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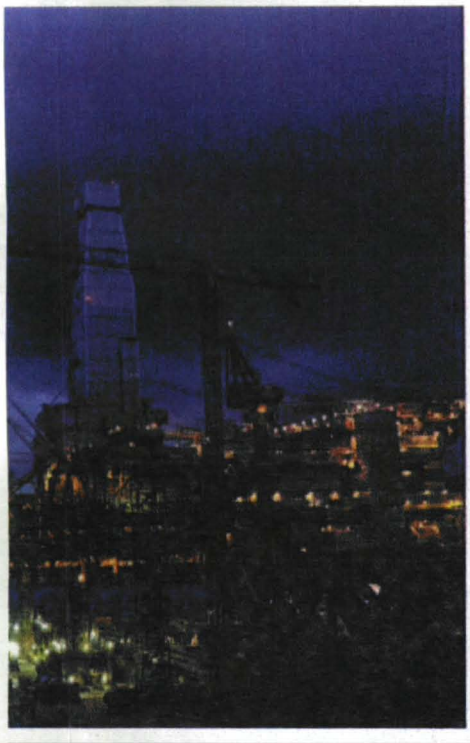
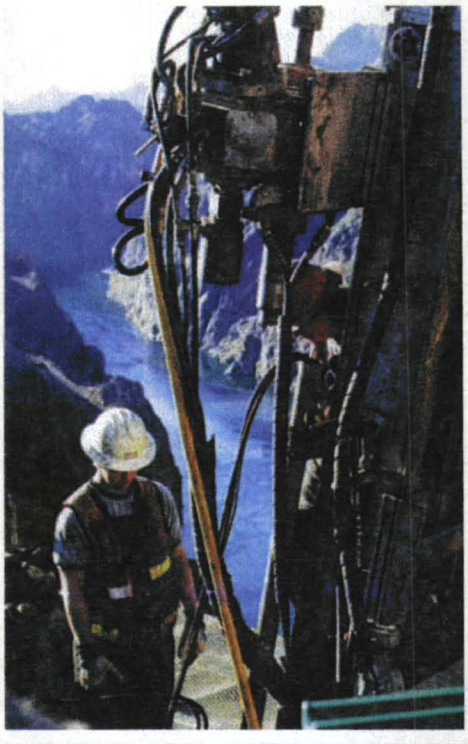
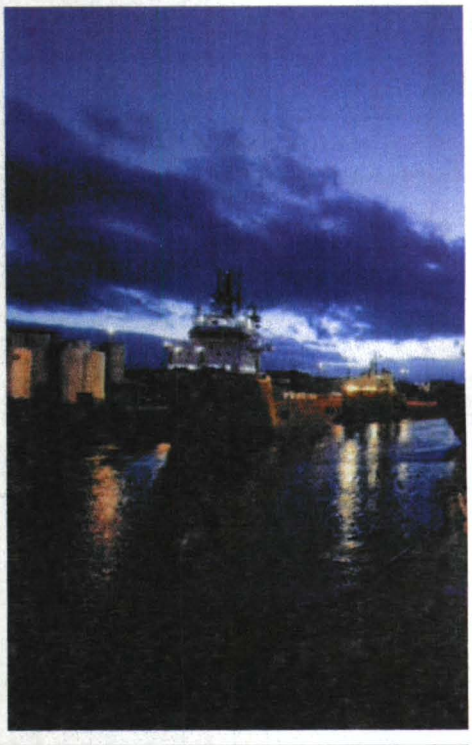
26 JUL 2012

Manchester City Council

Harpurhey Tip Site

Outline Design and Remediation Strategy

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Harpurhey Tip Site

Outline Design and Remediation Strategy

AMEC Environment & Infrastructure UK Limited

June 2012

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Purpose of this Report

The purpose of this report is to provide a Remediation Strategy and Outline Design for remedial works to be undertaken at the Harpurhey tip site in order to sever significant pollutant linkages identified to both human health (acute exposure via ingestion from cyanide identified in shallow soils) and controlled waters (reservoirs on site). The contamination source is a former gas works tip located at within the north eastern corner of the site. The preferred scheme for remediation briefly comprises reprofiling of the tip slope, with provision of a cover system incorporating a drainage system to minimise infiltration along the tip surface.

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1. Scope and Introduction

1.1 Scope

AMEC Environment & Infrastructure UK Ltd (AMEC) was commissioned by Manchester City Council ('MCC'; the Council) to provide an Outline Design and Remediation Strategy for the Harpurhey Tip site.

The tip on site has been determined as Contaminated Land under Part 2A of the Environmental Protection Act 1990. The purpose of this report is to summarise and document the proposed strategy, including the background and decision process that led up to the development of the strategy and provide a prescriptive approach to the remedial works and subsequent monitoring and validation / compliance requirements. This report has been prepared in accordance with the requirements specified within CLR11 Model Procedures[1].

AMEC have previously undertaken a remedial options appraisal for the site, which documents the three main stages of the contaminated land Remedial Options Appraisal[2] for the Harpurhey tip (the site), as defined in the CLR11 Model Procedures. The reader should refer to this document for further information relating to the decision on the preferred strategy.

In addition to AMEC's remedial options appraisal, this report should be read in conjunction with the following reports:

- AMEC, May 2012, Final Harpurhey Tip Slope Stability Analysis Report;
- AMEC, May 2011, Addendum Report – B20(c) Inspection of Special Site under Part 2A Environmental Protection Act 1990, Tip Site, Harpurhey Road, Manchester (ref: 5788001800.v3);
- AMEC, May 2008, B20(c) Inspection of Special Site under Part 2A Environmental Protection Act 1990, Tip Site, Harpurhey Road, Manchester (ref: 5788001379/TS.v1);
- AMEC, August 2007, Factual Report, Tip Site, Harpurhey Road, Manchester (ref: 5788001379/TS.v1);
- Dames & Moore, 1999, Remedial Assessment of the Harpurhey Reservoirs Site Manchester – Phase 1 (Ref: 41338-001-407/MS/ct); and
- The Environmental Consultancy University of Sheffield (ECUS), 1993, Site Investigation and Assessment, Harpurhey, Manchester.

1.2 Structure of this Report

This report presents the following:

- Setting of site-specific remediation objectives (this section);

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- Legislative context (Section 2);
- Summary of conceptual model and relevant pollutant linkages and site setting and constraints (Section 3);
- Summary of remediation approaches considered and justification for preferred strategy (Section 4);
- Outline of remediation design. This will, in broad terms, detail how the remediation will be implemented on site and associated monitoring, verification and reporting requirements (Section 5, 6, 7 and 11); and
- Summary of health and safety and environmental management protocol to be applied during the remediation works (Section 9 and 10).

1.3 Remediation Objectives

The objectives of the remediation at the site are as follows:

1. Reduce/remove the risk to human health, environmental harm and environmental liability from significant contamination identified on site;
2. Break, as far as practicable, the identified pollutant linkages to surface waters while recognising that the overarching consideration for controlled waters is the requirement to ensure that the water quality in the lower reservoir is suitable for its current use;
3. Provide a site suitable for its current use as public open space;
4. Where practicable, be in keeping with the planned amenity use for the site;
5. Minimise the adverse impact to off-site receptors from the remediation works;
6. Where practicable, utilise a sustainable approach to remediation; and
7. Provide a practical and cost effective long term solution in accordance with Best Available Technologies (BAT).

With regards to Objective 1, the primary focus of the remediation is to sever the significant pollutant linkages to human health identified at the site. Water quality in the upper reservoir is considered to be of less concern due to its 'sacrificial' nature, but the significant pollutant linkages associated with the reservoirs need to be broken/reduced to ensure that the water quality in the lower reservoir is of suitable quality to sustain its current use (informal fishing) as outlined in Objective 2.

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2. Legislative Context

The contaminated land regime is set out within Part 2A of the Environmental Protection Act 1990 (EPA, 1990). The regime came into force in England on 1 April 2000 and was subsequently revised in 2006. The regime and the secondary legislation, the Contaminated Land (England) Regulations 2006 and more recent Contaminated Land (England) (Amendment) Regulations 2012, are in turn supported by Statutory Guidance issued by the Department of the Environment, Food and Rural Affairs (Defra) in September 2006*, Defra Circular 01/2006: Environmental Protection Act 1990: Part 2A Contaminated Land.

Part 2A provides a statutory definition of 'Contaminated Land' as follows:

> *"Any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substance in, on, or under the land that;*
>
> *Significant harm is being caused, or there is significant possibility of such harm being caused; and*
>
> *Pollution of controlled waters is being, or is likely to be caused".*

Central to the regulatory system is a rigorous procedure of risk assessment, which is used to determine the existence of 'contaminated land' according to the definition. Under the risk assessment procedure, for such harm to the non-aquatic environment or pollution of controlled waters to be possible, there must be a 'significant pollutant linkage'.

*Note that the statutory guidance used in the preparation of this document has just been superseded in April 2012. Due to the stage at which the site is at, i.e. assessment actions and remedial proposals, with exception of the assessment of seriousness (which is now considered before determination) the changes to the Statutory Guidance do not result in significant alterations to these reports or the approach being used to address the site.

2.1 Determination of Contaminated Land

In February 2011 the Council determined the site as Contaminated Land under Part 2A (Section 78A (2)) of the Environmental Protection Act.

The grounds for this determination were as follows:

> *"An unacceptable acute risk to human health and property (domesticated animals) exists from the presence of free cyanide and total cyanide in the shallow materials of the tip area, and within sludges on the eastern margin of the upper reservoir (along the base of the tip), at levels in excess of site specific assessment criteria.*
>
> *In accordance with Chapter A (Table B) of the Statutory Guidance this unacceptable risk constitutes a significant possibility of significant harm to human health.*

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Pollution of controlled waters is being caused by the entry of pollutants from within the waste mass into the upper reservoir. There is also an unacceptable risk to controlled waters arising from the presence of cyanide, iron, zinc, copper, cadmium, chromium, lead, nickel, sulphate, sulphide and acidic conditions in the tip materials at levels in excess of relevant assessment criteria.

In accordance with Part 4 (A.35 to A.39) of Annex 3 of the Statutory Guidance the above constitutes actual and likely pollution to controlled waters."

2.2 Remediation under Part 2A

Guidance on what needs to be undertaken by way of remediation is described within paragraph C18, Annex 3 of the Statutory Guidance. Paragraph C18 states that "*the standard to which the relevant land or waters should be remediated should be established by considering separately each significant pollutant linkage identified on the land in question. For each such linkage, the standard of remediation should be that which would be achieved by the use of a remediation package which forms the best practicable techniques for remediation for:*

(a) Ensuring that the linkage is no longer a significant pollutant linkage, by doing any one or more of the following:

- Removing, or treating the pollutant;
- Breaking, or removing the pathway; or
- Protecting, or removing the receptor; and

(b) *Remedying the effect of any significant harm or pollution of controlled waters or any harm so far as attributable to radioactivity, which is resulting, or has already resulted from, the significant pollutant linkage."*

Paragraph C19 of the Statutory Guidance states that "in deciding what represents the best practicable technique for any particular remediation, the enforcing authority should look for the method of achieving the desired results which, in the light of the nature and volume of the significant pollutant concerned and the timescale within which remediation is required:

a) is reasonable; and

b) represents the best combination of the following qualities:

i) practicability, both in general and in the particular circumstances of the relevant land or waters;

ii) effectiveness in achieving the aims set out in paragraph C18 above; and

iii) durability in maintaining that effectiveness over the timescale within which the significant harm or pollution of controlled waters or harm so far as attributable to radioactivity may occur.

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The Statutory Guidance also states that remediation under Part 2A should consider the reasonableness and cost of remediation scheme and the seriousness of harm caused or likely to be caused to the receptor in question (Annex 3, Part 5).

A number of contaminants were identified in the determination as requiring mitigation. Of these, free cyanide is of greatest concern given the potential pollutant linkage which is present at the site with potential trespassers coming into contact with either sediments or the exposed bank phase of the waste tip. Free cyanide represents an acute risk to human health from potential ingestion. Some measures have been taken to limit potential exposure by adding a fence and partially covering approximately 50% of the surface materials on top of the tip. The remaining 50% of exposed soil represents an on-going risk to both human health and to surface water quality. These measures are not considered to be fully effective and durable (given the locality of the site).

In order to assess the extent, and hence in part seriousness, of the pollution of controlled waters at the site, additional surface water monitoring (monthly between January and March 2012) across the upper and lower reservoirs, which are in continuity with each other, was recently undertaken. The results of the additional sampling confirm previous findings that the water quality in the upper reservoir is impacted by contamination emanating from the adjacent tip material.

The results on this occasion also appear to indicate that the lower reservoir is also being impacted from contamination arising from the tip. This is further supported by the fact that the lower reservoir also (unusually in AMECs experience) had an orange colouration (most probably iron hydroxide precipitation) during the February monitoring visit, was cloudy blue/green during the January and February visits and had an iron sheen / scum across the surface during the January visit. These results suggest the potential migration and mixing of metal contamination between the upper and lower reservoirs, which has not previously been recorded.

The proposed scheme must provide a cost effective and practical solution to address the identified pollutant linkages within the determination and the more recently identified potential impact within the lower reservoir, by addressing the specific site conditions and constraints

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3. Site Characteristics, Factors and Constraints

3.1 Site Location and Environmental Setting

The site is located off Harpurhey Road, Manchester and centred on National Grid Reference 385460, 401610. It is bounded by Harpurhey Road to the north and east, an industrial estate to the south and the River Irk to the west (see Figure 3.1).

The site is currently undeveloped with two reservoirs (upper and lower reservoirs), which are in continuity with each other with filter beds present in the western section of the site. The filter beds (reed beds) are not maintained and are considered to be largely silted up. The eastern section of the site is located at a higher elevation, with the ground level sloping down from the north-eastern corner to the south-eastern corner of the site. The north-eastern section of the site mainly comprises the former gas works waste tip. Water draining from the tip enters the 'Upper Reservoir', either via groundwater flow or from surface water run-off. The Lower Reservoir has an outlet which discharges into the adjacent river. This outlet has become blocked and as a result the water levels in the Lower Reservoir have risen to that of the Upper Reservoir. The overflow to the river now comprises an informal channel created by overflowing water. Given that the two reservoirs are in continuity, impacted water is discharging in an uncontrolled manner into the River Irk.

The areas surrounding the tip and along the slope towards the south-eastern corner of the site are vegetated with sparse grass, trees and brambles. There is a bund at the eastern perimeter of the site, running parallel to the alignment of the adjacent road, which is heavily vegetated with trees, shrubs and brambles.

