relative Percent Difference (RPD) of duplicate samples.

- **Accuracy** - measures the bias in a measurement system. The accuracy of the laboratory data that are generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.
- **Representativeness** –expresses the degree which sample data accurately and precisely represent a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.
- **Comparability** - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples; ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- **Completeness** – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.

Table A4.1 Summary of Quality Assurance / Quality Control Program

Data Quality Indicators	Frequency	Data Quality Criteria
Precision		
Blind duplicates (intra laboratory)	1 / 20 samples	<30-50% RPD[1]
Blind duplicates (inter laboratory)	1 / 20 samples	<30-50% RPD[1]
Accuracy		
Surrogate spikes	All organic samples	60-140%
Laboratory control samples	1 per lab batch	60-140%
Matrix spikes	1 per lab batch	60-140%
Representativeness		
Sampling appropriate for media and analytes		-
Samples extracted and analysed within holding times.	-	pH (7 days), organics (14 days), inorganics (6 months)
Trip spike	1 per sampling event	70-130% recovery
Trip blank	1 per sampling event	<LOR
Comparability		
Standard operating procedures for sample collection & handling	All Samples	All samples
Standard analytical methods used for all analyses	All Samples	All samples
Consistent field conditions, sampling staff and laboratory analysis	All Samples	All samples
Limits of reporting appropriate and consistent	All Samples	All samples
Completeness		
Soil description and COCs completed and appropriate	All Samples	All samples
Appropriate documentation	All Samples	All samples
Satisfactory frequency and result for QC samples	All QA/QC samples	-
Data from critical samples is considered valid	-	Critical samples valid

If any of the DQIs were not met, further assessment was necessary to determine whether the non-conformance significantly affected the usefulness of the data. Corrective actions include requesting further information from samplers and/or analytical laboratories, downgrading of the quality of the data or alternatively, collection of replacement data.

A4.7 Optimise the Design for Obtaining Data

The objectives of the works were to provide initial clarity on:

- Whether stabilisation will be a suitable remedial method to render the site suitable for commercial land use;
- Whether stabilised soil will be suitable for disposal off site in accordance with the requirements of IA 2005/14 (NSW EPA, 2005);
- whether the treated soil will be capable of being retained on site from both human health and environmental perspectives; and
- what allowances will need to be made for treatment of water generated during dewatering, in terms of the magnitude of water requiring treatment and type of treatment required.

All works were undertaken as per the methods specified in **Section A6**. The results of all additional work were assessed against historical results for contaminant concentrations in soil and slug test results in shallow wells. The results obtained are to be used to direct the design of the remediation programme for the site. Where the results of the trial works were inconclusive or inconsistent with the historical dataset, then to enable resolution, additional works have been included in the finalised remedial strategy for the site.

A.5 Sample Locations

As discussed in **Section A.2**, the pre-remedial trials were undertaken by a staged program of works. The program was staged to minimise the scale of subsurface disturbance to occur prior to remediation. The scope of works was as follows:

- Sampling of test pits excavated in the footprints of the Archaeological Research program pits:
  - In the vicinity of three former sampling locations, namely BHC, MG02 and MG10A, glass jar and bulk samples were collected at JBS TP3 4.0-4.2m, JBS TP3 1.3-1.7 m and JBS TP1 0.3-0.4 m depth respectively. Sampling depths were targeted to horizons previously demonstrated to be impacted by CoC. A duplicate bulk sample was collected at JBS TP3 4.0-4.2 m for analysis as a stabilisation trial control sample ; and
  - In the footprints of the remaining archaeological test pits, three samples were analysed from JBS TP2, JBS TP4 and JBS TP5;
- Completion of short interval pump tests at MW04S, MW06S, MW37S and MW42S
- Completion of a water treatment trial on water collected during the pump tests. Three treatment technologies are to be trialled, namely an oil/water separator, a sand filter and a GAC filter.