Based on observations of surface cover and ground conditions made by AMEC staff during the intrusive works and site topography, the site has been divided into three distinct areas, as follows:

- Area 1 - Main tip area
- Area 2 - Eastern and south-eastern bunded area, adjacent to Harpurhey Road
- Area 3 - Western (low lying) area, adjacent to the River Irk and the reservoirs (upper and lower)

Geology

The geology of the site comprises Made Ground (gas works waste with brick and ash fill in Area 1 and brick and ash fill in Areas 2 and 3) over drift deposits (alluvium/glacial sands and gravels, with occasional sandy clays). The solid geology of the site has been determined with reference to information contained within the British Geological Survey (BGS) Map for Manchester (Solid Sheet 85). The BGS map indicates that the north eastern section of the site is underlain by Permian Manchester Marl, with the remainder of the site being underlain by Triassic Bunter Sandstone. The map also indicates that the site is within a heavily faulted area, with the faults to the north and south of the site, trending in a south east – north west direction.

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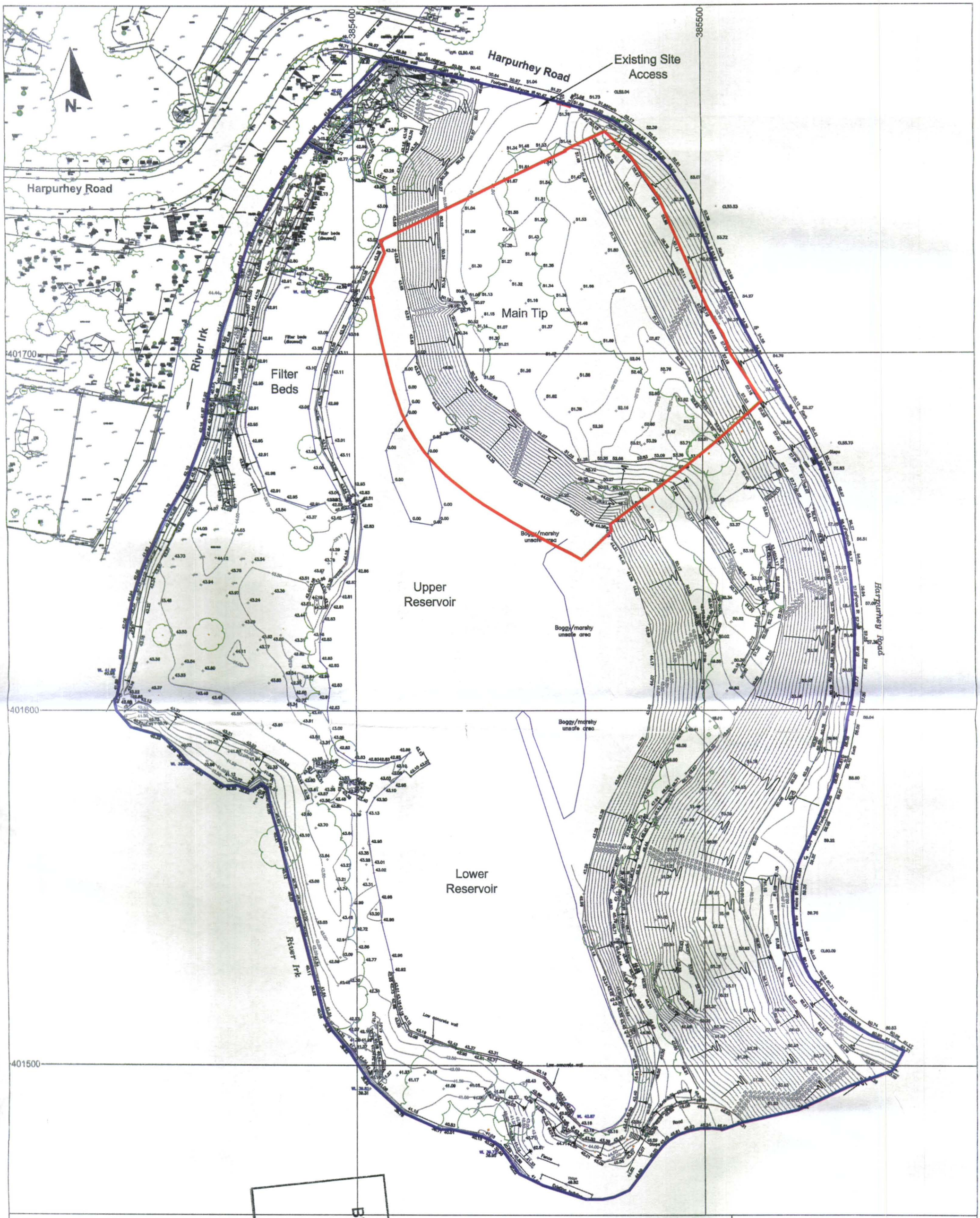
N
385400
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Harpurhey Road
Existing Site Access
Harpurhey Road
River Irk
Filter Beds
Filter beds (disused)
Main Tip
Upper Reservoir
Lower Reservoir
Boggy/marshy unsafe area
Boggy/marshy unsafe area
Boggy/marshy unsafe area
Harpurhey Road
River Irk
Low concrete wall
Low concrete wall
Fence
Road
Key
Site boundary
59.77 Level
Contour
Estimated extent of remedial works
PLANNING AND BUILDING CONTROL
26 JUL 2012
0 m
50 m
Scale 1:1000 @ A3
Manchester City Council
Harpurhey Tip site
Outline Design and Remediation Strategy
Figure 3.1
Site Layout
March 2012
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amec

Groundwater Classification

The Environment Agency maps (i.e. Groundwater Vulnerability Map and online Aquifer Maps) show that the north and north-eastern section of the site is situated on a Secondary B Aquifer (formerly a Minor and Non Aquifer) associated with the Manchester Marls. The west / south-western section of the site is situated on bedrock Principal Aquifer (formerly a Major Aquifer). The Environment Agency maps indicate that the superficial deposits underlying the site are classified as a Secondary A Aquifer. The site lies outside of the Source Protection Zone (SPZ).

Groundwater and Surface Water Monitoring

Two main water bodies have been identified within the site, which are in hydraulic continuity with the reservoirs and the River Irk on the western boundary of the site. Many of the boreholes have been lost and therefore comments draw on historical monitoring data taken between 2007 and 2009. Because many of the water levels recorded were undertaken at different times from each well and because the variation in water levels is limited the values have been averaged to provide a general indication of relative water levels in relation to surface water and groundwater. These records show that three boreholes with deep well installations screening groundwater between 15 m and 26 m bgl have water levels similar to that measured in the reservoirs typically found at 42.9 m AOD. The borehole details are as follows:

- Northern area of the tip, borehole TSDBH9 screens 30.6 m to 36.6 m AOD, WL 42.95 m AOD (2007);
- Central area, borehole TSDBH10 screens 25.2 m to 31.2 m AOD, WL 42.83 m AOD(2009); and
- Beyond southern tip area at borehole TSDBH12, screens 26.8 m to 32.8 m AOD, WL 43.33 m AOD (2007-08).

Four boreholes monitor the water levels within the tip waste in the central and southern area. These are screened across the waste material and show that perched water levels range between 44.5 m AOD in the west and 46.4 m AOD in the east. Some confinement of groundwater may be present in the waste in the central area of the tip with a 1.7 m difference in depth to water, in wells that are 12 m apart (ECBH4 and TSLBH6). A further eight monitoring wells have been installed in the tip with screen sections below the main body of waste in the alluvial silt/sand/gravel. These together with the wells monitoring the waste indicate the presence of a perched water body with a steep gradient from 46.4 m in the east to 43.7 m to the west. These water levels are artificially high by comparison to the main groundwater body and the steep groundwater gradient (which is likely to be localised), suggests that the waste material has low permeability.

Water levels monitored between the reservoirs and the River Irk (western site area) show the water table in TSWS8 and TSWS4 at 41.4 m AOD. The main water body and the perched water are likely to be in hydraulic continuity with the River Irk, which has a typical water level of 39.8 m AOD, beyond the west and south-western site boundary.

The groundwater unit present within the alluvial deposits is assumed to be in hydraulic continuity with the underlying Principal Aquifer (sandstone).

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3.2 Previous Investigations

The site has been subject to numerous site investigations dating back to 1993, with the larger and more recent site investigations being undertaken by the Environmental Consultancy University of Sheffield (ECUS) in 1993, Dames and Moore in 1999 and AMEC in 2007 and 2009. Two exploratory hole location plans showing the more recent sampling locations are presented as Figures 3.2 and 3.3. The reader should refer to AMEC's B20(c) report[3] and Addendum report[1] for further information on both historical investigations.

The site investigations have identified contamination within site soils, principally associated with spent oxide present in the tip and Made Ground. Contamination has also been noted within both contaminated leachate / shallow groundwater present at the base of the tip and with the Upper Reservoir and filter beds.

3.3 Summary of Slope Optioneering Report

The Slope Stability Optioneering report (AMEC Report Ref: 30323-03.SO.i2, May 2012) considered seven possible options to support or prevent collapse of the tip bank. These options included a 'do nothing' approach, partial re-grade, full re-grade, partial gabion, partial toe berm, total gabion and total toe berm.

The preferred solution for the western tip slope is effectively a combination of the re-grading options, and the do nothing / managed woodland option. The majority of the slope should be regraded to a gradient of between 1V:2H and 1V:3H, and covered with a 'geocomposite pozidrain' comprising impermeable HDPE membrane with protective cover soils and capping. The wooded area at the northern end of the slope will be left largely undisturbed (except for applying a top dressing of soil locally in areas where contamination is present, and using a geo-grid to limit movement of the placed soil) and be fenced off, to create an area of managed woodland. Fencing off the northern wooded area will restrict access in order to address potential slope failure risks in this area.Some works will be required to clear rubbish and unwanted vegetation from this area prior to fencing off.

Contaminated sludge and silt will be removed from the reservoir at the toe of the slope and disposed of on the tip surface, where it will become encapsulated by the capping works.

The recommendations concluded the slope be re-graded to a minimum between 1V:2H and 1V:3H. The report recognised that there would be benefit in reducing the slope to support an approach which uses a capping design where the reduced slope gradient would result in less energy for surface water run-off effecting erosion and minimises the potential for a capping material to slump. The re-grade for the cap reduces the risk of slope failure which would result in significant amounts of contamination entering the reservoir.

It is also suggested that 'rip-rap' boulders are placed at the toe of the slope to dissipate erosion by wave action. Despite the wave action on the reservoir being minimal, moving water has a constant effect of erosion on soil. The line of boulders along the foot of the slope, are a low cost and effective preventive measure to reduce soil erosion and undermining which can lead to slumping.

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3.4 Summary of Recent Surface Water Sampling

Recent surface water monitoring has been undertaken at the site over a period of three months, with samples being collected from twelve sampling locations across both the upper and lower reservoirs on a monthly basis (3 visits). The results are presented in AMEC's Factual report (ref 30323-02 dated May 2012). The results suggest the potential migration and mixing of metals contamination between the upper and lower reservoirs, which has not previously been recorded. This is supported by visual observations which include cloudy green colouration noted in the lower reservoir during the January and March 2012 monitoring visits, an iron sheen / scum across the surface during the January visit and an orange (ochreous) colouration in the lower reservoir during the February 2012 visit.

3.5 Summary of Surface Soil Samples - Northern Site Area

In order to further characterise the contamination status of shallow material present in the north western, more vegetated, corner of the site, fifteen surface soil samples were collected by MCC and analysed for total and free cyanide. The results and indicative sampling location plan are presented in Appendix B of the Remedial Options Appraisal Report (ref: 30323-03i1 dated May 2012).

The results indicate that with the exception of two samples, concentrations of total cyanide are generally low in comparison to those identified elsewhere within the tip waste, with total cyanide concentrations ranging between 8.6 mg/kg to 541.6 mg/kg and free cyanide ranging between <1 mg/kg to 18.3 mg/kg.

Higher concentrations of both total and free cyanide have been identified at sample locations SS7 (total CN 1819.3 mg/kg and free CN 24.5 mg/kg) and SS12 (total CN 2254.6 mg/kg and free CN 326.2 mg/kg). Both of these locations were collected from along the tip slope.

The results have been compared to the site specific assessment criteria (SSAC) derived for free and total cyanide at the site (see AMEC's Addendum report for more information[1]). Samples which have been collected from the top of the tip have been compared to the SSAC for Area 1 (free CN 41 mg/kg and total CN 3400 mg/kg), with the samples collected from the tip slope being compared to the SSAC derived for the sludge material (free CN 100 mg/kg and total CN 8300 mg/kg - based on an older age group which are more likely to venture into this area). The results indicate that, with the exception of free cyanide at sample SS12, there are no exceedances of the SSAC for those samples collected from the tip slope (SS1, SS4, SS7, SS12 and SS15). Furthermore, concentrations of both free and total cyanide from samples collected across the top of the tip within the north western corner are below the SSAC.

Previous shallow soil sampling (5 No. samples) within the north western corner of the tip has identified elevated concentrations of total cyanide (above SSAC of 8300 mg/kg and 3400 mg/kg, respectively) at two

[1] AMEC, May 2011, Addendum Report – B20(c) Inspection of Special Site under Part 2A Environmental Protection Act 1990, Tip Site, Harpurhey Road, Manchester (ref: 5788001800.v3)

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locations (HS2 – 28368 mg/kg and HS3 – 5514 mg/kg). Note HS2 is again located along the tip slope. The concentrations of free cyanide identified at these two locations are also in excess of the free cyanide SSAC (HS2 – 351 mg/kg [compared to SSAC of 100 mg/kg] and HS3 – 50 mg/kg [compared to SSAC of 41 mg/kg]).To conclude, out of the 20 shallow soil samples collected from this area of the tip, there have been exceedances of the SSAC for total and free cyanide identified at three separate locations. Two of these locations are along the slope of the tip (SS12 and HS2, where only more inquisitive children and adults will come into contact with this material. The third location however is on the top of the tip (HS3).

The identified areas will be addressed by surface-dressing with soil over several growing seasons, and it should also be noted that the northern wooded area will be fenced off to address risks to site users presented by long-term slope instability.

3.6 Relevant Pollutant Linkages

The significant pollutant linkages which require remedial action are presented in Table 3.1.