The methods to be employed in the collection and assessment of these data are detailed in **Section A.6.**

A.6 Assessment Methods - Soil Stabilisation Trials and Additional Leachability Testing

A6.1 Soil Sample Collection

JBS test pit locations are presented on **Figure A1**. All test pit locations were dug using a backhoe loader under the direction of trained JBS field staff. Soil/fill from the test pit above the target layer was stockpiled on plastic sheeting during excavation. Once the top of the target layer was identified, the material from this layer was stockpiled separately for sample collection. Proposed target layer depths were described in **Section A.5,** the actual sample collection depth was based on observed field conditions and are also summarised in **Section A.9.** Test pits were terminated at the base of the target layer or prior refusal.

For test pits where stabilisation testing was required, a 250 mL glass jar sample for analytical testing and a bulk sample (approximately 50kg) for treatment were collected from cuttings from the segregated target layer stockpile(s), placed in the appropriate sampling containers and sealed. Field duplicate jar samples and one duplicate bulk sample were also collected and analysed at the required frequency.

For test pits where samples were to be collected for analytical testing only, a 250 mL glass jar sample was collected directly from the excavator bucket, taking care to avoid collecting material in contact with the bucket walls.

A6.1.1 Soil Sample Containers

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indications of contamination were noted on field reporting sheets.

Test pit cuttings from the sampling layer were immediately transferred to sample containers of appropriate composition. For the bulk samples this comprised new, clean, plastic, bulk bags capable of containing up to 15 kg of soil without breach. For the analytical testing sample this comprised new, laboratory prepared, acid washed glass sample jars with Teflon lined screw closures. Labels on all sample containers were completed to record JBS job number; sample identification number; and date and time of sampling.

Filled, glass jar sample containers were sealed and transferred to a chilled ice box for preservation prior to and during shipment to the analytical laboratory. Bulk samples were maintained in cool, sheltered conditions at the JBS Office until delivery to the testing laboratory was possible. A chain-of-custody form was completed and forwarded with the samples to the laboratories. The following information was included on the chain–of-custody form:

- Sample identification;
- Signature of sampler;
- Date and time of collection;
- Place of collection;
- Type of sample;
- Number and type of container;
- Inclusive dates of possession; and
- Signature of receiver.

A6.1.2 Duplicate and Triplicate Sample Preparation

Field soil duplicate and triplicate samples were obtained during sampling using the following methods. Soil samples were divided into three samples with minimal disturbance to reduce the potential for loss of volatiles and placed in three laboratory prepared glass jars. All jars were filled with no headspace to reduce the potential for loss of volatiles and separately labelled as the primary, duplicate and triplicate samples before being placed in the same chilled ice box for transport to the laboratory.

A6.1.3 Decontamination of Soil Sampling Equipment

Soil sampling equipment used by JBS comprised only disposable gloves. The gloves were discarded following collection of each sample and a clean, new pair donned prior to handling the next sample material.

Test pits were excavated in order of the 'least likely contaminated' location to 'most likely contaminated' location to minimise the potential for cross contamination. At the completion and reinstatement of each testpit, the backhoe bucket was assessed for visible contamination and/or odours, and scrubbed and rinsed as appropriate.

A6.1.4 Stabilisation Testing Procedure

The glass jar sample of the untreated soil at each location was submitted to a NATA accredited laboratory for the analysis of total and leachable concentrations of heavy metals, B(a)P, cresol, BTEX, styrene and phenol.

A bench scale stabilisation trial was completed on the bulk sample collected at each test pit location. The samples were delivered to two laboratories for testing. Enviropacific Services Pty Ltd (Enviropacific) was subcontracted by JBS for completion of the stabilisation trial, and Cardno Bowler (Cardno) was subcontracted for completed of the clay content analysis, as follows:

- Preparation of a 20 kg subsample for clay content analysis by wet sieve analysis in accordance with *AS 3686-1993 Test Sieve Analysis*;
- Preparation of the remainder into 10 kg subsamples by removing the oversize components (*i.e.* passing the sample through at 20mm sieve) and noting descriptions of any oversize particles removed, foreign materials etc or other works required to complete the sieving;
- Subsamples were then divided and weighed out to form 5 kg samples per material. The subsampled material was sampled for laboratory analysis;
- Each 5 kg subsample was combined with calcium oxide based cement at the ratios of 5%, 12.5% and 20% (by mass) and mixed by hand for approximately 5 minutes;
- Water was added accordingly to achieve the moisture content required for the complete hydration of cement, noting the sample mass pre and post water addition;
- Samples were further mixed by hand for another 5 minutes;
- Mixed samples were cast into cylinders in accordance with *AS 1012.8.1-2000 Methods of testing concrete – Method of making and curing concrete – Compression and indirect tensile test specimens*;

- Cast cylinders were left to stand for approximately 24 hrs prior to wrapping and if required, transport to another NATA accredited laboratory, for curing in a fog room at 23°C for a further 6 days;
- All samples (*i.e.* 2 x 5 kg subsamples) shall be then tested in accordance with *AS1012.9-1999 Methods for testing concrete – Determination of the compressive strength of concrete specimens,* providing duplicate results for each treatment strength*;*
- Results of compressive strength analysis were compared to the requirements of NSW EPA General Immobilisation Approval 2005-14;
- A subsample of the treated material at each of the 5%, 12.5% and 20% cement strengths was collected and submitted to a NATA accredited laboratory for total and leachable concentrations of heavy metals, B(a)P, cresol, BTEX, styrene and phenol. ASLP testing was conducted on the treated soil samples to provide an indication of treated material performance under on site conditions; and
- Results of the analytical testing on treated and untreated samples were compared against the requirements of DECCW General Immobilization Approval 2005-14.

A6.2 Assessment Methods - Groundwater Pump Testing

The proposed pump test locations, MW03S, MW06S, MW07S and MW31 are shown on **Figure A1.** The proposed test methodology was a modified pumping test based on the procedure provided in MacDonald A, Barker J and Davies J (September 2008) '*The bailer test: a simple effective pumping test for assessing borehole success*' in Hydrogeology Journal. Data analysis was completed using the AquiferWin32 analysis package. The test was undertaken in the field by the following method:

- Install water level logger within monitoring well set up to record readings every second;
- Install groundwater pump to the lowest depth possible;
- Allow water level in well to stabilise for two minutes;
- Pump well for 10 minutes at maximum flow rate, or until pump is heard to go dry. Record time of pumping using stop watch;
- Maintain logger in position during well recovery, and remove once water level has recovered to 87% of pre-test level; and
- Remove pump and logger from well.

A 12V submersible electric pump was used for the tests. The maximum flow rates for pumps of this nature range from approximately 17 $L.min^{-1}$ at 1m depth to between 12 and 16 $L.min^{-1}$ at 6 m depth. The achieved flow rates, were however, dependent on the well and formation characteristics, and the stable maximum flow rates achieved are provided in **Section A.11.**

Given that the pump tests were targeted to the shallow perched aquifer, and the existing well network on the site is widely spaced and not systematic, the pumping well was used as the observation well for each of the tests in accordance with the modified pumping test method.

A6.3 Assessment Method - Groundwater Treatment Trial

Total Environmental Solutions Pty Ltd (TES) was subcontracted by JBS to construct a trial water treatment system (WTS) for site comprising an oil water separator, a sand filter and GAC filter. The WTS was constructed with taps in the pipe work connecting each treatment component to enable easy collection of water samples through the treatment process.

Samples of the trial water were collected at the influent and effluent points of each WTP component and submitted for analysis for TPH, PAHs, VOCs, Phenols and heavy metals. Measurements of water quality parameters, specifically Electrical Conductivity (EC), pH, temperature, dissolved oxygen (DO) and oxidation-reduction potential (ORP), were also collected for each water sample.

A6.3.1 Water Treatment Trial Sample Collection

The trial water was collected as grab samples for laboratory analysis. Sample bottles were filled directly from the influent and effluent taps installed on the system. A subsample was passed into a clean beaker for field filtering of samples for metals analysis. Bottles were filled to the top, and sealed tightly with the provided lids as soon as possible.