Table 3.1 Significant Pollutant Linkages at the Site

Source	Pathway	Receptor
Cyanide within near surface soils and wash out sediments	Intake of contaminated soil through ingestion	Humans (children) and domestic pets
Iron, zinc, copper, cadmium, chromium, lead, nickel within waste mass Acidic conditions within waste mass Sulphate within waste mass	• Contaminated surface run off • Leaching from soil / wash out sediments • Vertical and lateral migration in leachate • Lateral migration in groundwater	Reservoirs
Cyanide within waste mass Sulphide within waste mass	• Contaminated surface run off • Leaching from soil / wash out sediments • Vertical and lateral migration in leachate • Lateral migration in groundwater	Reservoirs
Iron, zinc, copper, cadmium, chromium, lead, nickel, acidic conditions, sulphate, sulphide and cyanide within waste mass	Potential bank collapse	Reservoirs

Significant possibility of significant harm being caused

Pollution of Controlled Waters (Surface Water) is being caused

Pollution of Controlled Waters (Surface Water) is likely to be caused

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Harpurhey Tip site
Outline Design and Remediation Strategy

Figure 3.3
Non AMEC SI Exploratory Locations

March 2012
30323-Mol05_BW.dwg youac

amec


AMEC TSR1
approx. 250m
upstream
Harpurhey Road
385400
385500
401700
401600
401500
River Irk
N
TSR1
TSR2
TSR3
TSR4
TSR5
TSD1
TSD2
SL1
SL2
SL3
SL4
SL5
SL6
SL7
SL8
SL9
SL10
SL11
SL12
SL13
SL15
SW1
SW2
SW3
SW4
SW5
SW6
SW7
SW8
SW9
HS1
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HS4
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HS22
HS23
HS24
HS25
HS26
HS27
HS28
HS29
HS30
BH1
BH2
BH3
BH4
TSTP1
TSTP2
TSTP3
TSTP4
TSTP5
TSSBH1
TSSBH2
TSSBH3
TSSBH4
TSSBH13
TSSBH14
TSDBH9
TSDBH10
TSDBH12
TSLBH5
TSLBH6
TSLBH7
TSLBH8
TSHA1
TSHA2
TSHA3
TSHA4
TSHA5
TSHA6
TSHA7
TSHA8
TSHA9
TASHA10
TSHA11
TSHA12
TSHA13
TSHA14
TSHA15
TSHA16
TSWS1
TSWS2
TSWS3
TSWS4
TSWS5
TSWS6
TSWS7
TSWS8
TSWS9
HA1
HA2
HA3
HA4
HA5
HA6
Boggy/marshy unsafe area
Low concrete wall
Fence
Kerb
Footpath
Road
Steps
PLANNING AND BUILDING CONTROL
26 JUL 2012
Key
Site boundary
Contour
Hotspot
AMEC surface water sample
AMEC sludge sample
AMEC borehole (2007)
AMEC hand auger (2007)
AMEC trial pit (2007)
AMEC window sample (2007)
AMEC borehole (2008)
AMEC had auger (2008)
AMEC shallow hand sample (2010)
AMEC borehole (2011)
AMEC drainage ditch sample
AMEC river sample
Estimated extent of remedial works
0 m
50 m
Scale 1:1000 @ A3
Manchester City Council
Harpurhey Tip site
Outline Design and Remediation Strategy
Figure 3.2
AMEC SI Exploratory Locations
March 2012
30323-Mol02_BW.dwg whitr02
amec

4. Summary of Remedial Options

4.1 Pollutant Linkages under Consideration

For the purposes of this Remediation Strategy, the relevant significant pollutant linkages (RPSLs) have been grouped, where possible into groups of pollutant linkages which are considered to have similar characteristics in relation to the remediation techniques considered, as follows:

i) RSPL01: Source; cyanide contamination throughout soil profile but in particular in the wash out sediments at base of the tip, on the surface of the tip and on the sloped bank. Pathway; ingestion. Receptor; site users;

ii) RSPL02: Source; metals, acidic pH, cyanide, sulphide and sulphate contamination in the soil profile. Pathway; leaching and permeation through the soil profile and lateral migration of groundwater. Receptor; 'Reservoirs';

iii) RSPL03: Source; metals, acidic pH, cyanide, sulphide and sulphate contamination in the soil profile. Pathway; surface run off. Receptor; the 'Reservoirs' (surface waters).

iv) RSPL04: Source; metals, acidic pH, cyanide, sulphide and sulphate contamination in the soil profile. Pathway; erosion, transportation of sediments from the tip bank and/or bank collapse - the result of steep gradient and slope instability, plus leaching. Receptor; 'Reservoirs' (surface water).

4.2 Remediation Actions

Based on the relevant pollutant linkages provided above, the following remediation actions have been identified to fulfil the remediation objectives, as outlined in Section 1.3. These actions are presented in Table 4.1 below.

Table 4.1 Remediation Actions

Contaminant	Remediation Action Required
Cyanide in tip waste and at surface	**Break** exposure pathway - ingestion, pathways for site users and/or **modify** the behaviour of receptors (e.g. through fencing or strategic planting).
Cyanide, acidic pH, sulphate, sulphide, metals in tip waste / leachate	**Remove/treat** source and/or **break/modify** pathway of leaching through soil profile and migration via shallow groundwater pathways for impact to the Reservoirs. **Remove/treat** source and/or **break/modify** pathway of surface run off to the Upper Reservoir and subsequently Lower Reservoir **Remove/treat** source and/or **break/modify** pathway of erosion of the tip mass (through bank collapse or surface run-off) into the Upper Reservoir and subsequently the Lower Reservoir

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4.3 Remedial Approaches Considered

Given the complex nature of the site and contaminants of concern, it is considered that a combination of remedial techniques would likely be required to sever the pollutant linkages to human health and provide betterment to surface water quality, with the requirement that water quality in the lower reservoir is suitable for its current use (informal fishing).

A Stage 1 remedial options assessment (in line with CLR11) was undertaken in AMEC's remedial options appraisal, which identified all potential remedial approaches available and the suitability of these for the site, given the site factors, constraints, remedial objectives and contaminants of concern.

The following remediation approaches were considered further within the Stage 2 assessment as feasible options for remediation at the site.

1. Do Nothing;
2. Strategic Planting;
3. Capping and re-grading;
4. Off site disposal;
5. Stabilisation and re-grading; and
6. Permeable Reactive Barrier (PRB).

For completeness, the assessment considered two passive approaches, which included a strategic planting scheme and a 'do nothing' approach.

The costs and benefits of each approach were considered and each approach was evaluated using appropriate assessment criteria for the site. The assessment criteria were derived to take into consideration the potential effectiveness, durability, practicability of the approach as well as the specific remediation requirements for the site and factors such as cost, health & safety risks, environmental impacts etc.

4.4 Preferred Strategy

Based on AMEC's remedial options appraisal, the preferred strategy for remediation at the site is an engineered impermeable capping system incorporating a geo-composite layer with cover materials for protection on a re-profiled surface with reduced gradient. The cap directly addresses RSPLs 01, 03 and 04 and should mitigate RSPLs 02 and meets the remediation objectives. The main advantage of this system is that it provides an element of control of water entering the reservoirs through reduced leaching and through the surface water drainage, which will channel clean water into the lower reservoir. Through dilution the water quality in the lower reservoir will be improved with time. This combined with a reduced contaminant loading in the upper reservoir i.e. from mitigating surface run-off and limiting the effect of leaching will

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improve the Upper Reservoir water quality. The recent surface water sampling has identified that the water levels are now the same between the two water bodies. This is partly due to the water outfall from the Lower Reservoir being blocked and partly due to a gap being created in the reed bed which separated the two surface water features (both unofficially by local users). Future maintenance work outside this design should include the reinstatement of the drainage outfall and the reed bed as this provides a retention time to prevent mixing between the two water bodies, thus protecting the water quality in the Lower Reservoir.

The proposed capping system will cover the majority of waste with the exception of the wooded area in the northern part of the site. It will comprise a polypropylene geotextile fabric combined with a cuspated HDPE core (Pozidrain®) which acts as an impermeable barrier; overlain by a soil layer which provides a protection layer / planting medium (subsoil / topsoil). This Pozidrain® has been developed for brownfield sites and is used commonly for construction of landfill capping and lining systems, but also used for embankment/slope stabilisation and drainage, restoration capping and has excellent chemical resistance properties.

This is a robust capping system, which reduces quantities for importation of soils, is cost effective and quick to install. The remedial options appraisal has demonstrated that this system will also be more cost-effective than the permeable Teram system, due to the cost of waste disposal and has the additional benefit of improving water quality. It also has the added benefit of being difficult to vandalise, which could be an issue on site. To allow access to provide an effective cap, vegetation clearance would have to be undertaken. This would include self seeded young birch trees. The intention is to leave the more mature broad leave trees undisturbed in the northern site area. To minimise any soil erosion, grass seed (meadow mix) would be used in the final restoration layer.

The EA has indicated that the pollution to the surface water is significant and that any remediation undertaken should ensure that the lower reservoir is maintained as suitable for its current. The system will require the steep banks to be re-graded and for a drainage system to be constructed at the base of the tip. Re-profiling the slope will provide greater certainty of maintaining the integrity of the cap and the reduced gradient will provide lower energy for surface run-off thus reducing soil erosion. The Pozidrain® layer combined with drainage would provide clean uncontaminated water to enter the reservoirs ultimately providing benefit. Whilst some lateral migration of groundwater may continue to occur at the base of the tip, the impermeable barrier will prevent vertical migration from infiltration through the tip waste which will significantly reduce leaching into groundwater and thus groundwater impact affecting water quality in the reservoir. The cap will also serve to prevent contaminated surface run-off occurring which has a direct impact on the water quality in the reservoir. It is believed that high concentrations of contamination are present at the toe of the slope, the result of historical wash-out occurring from the waste. The design of the cap also serves to remove the principal pollutant linkage which is to humans from direct contact with the waste material.

The objective would be to maintain all existing materials on site. This system will meet sustainability objectives; the practicalities of undertaking the works would come at minimal disruption to neighbours; it would allow the wash out sediments to be reintegrated back into the main body of the tip (following lime treatment); and address the issue of processing soils in a confined area. The disadvantages are that the tip

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and side slopes would be cleared of immature saplings and shrubs with the exception of areas to the north and along the eastern site boundary.

The strategy does not include mitigation of pollution already caused to the reservoirs; except for the removal of some of the contaminated historical wash out sediments present in the upper reservoir along the base of the tip (see Figure 5.1).

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5. Outline Remedial Design

5.1 Remediation Objectives

As noted in Section 1.3, the objectives of the remediation at the site are as follows:

1. Reduce/remove the risk to human health, environmental harm and environmental liability from significant pollutant linkages identified on site;
2. Break (as far as practicable) the identified pollutant linkages to surface water while recognising that the main consideration for controlled waters is to ensure there is an improvement to the lower reservoir to make suitable for its current use;
3. Provide a site suitable for its current use as public open space;
4. Where practicable, be in keeping with the planned amenity use for the site;
5. Minimise the adverse impact of the remediation to off-site receptors;
6. Where practicable, utilise a sustainable approach to remediation; and
7. Provide a cost effective long term solution in accordance with Best Available Technologies (BAT).

5.2 Scope of Works

A Remediation Plan is presented as Figure 5.1. A summary of the various tasks required for the remediation of the site is provided as follows:

- Task 1 – (Pre mobilisation works), Carry out detailed design. This will include a program and address the following: specification, installation of additional monitoring boreholes, flood risk assessment, design and access statement, conceptual water balance, stabilisation trials, application for planning, permits and consents and tender process).

Following tender award remediation implementation will commence with stages outlined below:

- Task 2 – Mobilise to site and carry out Temporary Works (including site set up, remove fencing, establish site security, road pre-condition survey); and
- Task 3 – Enabling Works (including tree clearance).

Main Works:

- Task 4 – (Includes earthworks for removing existing top soil cap, stockpile for re-use and re-grade slope; excavation of wash out sediments from toe of slope, placement of granular material, plus treatment and relocation of wash-out sediment from Upper Reservoir);

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- Task 5 – Installation of cap combined with drainage system;
- Task 6 - reinstate fencing to prevent access to lower slope and water's edge plus area to north (which may be unstable), plus reinstate pathway re-using materials to ensure no unnecessary additional costs are incurred; and
- Task 7 – Validation and Water level Monitoring (monitoring works before, during and after works and validation / confirmatory sampling for imported materials, cover system thickness and groundwater level monitoring. This task does not include any post completion surface water monitoring, which may be required).

Note that several tasks may be undertaken concurrently on site during the remedial works. Indicative timescales for each task and outline programme of works is provided as Table 5.1 below. Note that a more detailed programme of works should be provided following detailed design of the remediation scheme.

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Table 5.1 Indicative Timescale for the Remediation Design and Site Works

Task	Activities	Weeks																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	Detailed Design (includes installation of additional boreholes, monitoring levels and bench scale stabilization trials etc) [a]																										
1	Procurement of Remediation Contractor [b]																										
1	Discussions with EA, MCC and UU																										
1	Permissions and Licenses [c]																										
2	Remove fencing for re-use (10 days)																										
2	Tree and shrub clearance (5 days)																										
3	Site set up & Remove top soil & Slope re-profiling earthworks (20 days)																										
4	Dredging and stabilisation of wash out sediments (allow to drain down) (10 days)																										
5	Placement of cover system (Pozidrain & cover soils) (20 days*)																										
6	Construction of drainage system (10 days)																										
6	Reinstatement of fencing (5 days)																										
7	Validation testing and monitoring [d]																										
8	Verification report and sign-off																										

Note: * Assumes 20 days if 16 wagons per day are permitted.