Immediately after sample collection, another subsample of the water was passed through a flow cell to allow for the measurement of water quality parameters.

During the collection of treatment trial samples, characteristics of the water such as colour, odour and apparent turbidity or any indications of contamination were noted on field reporting sheets. Phase separated hydrocarbons (PSH) were not observed during the groundwater pumping or treatment process.

Filled and sealed sample bottles were transferred to a chilled ice box for preservation prior to and during shipment to the analytical laboratory. A chain-of-custody form was completed and forwarded with the samples to the laboratories. The following information will be included on the chain–of-custody form:

- Sample identification;
- Signature of sampler;
- Date and time of collection;
- Place of collection;
- Type of sample;
- Number and type of container;
- Inclusive dates of possession; and
- Signature of receiver.

A6.3.2 Duplicate Sample Preparation

One duplicate sample was obtained during the field sampling event using the following methods. Two sets of sample bottles were filled with the sample water. Once full, samples were sealed with zero headspace to reduce the potential for loss of volatiles and separately labelled as the primary, duplicate and triplicate samples before being placed in the same chilled ice box for laboratory transport.

A6.3.3 Laboratory and Field Analyses

NATA accredited laboratories were used for all laboratory analysis and testing of soil and groundwater samples. The schedule of analysis undertaken on samples of soils and groundwater is summarised in **Table A6.1**.

Table A6.1: Summary of Proposed Analysis Regime

Media	Analysis Frequency	Analytes
Soil	For each stabilisation treatment test pit sample (including one control sample):	
	1 sample untreated soil or fill	Total and leachable (TCLP) heavy metals(As, Cd, Cr, Pb, Mn, Hg and Ni), PAHs, BTEX, cresol, styrene and phenol Clay Content by wet sieve analysis[2]
	subsample soil to be treated with 5% cement addition by mass	Total and leachable (ASLP[1]) heavy metals (As, Cd, Cr, Pb, Mn, Hg and Ni), PAHs, BTEX, cresol, styrene and phenol; and Unconfined Compressive Strength (UCS) on cured sample[2]
	subsample soil to be treated with 12.5% cement addition by mass	
	subsample soil to be treated with 20% cement addition by mass	
	For each leachability sampling test pits location	
	Maximum of 3 samples per pit	Total and leachable (TCLP) heavy metals(As, Cd, Cr, Pb, Mn, Hg and Ni), PAHs, BTEX, cresol, styrene and phenol
Water	For each water treatment technology tested:	
	1 sample of influent water; 1 sample of water resident in the system; and 1 sample of effluent water.	Water quality parameters (EC, DO, pH, temperature and ORP) TPH PAHs (at 0.1 µg.L^{-1}) detection limits VOCs Phenols; Heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn)

Notes *1: ASLP testing to be undertaken using a sample of groundwater collected from an upgradient unimpacted well as the leaching media, test performed as per standard ASLP method.*

2: Tests will be undertaken by a geotechnical laboratory subcontracted by JBS. Given the known contamination status of the material under assessment, any of the subcontractors' personnel who will come in contact with the samples will be inducted onto the JBS Job Risk Assessment for the works, and briefed regarding the necessary health and safety requirements.

A6.4 Laboratory Analyses

Envirolab Services Pty Ltd (Envirolab) at Chatswood, NSW was contracted as the primary laboratory for the required analyses. The secondary laboratory was SGS Australia Pty Ltd (SGS) at Alexandria, NSW. Both laboratories are NATA registered for the required analyses. In addition, the laboratories were required to meet JBS internal QA/QC requirements.

Geotechnical testing of bulk and treated samples was completed by Cardno and Douglas Partners Pty Ltd. Both laboratories are NATA accredited for the testing undertaken.