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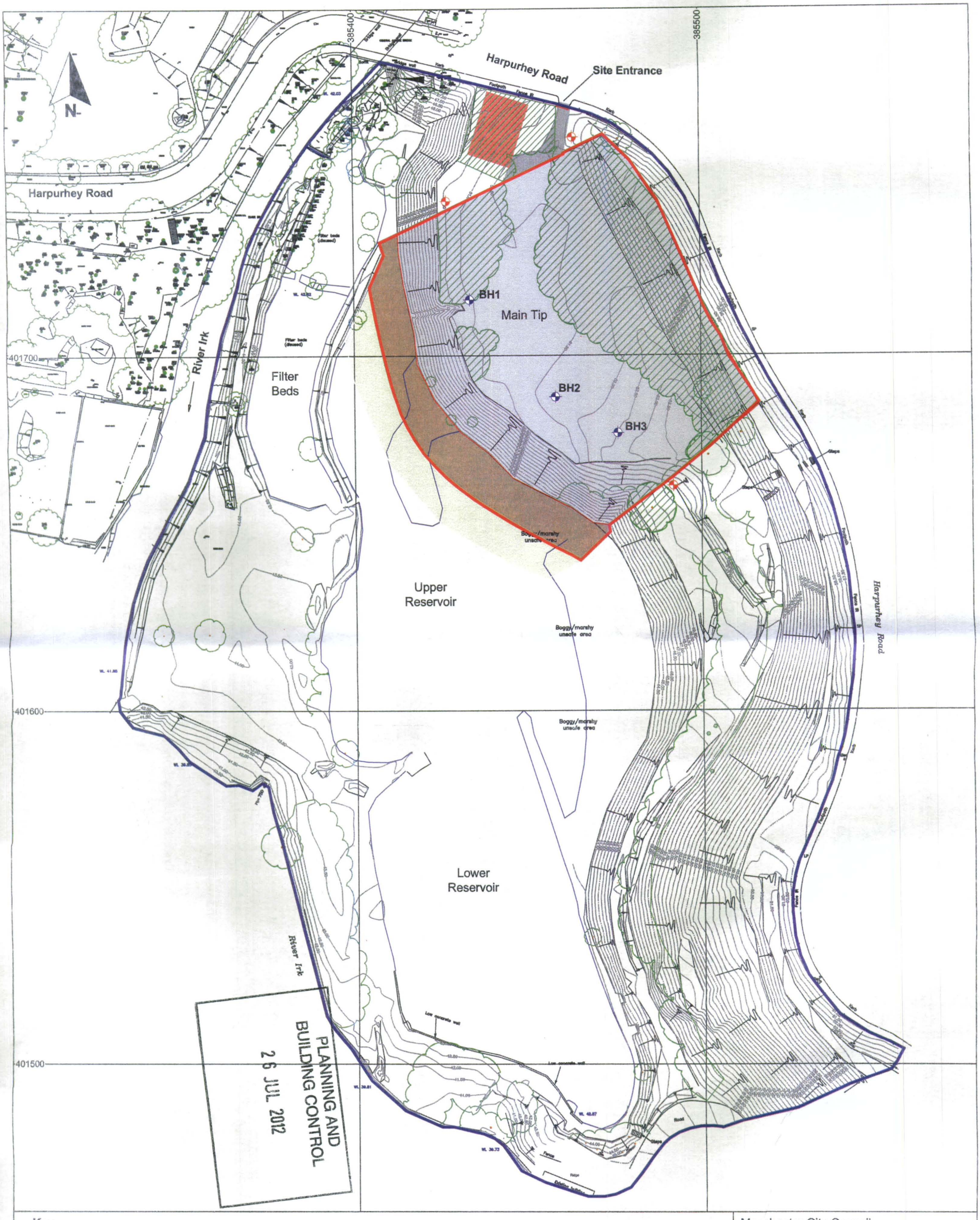
June 2012



Key

- Site boundary
- Contour
- Welfare facilities and offices
- Wash out sediments to be relocated
- Indicative area to be reprofiled and covered with cap
- Working platform at base of slope
- Vegetation clearance
- 2011 Borehole to be retained
- Route of haul road
- Estimated extent of remedial works
- New Borehole to be drilled (position to be confirmed)

0 m — 50 m

Scale 1:1000 @ A3

Manchester City Council
Harpurhey Tip site
Outline Design and Remediation Strategy

Figure 5.1
Remediation Plan

March 2012
30323-Mol011rev2.dwg youac

amec

5.3 Design Constraints

Site specific factors and constraints to the remediation works identified in the preliminary design are set out below in Table 5.2 and presented in Figure 5.2:

Table 5.2 Site Factors and Constraints and Mitigation Measures

Constraints		Mitigation
Timescale	• No agreed duration, but it is assumed that MCC will require the works to be undertaken in 2012 / early 2013 as there would be no certainty of funding for subsequent years.	• Preferred approach will be relatively quick to design and implement on site in comparison to other remediation schemes considered. The timing of the earthworks phase may be delayed by ecology on site.
End use	• The site is currently an area of public open space and the lower reservoir is used for informal fishing.	• The remediation scheme will allow the site to continue to be used as public open space and the lower reservoir for fishing.
Site Topography and Working Space	• Unstable tip materials. • Limited working area. • Access constraints. • Soft ground conditions at base of tip. • Working close to water's edge and requirement for dewatering at the base of the tip adjacent to the Upper Reservoir.	• Where practicable heavy machinery will not be located on the top of the tip. • Suitable heavy plant will be mobilised to site taking into account the soft ground conditions at the base of the tip and limited working area / access constraints. • The current access is via a bend on a busy road. A traffic management system will be adopted during the period when materials are brought to site. These may include banks man, signalling, signage etc. • Appropriate measures to support plant activities at the base of the tip will be considered during detailed design. • The extent and nature of dewatering activities will be considered during the detailed design phase with the proposed approach and disposal route for water being agreed with MCC, EA and United Utilities (where required). • The Contractor will develop a construction phase Environment Plan and Health and Safety plan. Appropriate measures will be taken to allow the safe working at the base of the tip and on unstable / boggy ground.
Contamination present	• Acute risk from exposure to cyanide from tip waste.	• Appropriate PPE to be used on site during the remediation works will be identified within the H&S plan for the site. The Contractor will ensure that all staff are made aware of the potential risks and measures to minimise exposure to contaminant materials. A shower unit and hand washing facilities will be available on site for decontamination purposes.
Service / utilities	• There are no active services on site.	• It is assumed that the site offices / welfare facilities and any other plant / equipment requiring electricity will be self contained with power provided using a diesel generator on site.
Ground and Groundwater Conditions	• Shallow groundwater and leachate is present across the tip and may cause stability issues with excavations and may need pre-treatment.	• The contractors will assess if dewatering is required to complete the earthworks phase • If required, an appropriate route for discharge of this water will be identified prior to the commencement of the work. This will be agreed with UU, MCC and the EA, as required.

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a). Timescales include for mobilisation and installation of 3 additional groundwater monitoring boreholes, 1 weeks stabilisation and then 1 levels monitoring visit. Also includes for bench scale stabilization trials.

b). Timescales are post tender award i.e. assumes a tendering process is complete and contractor has been appointed.

c). Assumes the only permit / licence agreement that are required are a Code of Practice / Materials Management Plan and any site specific amendments / risk assessments / method statements for any Contractor treatment plant Environmental Permits. Assumes a 2 week period for preparation and approval of these documents. Timescales exclude the need for other possible Environmental Permits (e.g. discharge consents to surface water or foul sewer) and / or any Ecological related permission or restrictions that may be required. The timescales shown also assumes that Planning Permission for the works (if required) area already in place.

d). Excludes post completion surface water monitoring.

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Constraints		Mitigation
Ecology	• The Upper and Lower Reservoir and filter bed are designated as a Site of Biological Importance by Manchester City Council. • Tree felling will be required on the tip and to make way for the haulage route and access to the base of the tip.	• The areas of tree clearance will be minimised as far as practicable and replaced, where requested. • The remedial approach should improve the water quality within the Upper Reservoir and minimise the risks to the Lower Reservoir. • Appropriate surveys will be undertaken to ensure that all steps are taken to minimise risk to wildlife during site works. Where required, intrusive works will be undertaken at a time to minimise disturbance to breeding birds etc. The works will include discussions with MCC ecologists as required for agreement on the approach. • It is understood that invasive species such as Himalayan Balsam and Japanese Knotweed are present in the area. However, the works proposed will not disturb these areas and no additional measures are required.
Stakeholders	• Stakeholders include the Local Authority and the Environment Agency. Further discussion with these stakeholders will be essential for development of the final remediation design.	• Discussions will be held with MCC and the EA during the detailed design phase to ensure that the works are agreed and approved, in principle, prior to procurement of a remediation Contractor • The Contractor will liaise with MCC, UU and EA, where required to ensure that the works are undertaken in accordance with the Remediation Strategy and Implementation Plan for the site.
Sustainability and BAT	• MCC require the remediation work to adhere to their sustainability objective, where practicable.	• The proposed remediation approach will re use material, where possible and minimise off site disposal and import of material to site. • A remedial options appraisal has demonstrated that the preferred approach is the Best Available Technique (BAT) for the site.
Planning/Consents/Permits	• Planning permission may be required.	• MCC will liaise with their planning department to determine if planning permission is required. In the event that it is, MCC will be responsible for ensuring that this is in place prior to the commencement of the works. • Timescales assume that Planning Permission will be obtained before start of construction works. • Any processing of soils will be carried out under an Environmental Permit which will be held by the contractors. Depending on the detailed design there may be a requirement for exemptions. Materials handling on site will be covered under a Code of Practice /Material Management Plan (MMP), which will completed by the contractor when commissioned. Discharge consents may be required.
Health, Safety and Environment	• Any remediation scheme will take measures to ensure the effect of site activities have limited impact on the local environment.	• The Contractor will ensure that a site Health & Safety plan is in place prior to mobilisation to site. This should be approved by MCC. • Appropriate Environmental Management procedures are identified in Section 8.
Security	• The site is currently fenced but is known to be accessed by local residents / trespassers. The site has also had an issue with motorcyclists and vandalism, fly tipping and bonfires on site.	• The Contractor will need to ensure that appropriate fencing is erected during the remedial works to make sure that members of the public do not enter the site during the remedial works. This is to ensure their safety with regards to minimising exposure to contaminated materials and deep excavations, but to also ensure that the risk of vandalism / theft of equipment is minimised. The use of a security team on site during the night and at weekends, when there will be limited site presence should also be considered by the Contractor.

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Constraints		Mitigation
Off site receptors	• The site is located in the vicinity of residential housing and a number of schools. • The upper reservoir separates the River Irk from the waste tip.	• The Contractor must ensure that impacts to off site receptors are minimised as far as is reasonably practicable. This may involve organising the timing of deliveries / transfer of material off site so that these do not clash with peak times, such as school pick up / drop off and minimising noise, dust and debris on the road as far as possible. • Local residents and schools will be kept informed of the commencement and progress of the remedial works, particularly the main earth works phase which has the potential to result in greater disturbance. • It is assumed that the shallow groundwater is in connectivity with the River Irk. Monitoring of the surface water in the River have not identified an issue with contaminant migration from the site to the River, however, this may change if contaminants are mobilised during the progress of the remedial works. Monitoring will be undertaken adjacent to the River from the shallow groundwater to identify any issues at an early stage and mitigate any issues as quickly as possible.

5.4 Remediation Project Team

The remediation project team will comprise the following:

- ***Client / Site Owner*** – Manchester City Council;
- ***Contractor*** – To be appointed following tender process; and
- ***Remediation Supervisor*** – independent consultant responsible for overseeing the works to ensure that the remediation is undertaken in accordance with the Remediation Strategy and Design Specification which will be recorded with compliance testing and recording of factual information.

5.5 Task 1 – Detailed Design / Pre Mobilisation Works

Task 1 will comprise the following aspects of work:

- Detailed design of the capping system, drainage and associated works & develop program and specification. As part of Task 1, three additional groundwater monitoring boreholes will be required to be installed and leachate / groundwater, reservoir and river water levels monitored on at least one occasion to feed into the Conceptual Water Balance and Detailed Design for the scheme. An allowance in the program and costings has also been included for limited bench scale sediment stabilization trails as part of the detailed design phase;
- Procurement of Remediation Contractor to undertake the works;
- Develop risk register;
- Planning and Consents related work such as preparation of a Flood Risk Assessment, Design and Access Statement and Materials Management Plan would also be undertaken in this phase.

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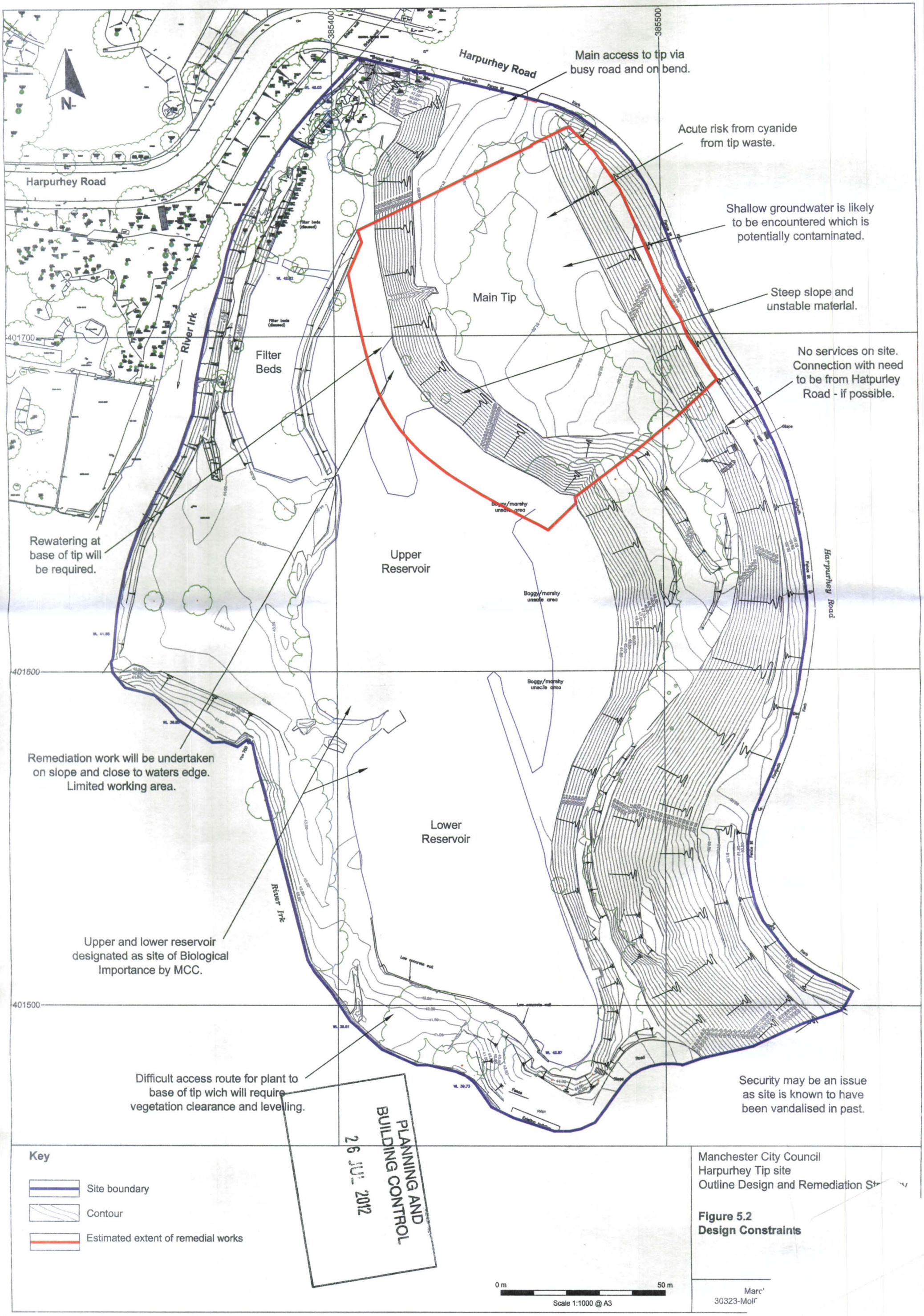
N
Harpurhey Road
Main access to tip via busy road and on bend.
Acute risk from cyanide from tip waste.
Shallow groundwater is likely to be encountered which is potentially contaminated.
Steep slope and unstable material.
No services on site. Connection with need to be from Hatpurley Road - if possible.
Main Tip
Filter Beds
River Irk
Upper Reservoir
Lower Reservoir
Boggy/marshy unsafe area
Rewatering at base of tip will be required.
Remediation work will be undertaken on slope and close to waters edge. Limited working area.
Upper and lower reservoir designated as site of Biological Importance by MCC.
Difficult access route for plant to base of tip wich will require vegetation clearance and levelling.
Security may be an issue as site is known to have been vandalised in past.
385400
385500
401700
401600
401500
Key
Site boundary
Contour
Estimated extent of remedial works
0 m
50 m
Scale 1:1000 @ A3
PLANNING AND BUILDING CONTROL
26 JUL 2012
Manchester City Council
Harpurhey Tip site
Outline Design and Remediation St
Figure 5.2
Design Constraints
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30323-Mol

At the time of writing we have assumed that the required licenses and permits (with the exception of Planning Permission) will be limited to a CL:AIRE Code of Practice / MMP and any site specific method statements / risk assessment modifications to the Contractor existing treatment plant Environmental Permits (formerly known as Mobile Treatment Licenses). The possible need to temporarily discharge of potentially contaminated tip leachate / perched groundwater and /or clean run off during the earthworks has been highlighted (see 5.8.3 Dewatering below). The need for potential Environmental Permits (discharge consents) for this will be discussed with MCC and the EA. In the event that such permits are required, the Contractor will obtain these, however, this will delay the start of the site works.