A7. Assessment Criteria

A7.1 Regulatory Guidelines

The investigation was undertaken with consideration to aspects of the following guidelines, as relevant:

- *Contaminated Sites: Guidelines for Assessing Service Station Sites,* NSW EPA, 1994 (EPA 1994)
- *Contaminated Sites: Sampling Design Guidelines,* NSW EPA, 1995 (EPA 1995)
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*, NSW EPA, 1997 (EPA 1997)
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, 2nd Edition,* NSW EPA, 2006 (DEC 2006)
- *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 (NEPC 1999)
- *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites,* Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, 1992 (ANZECC/NHMRC 1992)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4, 2000 (ANZECC/ARMCANZ 2000)
- *Australian Drinking Water Guidelines,* National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, 2004 (NHMRC/NRMMC 2004)
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards,* Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, June 2002 (EnHealth 2002)
- *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination,* NSW DEC, March 2007 (DEC 2007)
- *Contaminated Sites: Guidelines on Duty to Report Contamination under the Contaminated Land Management Act 1997,* NSW DECC, June 2009 (DECC 2009)

A7.2 Soil Criteria

Assessing the success of stabilisation in remediating soil is a two stage process, as follows:

1. Results of geotechnical testing on treated material and results of total contaminant concentrations on untreated soil were assessed against the '*Conditions of Approval*' as specified in '*General Approval of the Immobilisation of Contaminants in Waste*' (NSW EPA 2005), Approval Number 2005/14 - *Coal Tar Waste from former Gasworks Sites*. The conditions are summarised in **Table A7.1** and
2. Results of TCLP and ASLP testing on untreated and treated material were assessed against groundwater assessment criteria discussed in **Section 4.3**.

Table A7.1: Soil Criteria (units as specified)

Property	**Requirement (IA 2005/14, NSW EPA)[1]**
Concentrations in untreated material do not exceed	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)
UCS	1 MPa as the 95% lower confidence limit value (as assessed by AS1012.9-1999)

Additionally, the results of clay content testing on the untreated material were assess to determine whether this property is likely to affect the efficacy of stabilisation as the remediation method.

Should the treated material fail to comply with the requirements of **Table A7.1**, the material will need to be assessed against the criteria provided for off site disposal of waste as available within *Waste Classification Guidelines, Part 1: Classifying Waste'* (DECC, 2009);

A7.3 Soil Leachability Data

Soil leachability data was assessed against the :

- the site specific leachability criteria specified in **Table A3.1**; and
- criteria provided for off site disposal of waste as available within *Waste Classification Guidelines, Part 1: Classifying Waste'* (DECC, 2009).

A7.4 Treated Groundwater Criteria

Treated groundwater data were assessed against groundwater investigation levels (GILs). DEC (2007) '*Guidelines for the Assessment and Management of Groundwater Contamination*' instructs that GILs adopted for a site are required to take into consideration groundwater environmental values.

Environmental values are defined in ANZECC / ARMCANZ (2000) as '...*particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health which require protection from the effects of pollution, waste discharges and deposits*'.

The site lies within the lower estuaries of the Sydney Harbour and Parramatta River catchment boundary established by the DECC

(http://www.environment.nsw.gov.au/ieo/SydneyHarbour/map.htm, as on 17 June 2010). The interim water quality objectives established in NSW Government (2006) '*Environmental Objectives for Water Quality and River Flow*' for waterways affected by urban development in the Sydney Harbour and Parramatta River catchment include:

- Protection of aquatic ecosystems;
- Protection of visual amenity;
- Protection of secondary contact recreation; and
- Protection of primary contact recreation in the long term, *i.e.* in 10 years or more.

These water quality objectives are required to be applied at the point of ecological discharge, which previous investigations have stated would include Alexandra Canal located to the south-east of the site.

A discussion of the use of groundwater in urban areas for drinking or agricultural purposes is provided in Sydney Coastal Councils Group (September 2006) 'Groundwater Management Handbook' (SCCG, 2006). It is stated there that "*DNR advises that groundwater from individual domestic bores or spearpoints in urban areas should never be considered suitable as a drinking water supply. The health risk posed by untreated water from these installations can be significant. DNR also recommends that groundwater should not be used for watering edible produce (i.e. vegetables and fruits), nor for filling swimming pools and spas in an urban area. Any of these proposed uses requires frequent rigorous testing and treatment of groundwater to confirm its suitability for the intended purpose*".

Drinking water will be considered as a potential future use in the event that economical yields from the bedrock may one day be achievable. However, noting the commentary provided in SCCG (2006) it is considered inappropriate to strictly assess concentrations of contaminants in groundwater collected from the Site against drinking water criteria. Similarly, strict assessment of concentrations of contaminants in groundwater collected from the site against primary and secondary contact recreation is inappropriate.

The following criteria were considered to allow each of these beneficial uses to be assessed:

- 95% protection levels for marine waters provided in ANZECC/ARMCANZ (2000) to be assessed at the nearest down gradient receptor;
- Recreational water quality criteria provided in Section 5.2.3 of ANZECC/ARMCANZ (2000) to be assessed at the nearest down gradient receptor;
- Recreational and aesthetic water quality criteria provided in Section 5.2.3.3 of ANZECC/ARMCANZ (2000) to be assessed at the nearest down gradient receptor;
- Irrigation water quality criteria provided in Section 9.2.5 of ANZECC / ARMCANZ (2000) to be applied as a long term objective on the site boundary; and
- Drinking water criteria provided in NHMRC NRMMC (2004) '*Australian Drinking Water Guidelines*' to be applied as a long term objective at the site boundary and in consideration of the discussion provided earlier.

It is noted that the above summarised Australian guidelines do not provide guidelines for several substances. In these cases, DEC (2007) instructs that laboratory detection limits should be used as preliminary investigation levels. For substances with no drinking water criteria, reference may also be made to 'tap water criteria' provided to US EPA Region 9 (2004) 'Preliminary Remediation Goals'. It is noted that these are intended as screening level (preliminary) criteria, and may be based on toxicological data and exposure

parameters that may be less conservative than those which may be endorsed for use in Australia. The criteria used for assessment of soil leachability and groundwater data are summarised in **Table A7.2**.

Table A7.2: Assessment Criteria for Treated Groundwater(µg/l)

	Aquatic Ecosystems[1]	Recreation[3]	Visual Amenity[4]	Drinking Water[9]	Irrigation[10]	LOR[7]
Total Petroleum Hydrocarbons						
TPH (C_6 – C_{36})	7[2]	-	No sheen or odour	90[11]	-	250[7]
Monocyclic Aromatic Hydrocarbons						
Benzene	500	10	-	1	-	
Toluene	180[2]	-	-	800	-	
Ethylbenzene	5[2]	-	-	300	-	
Xylene (M+O+P)	625[2]	-	-	600	-	
Isopropylbenzene	30[2]	-	-	660[6]	-	
n-propylbenzene	-	-	-	240[6]	-	
1,3,5-trimethylbenzene	-	-	-	12[6]	-	
1,2,4-trimethylbenzene	-	-	-	12[6]	-	
Tert-butylbenzene	-	-	-	240[6]	-	
p-isopropyltoluene	-	-	-	-	-	1
n-butylbenzene	-	-	-	240[6]	-	
Trihalomethanes						
Bromodichloromethane	-	-	-	250	-	
Halogenated Aromatic Compounds						
1,2-Dichlorobenzene	160	-	-	1,500	-	
1,4-Dichloeobenzene	60	-	-	40	-	
Halogenated Aliphatic Compounds						
Vinyl chloride	100	-	-	0.3	-	1
1,1-Dichloroethane	250[2]	-	-	810[6]	-	
1,1-Dichloroethene	700[2]	-	-	30	-	
Cis-1,2-dichloroethene	700[2]	-	-	60	-	
Trans-1,2-dichloroethene	700[2]	-	-		-	
1,1,1-Trichloroethane	270[2]	-	-	3200[6]	-	
Trichloroethene	330[2]	30	-	0.028[6]	-	1
Tetrachloroethene	70[2]	10	-	50	-	
1,2,3-trichloropropane	-	-	-	0.0056[6]	-	1
Heavy Metals						
Arsenic (III/V)	2.3[2] / 4.5[2, 5]	50	-	7	100	
Cadmium	0.7[1]	5	-	2	10	
Chromium (III)	10	50	-	-	-	
Chromium (VI)	4.4		-	50	100	
Copper	1.3	1000	-	2,000	200	
Lead	4.4	50	-	10	2000	
Manganese	80[2]	100	-	500	200	
Mercury	0.1[1]	1	-	1	2	
Nickel	70	100	-	20	200	
Zinc	15	5000	-	3000[8]	2000	
Polycyclic Aromatic Hydrocarbons						
Naphthalene	50	-	-	6.2[6]	-	
Acenaphthylene	-	-	-	-	-	0.1
Acenapthene	-	-	-	370[6]	-	
Fluorene	-	-	-	240[6]	-	