It is likely that these items will be undertaken concurrently in order to minimise the duration of the pre mobilisation works phase. Given that MCC ecologists have undertaken works for the site it has been assumed they will address the issues around ecology, which will be taken into consideration as part of the detailed design process.

5.5.1 Detailed Design

The detailed design phase is likely to comprise the following:

- MCC undertake an ecology survey – establish if measures required for mitigation to ensure timescale is not going to impact on ecological issues;
- Installation of 3 additional groundwater monitoring boreholes. Monitoring of groundwater, reservoir and river levels on at least one occasion to feed into the hydrological / water balance assessment.
- Basic hydrological / Conceptual Water Balance assessment and Flood Risk assessment to inform the detailed design for the capping system;
- Detailed design of the capping system, drainage and associated slope re-profiling works; and
- Treatability testing for stabilisation of wash -out sediments.

Detailed design for the capping system and associated works will be undertaken to provide a specification for the contractors to works to. During this phase of works several further assessment actions will need to be undertaken which will include conceptual water balance assessment. This will assist in determining how water levels may be affected by installation of the cap to ensure there are no detrimental affects – such as the lowering of the water level in the reservoirs and subsequent exposure of contaminated sludge in the Upper Reservoir. The flood risk assessment will assist in providing confidence to ensure that the cap is engineered so that there is no significant change in flood risk to the immediate area. The piped outfall from the lower reservoir has been blocked for a number of years and as a result the water level in the reservoirs is artificially high. Water currently drains via informal over-topping over the western wall of the lower reservoir. The water levels in the reservoirs shall be considered as part of the detailed remediation design along with the likely effect on the remediation scheme if they are subsequently lowered when the outfall is reinstated. Water level monitoring will be undertaken as part of the detailed design, to assess further the relationship between leachate, groundwater and the water levels in the reservoirs and the river. As explained above, this

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will require the installation of an additional 3 groundwater monitoring boreholes within the tip and gauge boards in the reservoirs.

Leachate / Groundwater Levels

In order to monitor the water levels for input into the conceptual water balance, the number of monitoring installations within the monitoring network will have to be increased. We have scoped the supplementary drilling works to augment the current leachate and groundwater monitoring network recently installed at the site as part of the slope stabilisation investigation (2011 BHs1 – 4) providing that these can be protected during the earthworks and can be extended to the new surface level created.

Three cable percussive boreholes with monitoring standpipes will be installed with the standpipe response zones designed to target either water in the waste mass or in the alluvium. The proposed monitoring network incorporating the existing new boreholes is detailed below:

- One cable percussive hole (BH1a) will be drilled adjacent to the current borehole BH1 with the standpipe response zone designed to target the groundwater in the underlying alluvium.
- Two new cable percussive boreholes will be drilled in close proximity to each other on the eastern boundary to provide triangulation across the site. One of these boreholes will be installed with a monitoring standpipe to target the water within the tip and the other will be installed to target the groundwater in the alluvium.
- The current monitoring installation at 2011 BH1 will form the down gradient monitoring infrastructure for the water level within the tip.
- The existing monitoring installations at 2011 BH2 and 2011 BH3 will be used to monitor water levels in the tip and in the alluvium respectively.

In order to establish a groundwater monitoring network, the boreholes will be advanced to depths of between 10m and 15m to target the site leachate and groundwater respectively. Each borehole will be advanced using 200mm casing and reduced to150mm where natural ground is encountered and aquifer protection measures will be employed.

Ground monitoring wells will be installed at a base depths of between 7 m and 10m below ground level (subject to groundwater being encountered at shallow depth) to target the water within the tip and between 10 and 15m to target the deeper groundwater in the alluvium (where present). The response zone of these boreholes will be specifically for the purposes of groundwater level monitoring and will be sealed within the targeted stratum. On completion, the monitoring wells will be finished with lockable up stand covers, grouted and concreted into position. In our costs we have allowed for the installation of 63 mm standpipe.

The new boreholes will be surveyed in by a specialist contractor and the standing water levels will be monitored after allowing the installations to stabilise over a 14 day period.

Surface Water Levels

The standing water levels in the upper and lower reservoirs will be monitored in situ using gauge boards that

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will be installed in an accessible area and surveyed in.

River Levels

The river level will be monitored from the road bridge using a dip meter from a defined point which will be surveyed in.

Conceptual Water Balance

A conceptual water balance will be undertaken for the site before the remedial earthworks. This aims to provide a basic (conceptual) assessment of the inputs (rainfall, infiltration, run off, leachate /groundwater flows) and outflows (surface water flows, groundwater flows) and other losses (evapo-transpiration) into and out of the hydrological / hydrogeological systems on site. This will allow a basic assessment to be undertaken of the effect of the proposed capping and drainage systems on the site hydrology and hydrogeology. The assessment will require rainfall, effective infiltration and evapo-transpiration data, surveying and monitoring of groundwater, leachate and surface water (reservoirs and river) levels to allow an approximation of annual inputs and outputs.

Bench Scale Stabilisation Trials

Small scale bench trials will be undertaken to determine the suitability of lime stabilisation for the wash-out sediments to be reincorporated into the waste. This will be controlled under a Materials Management Plan which will be developed by the contractors. As part of these trials, consideration will be given to the effect that lime may have on contaminants present in the waste material.

The detailed design will be presented within an implementation plan for the site and will include specific details relating to how the re-profiling works and capping system will be undertaken. This will also include information relating to which areas will require vegetation clearance; where the haul road will be constructed and how; how the drainage works will be incorporated into the capping system; how the dredging of sediments from the Upper Reservoir and subsequent stabilisation will be undertaken; and how dewatering will be dealt with on site during the earthworks.

5.5.2 Tender Process and Procurement of Remediation Contractor

Following the completion of the detailed design for the remediation works MCC will be responsible for procuring a suitable remediation contractor to undertake the works on site. This shall be completed in accordance with MCC's procurement policy.

5.5.3 Regulatory / Statutory Undertaker Discussions

Discussions will be required with the MCC Planning Department to determine whether the remediation works will require planning consent. It has been assumed MCC may wish to take responsibility for completing the planning application and obtaining approval for the works from the planning department.

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It has also been assumed MCC will liaise with its ecologists to ensure that any ecological constraints have been addressed through recommendations from the surveys. Any mitigation measures to be adopted during the remedial works are to be agreed with MCC and stated within the implementation plan.

Groundwater may be encountered during the slope stability works, although this is dependent on the groundwater levels at the time of the remedial works. The Contractor should liaise with United Utilities and the Environment Agency to agree suitable levels / compliance criteria for the discharge of groundwater (if required) during the earthworks phase of the remediation. These discussions should be documented and formal agreement should be sought in writing for inclusion within the verification report for the site.

5.5.4 Permissions and Licenses

It will be the responsibility of the Contractor to ensure that all permissions and licenses required are in place prior to the commencement of the remediation works.

Any 'cut and fill' with re-use of Made Ground and / or wash out sediments on the site may require an Environmental Permit, exemption from Environmental Permitting or more likely agreement under the CL:AIRE Code of Practice.

It is recommended that discussions are held with the Environment Agency (EA) to see which of the above regimes would be most appropriate to the site. In the event that the EA accept that the re-use and re-grading of site won and imported materials can be undertaken under the CL:AIRE Code of Practice[4](CoP), then a Materials Management Plan (MMP) should be drawn up by the contractor in accordance with the CoP. The Code of Practice is voluntary and sets out good practice for assessing whether materials are classified as waste or not and determining when treated waste can cease to be waste for a particular use. The EA will take account of the Code of Practice in deciding whether to regulate materials on site as waste.

The stabilisation of the wash out sediments from the Upper Reservoir and potential treatment of groundwater during dewatering activities shall be controlled under an Environmental Permit (formerly known as mobile treatment licence (MTL)). The Environment Agency view the temporary storage of waste materials, for the purposes of reclamation, restoration or improvement of land, to be associated either with deployment of an Environmental Permit (EP), or in their subsequent use, as part of an licensing/permitting / CoP position statement or a waste exemption.

The Contractor will be responsible to using either their own EP and providing a site specific method statement / working plan to the EA or obtaining suitable licensing / permitting for these works to be undertaken on site.

Any water encountered during the re-grade will be temporarily channelled to the upper reservoir and later directed through the drainage system that forms part of the main works. The need for this activity to be controlled and possibly regulated under an Environmental Permit (discharge consent) will be discussed with the MCC and the EA at the detailed design stage. If permits are required, the Contractor will be responsible for obtaining these, or finding an alternative method for managing any water encountered during the works.

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5.6 Task 2 – Temporary Works

5.6.1 Removal of Fencing

The fencing around the tip will be removed where it affects the works, temporarily stored and re-used upon completion.

5.6.2 Site Office / Welfare Facilities

Temporary site office and ancillary welfare facilities, such as hand washing and toilet facilities will be established. Given the site constraints, these are likely to be positioned adjacent to the west side of the northern site entrance (as illustrated on Figure 5.1).

The Contractor will be responsible for organising a suitable location for these facilities and agreeing this with MCC.

5.6.3 Site Security

Suitable fencing will need to be erected around the site to ensure that there is no access from unauthorised personnel. The Contractor will be responsible for ensuring that the site is secure for the duration of the works.

5.7 Task 3 – Enabling Works

5.7.1 Tree / Shrub clearance

Some vegetation and tree clearance, primarily consisting of young birch trees and shrubs, will be required at the top of the tip, and around the Upper Reservoir to facilitate the remediation works. This will be undertaken at a time agreed with MCC's ecologists, in order to minimise potential ecological impacts at the site. Figure 5.1 shows the areas which are likely to require tree / shrub clearance. The location and nature of vegetation clearance will be discussed and agreed with MCC during Task 1.

5.7.2 Installation and Protection of Monitoring Boreholes

It is understood that most of the historical monitoring boreholes have been lost, damaged or vandalised and are therefore no longer present or servicable. If during the re-grading process boreholes are found and can be salvaged then they may be protected for future groundwater level monitoring. Assuming the original monitoring wells have been lost/damaged, it is proposed that three new borehole will be installed along the periphery of the area to be re-graded/capped in an attempt to avoid losing these during the remedial works. The purpose of these new boreholes is to provide groundwater level data for input into the conceptual water balance / detailed design. Ideally these boreholes will be protected and retained during the earthworks so

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that they can be used for post completion monitoring purposes. Protection of boreholes can usually be achieved by placing concrete manhole chamber rings around them, however, the Contractor will be required to provide a methodology to ensure the boreholes are protected and retained. Water level monitoring will also be useful for verification purposes to determine the affect the cap is having locally on the water table levels. If the water levels in the upper reservoir drop then sediments may become exposed opening a potential human exposure pollutant linkage. The requirement for these additional boreholes will be discussed and agreed with the EA as part of the detailed design.

5.7.3 Decommissioning Boreholes

A number of the boreholes have been vandalised and are therefore no longer functional. Boreholes which are installed within the body of the waste can be abandoned as they do not pose a risk for vertical migration. Boreholes with screened sections in the alluvium will require formal process of decommissioning in accordance with the procedures set out in the Environment Agency Guidance Note – '*Good practice for decommissioning redundant boreholes and wells'* dated January 2012.

The abandoned and decommissioned boreholes are listed in Table 5.3 below.

Table 5.3 Boreholes to be Abandoned and Decommissioned

Boreholes to be abandoned	Boreholes to be decommissioned
	TSDBH9
TSSBH1	TSSBH10
TSSBH2	TSSBH12
TSSBH4	TSWS4
TSLBH5	TSWS8
TSLBH6	
TSLBH7	
TSLBH8	
ECBH4	

5.8 Task 4 – Main Remediation Works

5.8.1 Topsoil Strip

Prior to the slope re-profiling works the existing topsoil on the tip (300mm deposited as a temporary cover system by MCC) will be stripped using a tracked excavator. The top 200 to 250mm will be stockpiled for re-

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use following the placement of the cover system. This will be subject to compliance testing to ensure that it is suitable for re-use within the cover system (see Section 5.11 for further information).

The remaining 50 to 100 mm will be left in-situ as there is the potential for mixing to have occurred with the underlying tip materials. This material will be re-profiled along with the tip waste during the re-profiling works.