	Aquatic Ecosystems[1]	Recreation[3]	Visual Amenity[4]	Drinking Water[9]	Irrigation[10]	LOR[7]
Phenanthrene	0.6	-	-	-	-	0.1
Anthracene	0.01[2]	-	-	1800[6]	-	
Fluoranthene	1[2]	-	-	1500[6]	-	
Pyrene	-	-	-	180[6]	-	
Benzo(a)anthracene	-	-	-	0.092[6]	-	
Chrysene	-	-	-	9.2[6]	-	
Benzo(b&k)fluoranthene	-	-	-	0.092[6]	-	
Indeno(1,2,3-cd)perylene	-	-	-	0.092[6]	-	
Benzo(g,h,i)perylene	-	-	-	-	-	0.1
Dibenz(a,h)anthracene	-	-	-	-	-	0.1
Benzo(a)pyrene	0.1[2]	0.01	-	0.01	-	0.1

1. 95% protection levels (marine ecosystems) have been used. When these levels fail to protect key test species, the 99% protection levels were used - ANZECC/ARMCANZ (2000).
2. Insufficient data to derive a reliable trigger value. In these instances, reference has been made to low reliability trigger levels contained in ANZECC/ARMCANZ (2000).
3. Recreational purposes - Table 5.2.3 ANZECC/ARMCANZ (2000)
4. Recreational water quality and aesthetics – s.5.2.3.3 ANZECC/ARMCANZ (2000)
5. Criteria for As (V) selected
6. US EPA Region 9 (2004) tap water criteria
7. Laboratory limit of reporting provided for substances with insufficient published ecological / health investigation guidelines, or where published guidelines fall below laboratory limit of detection.
8. Based on aesthetic considerations. No Health based guideline published.
9. NHMRC NRMMC (2004) 'Australian Drinking Water Guidelines'
10. ANZECC / ARMCANZ (2000) Section 9.2.5., long term vales used.
11. Lowest of fraction specific criteria provided to WHO (2005) 'Petroleum Products in Drinking Water'

A.8 Pre-Remedial Investigations - Quality Assurance / Quality Control

A8.1 Soil QA/QC Results

The QA/QC results for soil samples collected at the site are summarised in **Table A8.1** and discussed in **Section A8.2** below. Detailed laboratory QA/QC results are included in the laboratory reports in **Appendix F** of the Revised Remedial Strategy document. Tabulated QA/QC results are provided in **Appendix G** of the Revised Remedial Strategy document.