5.8.2 Slope Re-profiling

The intention of re-grading the western slope of the tip is to provide a more stable slope and to reduce the energy from any surface water run-off which washes material out/off from the body of waste from the tip. Using a topographic model, Figures 5.3 and 5.4 provide three cross sections illustrating the existing profile through the waste and compares this with the regraded slope. To date one mechanism which impacts the water quality in the upper reservoir is from surface run-off which provides increased sediment loading with concentrated contaminants accumulating between the toe of the slope and the surface water body. The intention is to provide a reduced gradient. As part of the re-grade a levelled area will be provided along the length of the tip, which may be used as a footpath forming part of the cap, placed mid-way up the slope which will provide a view across the reservoir. From the northern site boundary to approximately 40 m within the site, the area will remain unaltered. The existing mature broad leaf trees in this northern area shall remain undisturbed, whilst the remaining area will undergo re-profiling earthworks.

The re-profiling works will include the following:

- Remove existing fencing taking care not to damage and temporarily store for future re-use.
- Strip back between 200 and 250mm of existing top soil and stockpile in an area of the site where it can be re-used at the end of the works. Also remove gravel placed along the existing pathway for possible re-use.
- Remove birch trees to provide open area for installation of the cap - identified for re-profiling. To minimise disposal costs the trees can be chipped and kept to one side to be added to top soil as the final cover layer to the cap.
- Create a ramp to the bottom of the slope plus a level surface for a machine to use as a platform for excavating the wash out sediments – likely to extend 5 m out and approximately 0.8 m depth for the length of the slope. It is proposed these materials will be piled up allowing it to drain down over a number of days, turning occasionally before undertaking lime treatment.
- Starting from the top of the existing slope, draw material back in line with the upper bank approximately 10 m in from the eastern site boundary. The cut and fill process requires the movement of around 7700m^3 to alter the slope from a 1 in 2 to a 1 in 4 gradient. Once excavated to achieve the required re-grading, the waste material is to be placed in no greater than 300 mm layers and compacted using a tracked excavator. The final 300 mm layer should be free from oversize stones/cobbles/boulders, to avoid puncturing the capping system. Therefore this material may is likely to require riddling prior to placement. No compaction using a vibrating roller is required.

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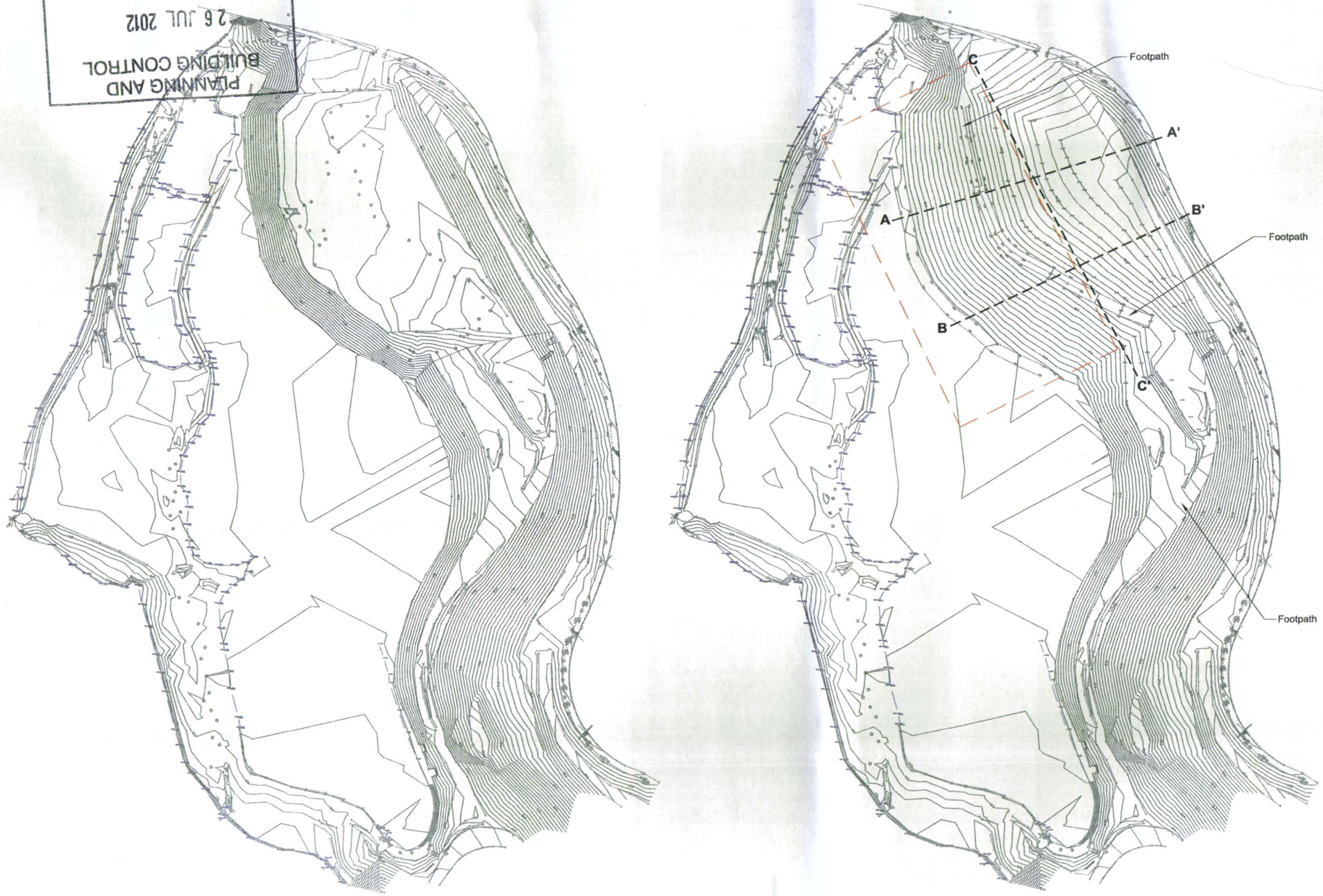
Existing Profile of Harpurhey Tip

Regraded Profile of Harpurhey Tip



Key

Line of cross section shown on Figure 5.4

Area of detail shown on Figure 5.5

0 m 75 m

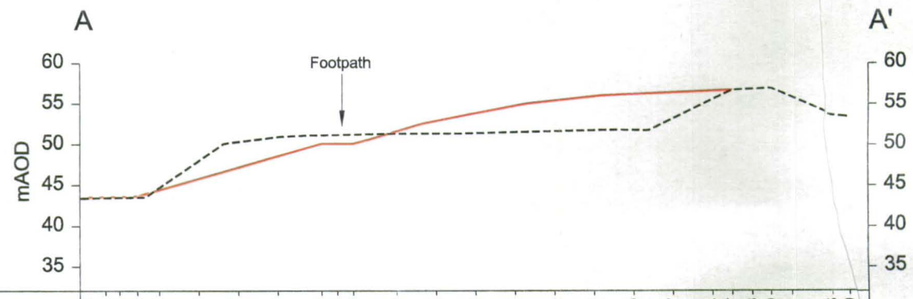
Scale 1:1500 @ A3

Manchester City Council
Harpurhey Tip Site
Outline Design and Remediation Strategy

Figure 5.3
Topography Pre and Post Regrading

March 2012
30323-Mol06.dwg parkj

amec



| Datum 33.0mAOD | | |

- After creating the revised slope profile an excavation will be opened up to receive the wash-out material from the base of the slope. This will be of sufficient size to accept the waste but keeping it above the water table currently at ~45 m AOD.

- At the base of the slope the intention is to excavate a series of trenches perpendicular to the toe of the slope with ~3 m centres (say 0.5 m width and 0.5 m depth and 5 m length from the toe). These will be filled with gravel to act as French drains behind the cap. This is a preventative measure to protect the cap against groundwater percolating through the waste laterally and building up a pressure head behind the engineered cap. The groundwater moving laterally will be encouraged to pass into the upper reservoir.

- Having removed the sediments from the wash-out material the void created will be backfilled with gravel/cobbles to allow drainage.

5.8.3 Dewatering

Dewatering is unlikely to be required as part of these works. If during re-grading works a spring line appears, then this will be temporarily directed into the upper reservoir until the formal drainage system has been constructed. Thereafter the drainage will allow water within the tip to continue to discharge to the upper reservoir, though this will be lateral flow and not from vertical migration. The base-flow into the Upper Reservoir will continue as normal though with the benefit of reduced leaching from the waste tip. Surface water will collect along the surface of the cap, as clean water and will be channelled through drainage to the lower reservoir as clean water as described in Section 5.8.5. The acceptability of this solution is to be agreed with the Environment Agency.

5.8.4 Stabilisation

The eroded materials at the base of the tip will be excavated / dredged during Task 4. This material is likely to be saturated and therefore following excavation it will be mounded up on a platform at the toe of the tip to allow it to drain down reducing the moisture content. There will be benefit in turning the material over to encourage drainage prior to the addition of lime or cement. Lime or cement addition shall be completed at around 2 % allowing it to stand for a couple of days after again turning the material over to ensure the lime is consistent throughout the spoil. The exact amount of lime or cement required to stabilise this material will be determined during the bench scale treatability trials to be undertaken during Task 1. After a period of curing the material will be placed within the tip in the unsaturated zone during re-profiling of the slope.

5.8.5 Engineered Cap

A capping system is required at Harpurhey in order to reduce the surface water infiltration into an area of gasworks waste material which is currently leaching contaminants into the reservoir(s).

An engineered capping system comprising a Pozidrain geocomposite membrane, combined with surface cover of imported 'clean' material will provide a solution to meet the remediation objectives. The Pozidrain comprises a high strength flexible polyethylene cuspated core bonded to two layers of non woven geotextile.

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The system has been a well proven system for brownfield sites which includes in its application landfill lining and capping systems. The material is laid out from roles 4.4 m width and 50 m length, directly onto the surface of the waste. These will be rolled down the slope perpendicular to the toe. The edges are overlapped with the HDPE core either butted against each other or overlapped slightly (having peeled back a layer of geotextile). The material is puncture resistant and the cuspations allow water (and gas if required) to migrate along its surface freely. The material is impermeable comprising an HDPE cuspated membrane; though the seams are not entirely water tight as they are not welded. A role of Pozidrain will be laid perpendicular to the roles laid out on the slope, along the toe of the slope in an excavated channel. This will maintain separation between surface run-off and groundwater base-flow. The trench will carry 'agri-drain' and gravel as part of the drainage system. Further detailed will be provided as part of the detailed design. It is anticipated approximately 90% of any infiltration will be directed along the surface of the Pozidrain into a managed drainage system.

Having rolled out the geocomposite, soil will be placed over the top to a minimum 500 mm thickness. This acts to weigh down and protect the geocomposite and provide a running surface for traffic or pedestrians. A thicker cap, perhaps 800mm thickness, provides greater protection and resistance from erosion and would provide a root zone if planting is required in the future, plus it provides protection from burrowing to rabbits. The less cover material used will reduce the robustness of the cap and will limit any future planting schemes. The overlying soils will be tracked rather than compacted, using a D3 type dozer (or similar) to move materials into place. As part of the re-profiling an area running the length of the tip, 1.5 m width, will be left level which may be used as the base of a footpath if required in the future.

Imported material for the protective cover will comprise a combination of hardcore base to approx depth of 300 mm (to limit rabbit damage) and imported / site won sub-soil and topsoil to approximately 200 mm as cover and growing medium for grass seed. This will comprise site won sub-soil / topsoil for cost effectiveness, but will also act as a suitable growing medium to support growth of grass. A grass seed mix will be sown to bind together surface soils and prevent erosion of the engineered cap.

The initial surface topsoil layer already present overlying the waste (approximately 5,000 m^2, 0.2 m thick, so estimated 1000 m^3) may be excavated and stockpiled for re-use within the engineered capping system. The remaining gasworks waste material will be excavated using a cut and fill approach to achieve the required grading of no less than a 1 in 4 slope.

Imported material (including the segregated sub soil / topsoil) will be placed overlying the cap comprising the following:

- 200 mm of sub-soil / topsoil (including the 1,000 m^3 segregated as part of the cut and fill works); and
- 300mm imported hardcore (typically recycled MOT (Type 1) with a <50 mm grading).

The total area to be capped is approximately 7800 m^2 and the volume of material required for placement overlying the capping membrane (at 0.5 m thickness) is 3900 m^3, based on the following:

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- 560 m^3 imported sub-soil;
- 1000 m^3 recovered sub soil / topsoil from the cut and fill works; and
- 2340 m^3 imported hardcore (as specified above).

The imported material shall be placed in two layers, a layer of hardcore, overlain by the sub-soil / topsoil. This shall be compacted using a tracked excavator. No compaction using a vibrating roller is required.

Specification for Imported / Site Won Sub and Topsoil:

Sub-soil / topsoil are required to form a suitable growing medium at the site. The imported sub soil / topsoil should meet the specification agreed for the site. A sample frequency of 1 per 250m^3 will be used, however this requirement may be relaxed where sufficient provenance details can be provided.

The analytical suite and acceptance criteria will be agreed with both MCC and the EA during the detailed design stage.

In addition, no visible or olfactory evidence of contamination should be observed. Samples shall be collected as 'end-tipped' from wagons prior to placement.

Hardcore

The required imported hardcore should be of a grading less than 50 mm and preferably comprise recycled material in order to increase the sustainability of the capping layer. The imported hardcore should meet the specification for the site, with regard to contaminant concentrations and leachability. A sample frequency of 1 per 250m^3 will be used, however this requirement may be relaxed where sufficient provenance details can be provided.

The analytical suite and acceptance criteria will be agreed with both MCC and the EA during the detailed design stage.

5.8.6 Drainage

The drainage comprises two elements. The first is to have a French drain system at the bottom 5 m of the slope, below the cap, to prevent lateral flow of groundwater building up and breaking through the underside of the engineered cap. This water may potentially be impacted as it passes laterally through the waste tip. The cap may have the localised effect of reducing the water level in the area below the tip and therefore the French drains may only come into use during periods of increased height in the water table. The secondary drainage system collects 'clean' water from surface run-off from the upper side of the cap. This includes

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directing surface water run-off through the geocomposite Pozidrain, collected in an 'agri-drain' at the base of the slope and channelling it as clean surface run-off around to the Lower Reservoir.

At the base of the slope the intention is to excavate a series of trenches perpendicular to the toe of the slope with ~5 m centres (say 0.5 m width and 0.5 m depth and 5 m length from the toe) as illustrated in Figure 5.5. These will be filled with gravel to act as French drains behind the cap.

5.8.7 Reinstate Fencing

The purpose of the fencing around the tip prior to remediation was to prevent public access to the exposed tip material. The remediation works will address this issue and hence the fencing will no longer be required for this purpose. However, it is likely that fencing will be required to prevent members of the public entering the Upper Reservoir via the tip slope and hence some of the former fencing could be reinstated along the slope for this purpose. The proposed alignment of the reinstated fence will be discussed and agreed with MCC during Task 1 and the detailed design phase.