Table A8.1 - Soil QA/QC Results Summary

Data Quality Indicator	Frequency	Results	DQI met?
Precision			
Soil Blind duplicates (intra laboratory)	1 field duplicate analysed – 9% of total samples >5% acceptable	0 - 121% RPD	Partial[1]
Soil Blind replicates (inter laboratory)	1 blind replicates analysed – 9% of total samples >5% acceptable	0-159% RPD	Partial[1]
Laboratory Duplicates	1 laboratory duplicate analysed depending upon analyte – 9% of total samples >5% acceptable	0-29% RPD	yes
Trip spike	1/1 batches (<LOR)	96-100%	Yes
Trip blank	1/1 batches (<LOR)	<LOR	Yes
Accuracy			
Surrogate spikes	All organic samples	39-130% recovery	Partial[1]
Matrix spikes	2/11 – 18% >5% acceptable	42-130% recovery	Partial[1]
Laboratory control samples	2/11 – 18% >5% acceptable	60-130% recovery	Yes
Representativeness			
Sampling appropriate for media and analytes	All samples	All sampling conducted in accordance with JBS procedures	Yes
Laboratory blanks	1/batch	<LOR	Yes
Samples extracted and analysed within holding times.	All	All samples were extracted and analysed within holding times for the target analytes.	Yes
Comparability			
Standard operating procedures used for sample collection & handling	All	A team of three field staff used same standard operating procedures throughout works	Yes
Standard analytical methods used	All	Standard analytical methods used	Yes
Consistent field conditions, sampling staff and laboratory analysis	All	Sampling was conducted by one field staff using standard operating procedures in the same conditions throughout the works. The primary lab and secondary labs remained consistent throughout the investigation.	Yes
Limits of reporting appropriate and consistent	All	Limits of reporting were consistent and appropriate.	Yes
Completeness			
Soil description & COCs completed	All	All bore logs and COCs were completed appropriately.	Yes
Appropriate documentation	All	All appropriate field documentation is included in the Appendices.	Yes
Satisfactory frequency/result for QC samples	All	The QC results are considered adequate for the purposes of the investigation.	Yes
Data from critical samples is considered valid	All	Data from critical samples are considered valid.	Yes

[1] See discussion of DQI outliers below.

A8.2 Soil QA/QC Discussion

A8.2.1 Precision

With the following exceptions, all field duplicates recorded relative percentage differences (RPDs) within the acceptable range of less than 30-50%:

- In field replicate pair JBS TP1/0.3-0.4 m and QC2, Cd of 1.1 and 2.1 mg/kg respectively (RPD, 63%);
- in field duplicate pair JBS TP1/0.3-0.4 m and QA2 all individual PAH compounds with the exception fluorene, had RPDs in the range of 80 and129 %;
- in field replicate pair JBS TP1/0.3-0.4 m and QC2 all individual PAH compounds with the exception acenaphthene, reported RPDs in the range of 51 and159 %

The elevated RPDs appear to be due to the heterogeneity of the fill material sampled at these locations. The elevated RPDs are considered not to significantly affect the reliability of the data set because the concentrations reported for these analytes in the duplicate pairs were either both significantly higher or both significantly lower than the assessment criteria. In no field duplicate pair exceeding allowable RPDs, did the assessment criteria value lie between the two reported concentrations. Therefore the difference in concentrations in these field duplicate pairs did not affect the assessment of site suitability at these locations. As a further level of conservatism, only the higher of the two values reported in each field duplicate pair was used in the assessment dataset.

A8.2.2 Accuracy

With the exception of the following, all surrogate spike recoveries reported were all within the acceptable range:

- Phenol-d6: 55% recovery in JBS TP2/0.4-0.5 m and 57% recovery in JBS TP2/1.4-1.5 m;
- 2-fluorophenol: 59% recovery in JBS TP1/0.3-0.4 m and 57% recovery in JBS TP2/1.4-1.5 m;
- Phenol-d6: 55% recovery in JBS TP2/0.4-0.5 m and 57% recovery in JBS TP2/1.4-1.5 m; and
- 2,4,6-Tribromophenol: 59% recovery in JBS TP1/0.3-0.4 m, 39% in JBTP4/1.6-1.7 m and 55% recovery in JBS TP4/1.0 m

With the exception of 34% and 42% recoveries for 4-nitrophenol, all matrix spike recoveries reported were all within the acceptable range.

These spike exceedances are considered not to significantly affect the accuracy of the dataset given that phenol concentrations were below the laboratory detection limit in all field samples analysed.