5.9 Task 7 – Verification and Monitoring

The remediation supervisor will be responsible for the following:

- Undertaking validation samples for imported materials;
- Undertaken depth /cover thickness validation;
- Collecting surface water samples from the reservoirs;
- Undertaking QA/QC for the cap construction; and
- Undertaking site monitoring such as groundwater levels from boreholes and any environmental monitoring that may be required. It is proposed to monitor water levels in three existing boreholes (BH1 – BH3 installed for the slope stability assessment in 2011) and in three new boreholes BH1a, BH4 and BH4a). Boreholes requiring water level monitoring are included in Table 5.6 below. Where possible, a water level reference stick will also be positioned adjacent to the bank of the Upper and Lower Reservoir so that the water levels within these two water bodies can be monitored during the works. River level monitoring will also be undertaken during the works.

Table 5.4 Boreholes to be utilised for Monitoring

Borehole reference	Screened zone / purpose	Existing / Scheduled Depth (m bgl)
Existing borehole BH1 (2011)	Made Ground / Tip Waste / To monitor leachate levels in waste	10.5
Existing borehole BH2	Made Ground / Tip Waste / To monitor leachate levels in waste	9.0

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(2011)		
Existing borehole BH3 (2011)	Sand River Terrace Deposits / To monitor groundwater levels in underlying sands	12.0
New borehole BH1A (2012)	Sand River Terrace Deposits / To monitor groundwater levels in underlying sands	15.0
New borehole BH4 (2012)	Made Ground / Tip Waste / To monitor leachate levels in waste	10.0
New borehole BH4A (2012)	Sand River Terrace Deposits / To monitor groundwater levels in underlying sands	15.0

5.9.1 Validation of Cover Thickness

The thickness of the final cover system will be appraised and validated using a combination of;

1. Contractors as built (i.e. as placed) records, measurements and photographs.
2. Comparison of pre and post topographic survey data.
3. Through the use of a series of small hand excavated cover thickness validation pits. These will be excavated across the cover area (approximately 7800m^2 in total) on a regular grid of 1 test pit every 25m^2 (i.e. 25 m grid). At each location the depth of topsoil, sub soil and granular hardcore will measured, logged and photographed. A photograph clearly showing the measuring staff and cover thickness will be taken.

5.9.2 Surface Water Monitoring Requirements

In order to establish the chemical quality of the River Irk and the upper and lower reservoirs prior to and following completion of the remedial earthworks, it is proposed to undertake a surface water monitoring programme which comprises two phases of works. The purpose of the river quality monitoring is to monitor any changes in contamination status within the River which could be attributed to the tip as a result of the potential mobilisation and migration of contaminants within the alluvium groundwater during the remedial works.

The first phase of the surface water monitoring programme will entail a single monitoring visit to augment the baseline chemical quality of the site's surface waters collected previously, prior to the start of remedial earthworks. It is intended to collect samples for testing from three designated sampling points (upstream, midstream and downstream) on the River Irk i.e. up, at and downstream of the potential discharges from the site and at two location in the upper reservoir and three locations in the lower reservoir. Sample locations will be agreed with EA and MCC during the Detailed Design stage, but are likely to include some of the recent sampling locations to allow comparison to the existing data set. Samples will be collected and analysed for the approved specified water chemical quality suite at an UKAS accredited laboratory.

The second phase of surface monitoring will be undertaken following the completion of the remedial earthworks (i.e. will not form part of the remedial works itself). It will entail an annual monitoring programme comprising quarterly monitoring visits using the same designated points as used for the baseline monitoring phase. Samples will be collected and analysed for the specified water chemical quality suite as baseline samples and the chemical quality data will be compared against the data recorded for the baseline

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and specified screening criteria to ascertain any adverse changes in the chemical quality at the downstream compliance point.

Samples of surface waters will be collected from the designated monitoring points in accordance with methodologies described in the Environment Agency Technical Guidance Note 2. Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water and British Standard for Water Quality Sampling (BS EN ISO 5667: 2006 Parts 1, 3, 6, 9 and 18) will also be adopted throughout monitoring and sampling of the surface waters throughout the duration of the programme.

For the majority of surface water samples, a dip or grab sample will be appropriate (as described in the methodologies provided in the EA Guidance document TGN02 and the BS ISO5667: 2006 Part 6). Physicochemical parameters will be recorded in-situ using a calibrated YSI 556m multi-parameter meter (or similar) and field observations and details for each sample point.

Analysis and Screening Criteria

Water samples will be tested for the following contaminants presented in Table 5.5 and screened against determinands presented in Table 5.6 below.

Table 5.5 Surface Water Analysis

Metals and metalloids [a]	Other contaminants
Lead	pH
Chromium	Conductivity
Copper	Ammonia
Arsenic	Free cyanide
Zinc	Sulphide
Iron	BOD
Nickel	COD
Mercury	Ammonical nitrogen
Cadmium	Nitrate
Manganese	Nitrite
	Sulphate

a – total and dissolved

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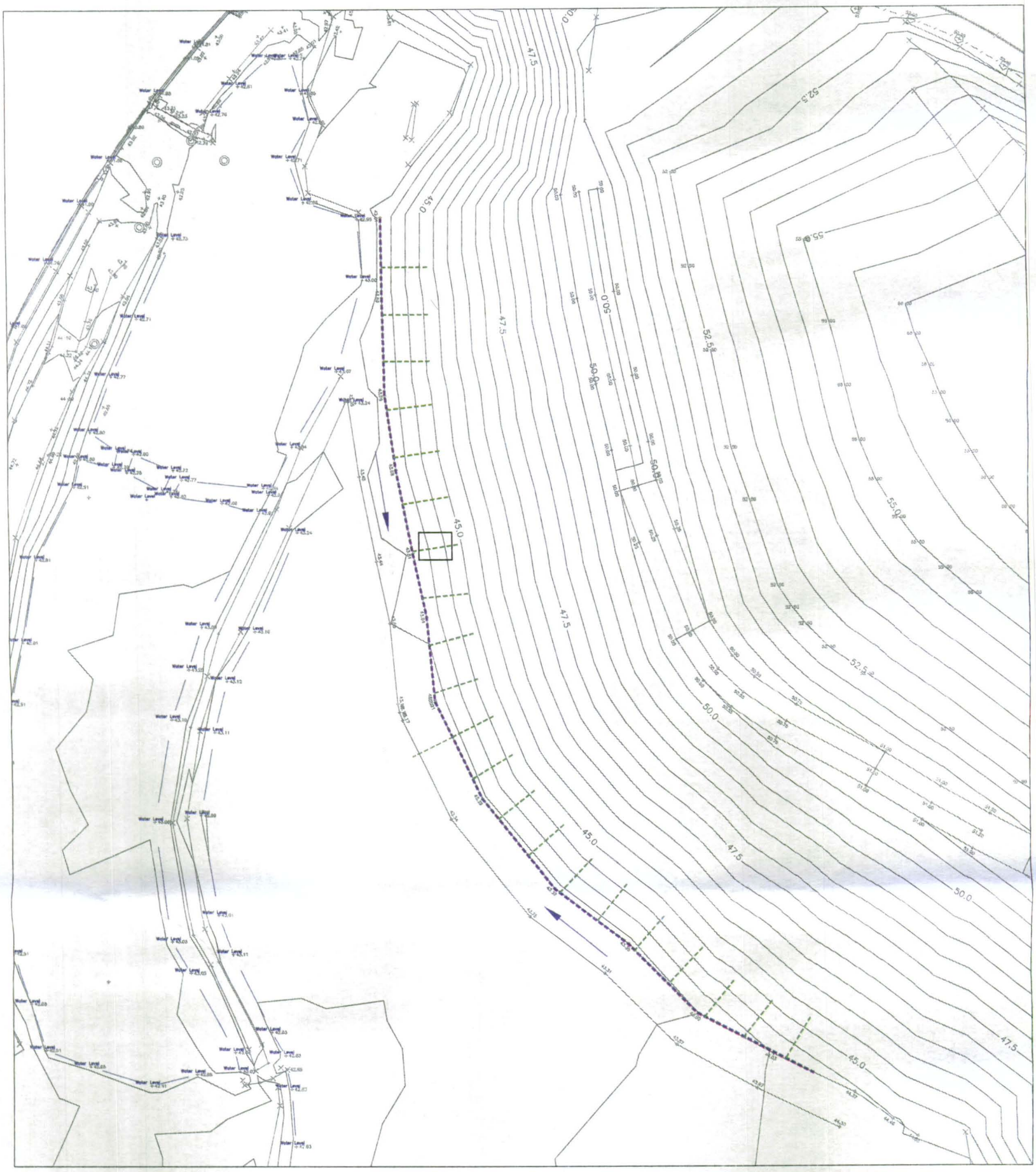
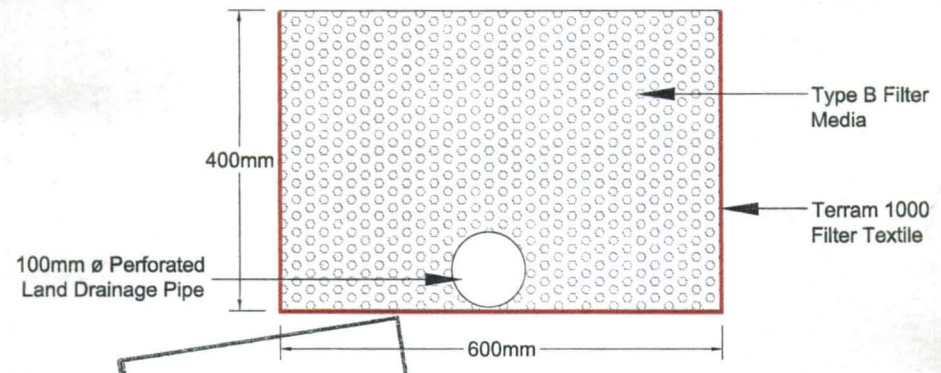


Filter Drain Type 1
Scale 1:10



PLANNING AND BUILDING CONTROL
26 JUL 2012

Key

- Carrier drain
- Filter drain (counter fort drain)
- Direction of flow

0 m — 30 m
Scale 1:500 @ A3

Manchester City Council
Harpurhey Tip Site
Outline Design and Remediation Strategy

Figure 5.5
Drainage Detail Below Engineered Cap

April 2012
30323-Mol08.dwg parkj

amec

Table 5.6 Screening Criteria for Water Monitoring

Contaminant	Screening Criteria µg/l
Dissolved Lead	7.2[a]
Dissolved Chromium III	4.7[a]
Dissolved Chromium IV	3.4[a]
Dissolved Copper	28[a]
Dissolved Arsenic	50[a]
Total Zinc	125[a]
Dissolved Iron	1000[a]
Dissolved Nickel	20[a]
Dissolved Mercury	0.05[a]
Dissolved Cadmium	0.25[a]
pH	6.0-9.0[b]
Ammonia	0.6[a]
Free cyanide	1[a]
BOD	5.0[a] mg/l
Manganese	30
Sulphate	400,000

a - River Basin Districts Surface Water and Groundwater Classification (Water Framework Directive) (England and Wales) Direction 2010

b - National Environmental Quality Standards (EQS) – List II substances. Source DoE Circular 7/89

5.9.3 Environmental Monitoring

Monitoring for hydrogen cyanide and hydrogen sulphide will be undertaken during the main earthworks phase of the remediation. Monitoring will be undertaken at the start of the day, during lunch and at the end of the day, or at more regular intervals if deemed necessary. Measurements will be collected from the areas of the site where people spend most of their time (i.e. at the excavation face, site office and welfare facilities). This is a precautionary measure as these gases have never been measured on site at concentrations that are considered to present a risk to site users.

A weather station will be installed on site for the duration of the work to monitor rainfall and wind direction.

Exposure to dust originating from exposed tip waste will present an acute risk to site workers (via ingestion of dust). As a result, suitable PPE will be worn by all site workers and dust suppression measures may be required.

If required, noise, odour and dust monitoring will be carried out at the site. The requirements will be agreed with MCC during the detailed design, Task 1 and will be reviewed in the event of any complaints being

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received from local residents and site neighbours. Note the odour nuisance issues may arise when the waste materials within the tip are exposed during the reprofiling works. As a result, odour suppression measures are likely to be required.

5.9.4 Verification Testing

There will be a requirement for verification testing to be undertaken during the site works to ensure that all highly contaminated sediments are removed from the verges of the Upper Reservoir. The number of samples collected will be dependent on the area and amount of sediment removed from the Upper Reservoir and will be under the discretion of the Remediation Supervisor. However, it is proposed approximately 8 samples will be collected along the 80 m length of the tip slope.

The samples will be analysed for total and free cyanide, elemental sulphur and pH on an accelerated 3 day turnaround. The samples will be compared against the validation criteria specified within Table 5.7 below to ensure that all highly contaminated wash out sediments have been removed and the results will be reported back to the Contractor and MCC within 24 hours of receipt of the analytical results.

Table 5.7 Validation Criteria for Wash out Sediments

Contaminant	Criteria
pH	pH 5 to 8
Free cyanide	330 mg/kg [w]
Total cyanide	8300 mg/kg [w]
Elemental sulphur	10 mg/kg [x]

w – AMEC site specific assessment criteria derived for acute ingestion present with AMEC's Addendum B20(c) report[3]

x – Laboratory limit of detection

In the event that any of the validation samples exceed the validation criteria the Remediation Supervisor will determine if further removal of material and subsequent testing is warranted. The proposed approach will then be agreed with the Contractor, MCC and the EA before proceeding.

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6. Indicative Costs

Indicative / budget cost estimates are summarised in Tables 6.1, 6.2 and 6.3, below. These are based on the installation of the capping membrane/system and the placement of 0.50 m of material overlying the capping system.

Indicative costs are presented for the 3 main phases of work i.e:

1. Pre-Construction Phase (i.e Detailed Design ((borehole installation, levels monitoring, water balance assessment, detailed design), procurement of a Contractor (preparation of specification, tender documents, tender assessment, meetings etc)), Planning related work ((i.e. Flood Risk Assessment / Design and Access Statement)), obtaining licenses and consents ((e.g. Code of Practice Agreement / preparation of Materials Management Plan)).
2. Construction Phase.
3. Post Construction Phase Surface Water Monitoring.

Table 6.1 Summary of Cost Estimates for Pre Construction Phase Works

Item	Cost (£)
Installation of 3 additional groundwater boreholes and surface water gauge boards (x2) and monitoring of water levels on 1 occasion. Includes 1 round of pre construction baseline surface water sampling, analysis and reporting from 8 locations.	10000
Detailed Design including Conceptual Water Balance	12000
Flood Risk Assessment and FDI application & supporting design drawings / specifications	5000
Design and Access Statement	3000
Materials Management Plan / Qualified Person review and sign off	3500
Bench Scale Stabilisation Trial	1000
Procurement of Contractor (preparing specification and tender documents, tender evaluation / meetings etc)	12500
Total	**47000**

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Table 6.2 Summary of Cost Estimates for Construction of Cap (0.5 m Capping Thickness)

Item	Cost (£)
Weekly establishment [1] on site (£5000 x 12 weeks)	60,000
Removing and re-installing fence (nominal sum)	15,000
Verification sampling imported soils	2500
Tree felling and chipping (nominal sum)	10,000
Excavation and turning treatment of wash-out material (600m^3 x £7.5/m^3 includes lime at 2%)	4500
Re-profiling Excavation (7700m^3 x £3/m^3)	23,100
Pozidrain (£4/m x 7800m^2)	31,200
Imported sub-soil [2]/ (560 m^3) inclusive of haulage (to make up difference with recovered top soil), includes gravel for French drain.	9000
Imported Recycled MOT (Type 1 <50 mm) (2340 m^3 0.3 m depth), inclusive of haulage.	44,500
Placement of protection layer (3900m^3 x £2/m^3)	7800
Seeding of topsoil with Meadow Grass[4] (assumes 7800m^2)	2000
Remediation Supervision and Verification including acting as Project Manager under NEC type contract[3]	19,650
Total	**229,250**

Note 1: The cost estimates provided are an estimate based on AMECs experience. Accurate weekly establishment costs cannot be provided until a specification and schedule have been developed and costed by the Contractor. However, Weekly establishment costs **typically** include:

- Site based supervisory and management staff e.g. site agent and foreman
- Site based general staff e.g. chainman and labourer
- Visiting supervisory and management staff e.g. quantity surveyor, health
- and safety manager etc
- Site accommodation e.g. offices and welfare facilities
- Site based general transport e.g. pick-up, diesel bowser etc
- Site services e.g. electrical generator, phones/communications, water,
- sanitation
- Monitoring, safety, surveying and testing equipment
- Site maintenance e.g. water control by pumping, dust and odour suppression, road
- sweeping etc
- Fencing and security

Note 2: Assumes cost for sub soils of approximately £16/ m^3.

Note 3: For the site supervision we have assumed the works duration is likely to be between12 and 14 weeks. We have allowed for part time site supervision for 20 days over this period to ensure the works are compliant with the specification.
• • We have assumed that the procurement strategy will be a traditional one, rather than a Design and Build form of contract.
• Allowance has been made for the production of 3 copies (both hard and electronic) of the design drawings, statements and implementation plan. Additional report copies will be charged on a time and expenses basis.
• We have assumed MCC will make enquiries into matters around the Planning Application process for the works. The remediation statement can be used as supporting information if required for the planning application
• For the above costing exercise we have assumed there is no requirement for additional Detailed Quantitative Risk Assessment or derivation of remediation criteria.

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• It is likely that the proposed remedial works will constitute 'construction works' under CDM and as they are likely to last longer than 30 days the project will be notifiable under the CDM Regulations 2007. The costs do not include for any CDM related work.

Note 4: Assumes a rate of approx 25 p/ m^2 for seed and application.

Table 6.3 Summary of Cost Estimates for Post Completion Surface Water Monitoring

Item	Cost (£)
Post completion surface water monitoring (8 location x 4 quarterly visits over 12 months). Includes sampling[1], testing (as per table 5.7) reporting and project management.	6000
Total	**6000**

1. Assumes the MCC would be able to provide a second man for Health and Safety reasons.

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7. Changes to the Remediation Strategy

In the event that remediation is unable to proceed in accordance with the approved remediation strategy due to practical, technical or financial reasons or other unforeseen circumstances, discussions will be held with all parties and a revised remediation strategy shall be submitted for the approval of MCC and EA, where required. Works thereafter shall be carried out in accordance with the revised remediation strategy.

7.1 Project Risk Register

A project risk register will be developed during the detailed design phase and will comprise information pertaining to potential key risk areas where the program and costs may be affected. For the site in question key risks are likely to comprise the following:

- Adverse weather, such as heavy rain may prevent work occurring on the site due to the potential for flash floods, particularly within the lower lying areas of the site. Likewise, heavy snow will restrict earthworks movements across the site and digging if the ground is frozen / icy. The Contractor should minimise earthwork activities during the winter months to minimise the risk of time lost due to adverse weather.

- Security – as discussed the site has previously had issues with vandalism and appropriate security measures will need to be in place to prevent this occurring during the remedial works. See Section 5.6.3 for further information.

- Unexpected ground conditions and – numerous investigations have been undertaken on the site, however these have concentrated on characterising the ground conditions within the main tip. Limited information is available with regards to the deeper ground conditions at the base of the tip and for the contaminated wash out sediments. With regards to the contaminated sediments, no information is available to determine the likely depth and extent of contamination and hence a precise estimation of the amount of material requiring excavation and relocation is currently unknown. The Council and Contractor will need to ensure that suitable contingency sums are applied to this to take into account the potential for a greater quantity of material requiring removal.

- Availability of materials – the Contractor will be responsible to obtaining the materials required to complete the remedial works in a timely manner agreed with the Council. Where material is required to be imported to site, this should be identified and where possible a supply date should be agreed to ensure that this is imported when needed to avoid holding up the remediation.

- Environmental issues as a result of the remediation – noise / dust complaints or incidences may occur which could delay work until a solution is found. The Contractor must ensure that suitable procedures are in place during the remediation works to avoid such events occurring.

- Exceedance of discharge consents – in the event that the water levels encountered exceed the discharge consents an alternative disposal route or pre-treatment will be required. Alternative solutions should be agreed during the detailed design phase so that these can be implemented quickly on site to avoid significant delays in the disposal of water on site.

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- Migration of contamination – in the event that the migration of contaminants towards the River Irk or worsening conditions are noted within the Upper or Lower Reservoir, works will need to be stopped until the potential source of contamination is identified or appropriate steps can be taken to minimise the long term impact of the watercourse. Depending on the scale of the impact this may have an impact on timescales for the remediation, resulting in some down time if such an event occurs.

- Unexpected contamination or unrecorded features - The discovery of unexpected, 'significant' contamination or unrecorded features such as tanks, culverts, shafts etc must be brought to the attention of the Site Manager or his nominated representative immediately. All works in the area must be halted immediately until the Contractor and Remediation Supervisor have defined any necessary action to be taken.

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8. Health & Safety

The Contractor will be responsible for producing a Construction Phase Health and Safety Plan under the requirements of the Construction (Design and Management) Regulations 2007. As part of the detailed design a pre-construction phase hazard identification and risk assessment will be completed to inform the Construction phase plan. This will include (but not be restricted to), the following measures relating to contamination and working activities:

- Working practise should conform to the Health and Safety Executive Guide 'Protection of Workers and the General Public during the Redevelopment of Contaminated Land, 1991'.
- The contractor shall make all personnel working on the site aware of the possible presence of contamination and the need to take precautionary measures. The lists of known hazardous materials likely to be encountered include but are not necessarily restricted to; cyanide, acidic pH, metals and elemental sulphur in soils and groundwater.
- Potential hazards which could occur as a result of the remedial works and appropriate measures to mitigate against these should be identified within the Health & Safety Plan. These are likely to include:
  - working on slopes;
  - unstable ground conditions;
  - working close to water;
  - working close to operating machinery and plant;
  - tree felling;
  - issues with security and public interface;
  - working in and adjacent to deep excavations;
  - acute risk from cyanide contaminated materials;
  - potential dust and gas generated from re-graded soils; and
  - access constraints to site.

The following Health and Safety measures shall apply to all site staff and visitors.

- Site induction course to be conducted for all personnel on site.

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- Personnel protective equipment (including overalls, safety hat, safety boots, dust masks, volatile organic compound / vapour resistant half masks gloves, and eye protection where appropriate) must be worn and fully maintained.

- Personnel must use decontamination / washing facilities prior to leaving a working area of the site.

- Strict personal hygiene should be promoted at all times. Contaminants may enter the body by skin penetration, skin absorption, ingestion or inhalation. Smoking or the consumption of food or drink shall not be allowed within any potentially contaminated areas.

- All personnel should be given advice on diseases associated derelict and potentially contaminated sites such as Leptospirois (Weil's disease) and tetanus etc.

- Personal entry into any trench or excavation should be avoided wherever possible. When working in confined spaces and / or undertaking deep excavations, adequate precautions including gas monitoring prior to entry and throughout the duration of the work must be taken against the hazards to oxygen deficiency, flammable, explosive or toxic gases and dust, including asbestos.

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9. Environmental Site Management

9.1 Environmental Management Procedures

The following activities have been identified as having the potential to impact on the surrounding area during the remedial / earthworks.

- Excavation of materials (re-grading / cut and fill); removal of self seeded young birch trees, disturbing the waste material, generating potential dust and odours;
- Vehicles movements to, from and around the site; potential to impact locally on traffic in Harpurhey, poor site access;
- Refuelling, storage, spillages of fuel, oil and chemicals; and
- Handling, transporting and disposing of contaminated materials and waste.

The Contractor will have in place systems to minimise disruption and impact on the surrounding area from the above activities. This will include a number of management systems which may include traffic management and monitoring regimes for dust, odours and vapours. Included within the management systems will be a robust complaints strategy the detail of which will be agreed with MCC.

Table 9.1 identifies a number of measures which will be employed, as considered necessary by the Contractor, to reduce impact to site neighbours and local residents. Other measures will be put in place to protect against impact to adjacent watercourses, land and ecosystems.

Table 9.1 Environmental Issues and Proposed Protection Measures

Issue	Mitigation Measures
Dust	• Generation of dust will be weather dependant. If the works are conducted during dry conditions dust will be reduced by damping down haul roads/stockpiles where necessary • Activity will be minimised during extremely windy conditions • When dusty material is being loaded onto trucks extra care will be taken to minimise drop heights • Trucks will be suitably covered when leaving the site with contaminated material • Vehicles will be encouraged to reduce their speed while moving around site in dusty conditions • The amount of disturbed surfaces left exposed for a significant period of time will be minimised

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Issue	Mitigation Measures
Traffic	• Routing agreement approved by MCC will be strictly adhered to for off site vehicle movements. Main traffic will be from mobilising plant to site and haulage of imported soils which form cap cover system. Either traffic control or banksman required at site entrance (which is on a bend in Harpurhey Road), to prevent accidents with other road users;
Noise	• Site working will be kept to the hours specified in the Planning Permission (if required) • The noise generated from site will be limited as the noisy activities are no more than wagon and excavator movements. Noise will be minimised by best practicable means; using modern machines with effective silencers.
Odour	• Strong odours are anticipated. The site RE will record olfactory observations at the site boundaries during excavation activities. Through these observations if measures are required to reduce odours/vapours then they will be applied. This may include altering working practices, cover the area of open excavation or if found to be persistent and problematic use of an odour suppression system.
Community	• The site shall be secure to prevent unauthorised access and vandalism
Tidiness of site	• Attention to cleanliness of the works shall be observed by the contractor at all times • A skip shall be provided by the Contractor for the disposal of site generated rubbish, which will be emptied regularly • A road sweeper will be used daily or as deemed necessary to keep mud off the roads during haulage. • Fires will not be permitted
Run-off into drains/watercourses	• Adjacent surface waters will be protected from impact of run-off by limiting activities if deemed necessary, during heavy rainfall, or by directing run-off into an area where it can be controlled • Temporary containment or cover measures shall be used on stockpiles, where necessary • Where possible, plant/activities will be located away from drains • Surface water, perched water or groundwater shall not be allowed to be discharged directly to sewer without the agreement/consent of United Utilities
Land Contamination	• Fuel, oil and chemical storage areas will be bunded correctly within an impermeable base and sides. Any water collecting within the bund shall be treated as contaminated and disposed of appropriately • Refuelling of vehicles and other plant must only be carried out within a designated area or using drip trays, as appropriate • Only construction equipment and vehicles free of all oil/fuel leaks will be permitted on site • Any spillages of contaminated liquids or other materials shall be reported to the Site Manager immediately. Stocks of absorbent materials shall be kept on site to deal with small spillages

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Issue	Mitigation Measures
Waste Management	• Throughout the works the Waste Management Duty of Care regulations will be strictly adhered to, including collation of all required paperwork and checking of transport and disposal contractors • Separate stockpiles shall be used for contaminated and uncontaminated materials • Vehicles carrying waste materials shall be suitably sheeted/netted or covered • An exemption from Environmental Permitting or a CLAIRE Code of Practise agreement (if required*) should be obtained from the Environment Agency for the re-use of suitable imported or site won material • Treatment / stabilisation of any contaminated soils / groundwater will need to be carried out under an Environmental Permit, similar exemption or enforcement position.

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10. Verification / Compliance Reporting

On completion of the works, the Remediation Supervisor shall provide a verification report in accordance with the Environment Agency's Report: SC030114/R1[5]. The verification report will include a description of the works undertaken providing a factual record of all remediation activities on site. The verification report will demonstrate compliance with the specification. This will include, but is not restricted to, the following:

- All validation / compliance testing and monitoring data;
- As-built topographic survey illustrating re-profiled slope prior to capping installation and topographic survey of restoration layer;
- As-built drainage details in line with specification;
- Drawings of works undertaken, including the location of stabilised wash out sediments contained within the slope re-profiling works;
- Any waste transfer notes, hazardous waste consignment notes etc.;
- Proof of purchase and photographs showing the correct installation of the Pozidrain® geocomposite cover system;
- Details of materials imported to site, including source, testing data, tonnages, delivery dates, and details of placement in terms of location and meeting specification; and
- Copies of correspondence with MCC, EA and UU.

Copies of the completion report shall be submitted to MCC and the Environment Agency for approval.

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11. Referencing

[1] Environment Agency, September 2004, Contaminated Land Report (CLR) 11 – Model Procedures for the Management of Contaminated Land

[2] AMEC, March 2012, Harpurhey Tip Site - Remedial Options Appraisal, Report Ref: 30323-03i2

[3] AMEC, May 2008, B20(c) Inspection of Special Site under Part 2A Environmental Protection Act 1990, Tip Site, Harpurhey Road, Manchester (ref: 5788001379/TS.v1)

[4] CL:AIRE, 2008, Definition of Waste: Development Industry Code of Practice

[5] Environment Agency, February 2010, Verification of remediation of land contamination, Report: SC030114/R1

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