



LAND AT THE INTERSECTION OF THE M8 MOTORWAY AND GREENOCK ROAD,
INCHINNAN, ERSKINE

CONSTRUCTION OF MOTORWAY JUNCTION

ENVIRONMENTAL STATEMENT

APPENDIX 11.1

SITE INVESTIGATION REPORT

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AOC Archaeology
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September 2006

BAE SYSTEMS Environmental Site Investigation Report

M8 Junction

Redrow Group Services Ltd



Site Investigation Report

M8 Junction

Redrow Group Services Ltd.

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INVESTORS IN PEOPLE

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EXECUTIVE SUMMARY

Introduction and Objectives

Redrow Group Services Ltd (RGS) BAE commissioned Systems Environmental to carry out an intrusive investigation of land that may be affected by a proposed motorway junction between the current M8 and A8 carriageways at Bishopton, Renfrewshire.

Site Characteristics and Setting

Approximately one third of the Site is made up of Southbar Landfill that is approximately centred at grid reference NS 446 693. The landfill is now closed and restored although there is still a current waste management license operated by WH Malcolm. The remainder of the Site comprises farmland and the former slip road from the M8 to the A8 carriageway.

Siteworks

Site works took place in two phases, firstly between the 8th April and 10th May 2006 with the groundwater sampling taking place on the 26th April, 3rd, 8th and 10th May 2006, and secondly between the 30th of August and 14th of September 2006. Site works included the formation of 10 No. cable percussion boreholes, 20 No. trial pits, 11 No. cone penetration tests.

Summary of Physical Ground Conditions

Made ground is known to be present in the part of the Site associated with the former landfill, as well as at locations within the Site close to the A8 and M8 carriageways.

The Site is indicated to be underlain by Late Devensian Glaciomarine Deposits comprising intertidal and subtidal clay and silt.

The solid geology across the Site is indicated to consist of two formations of Carboniferous age. To the north-east is the Limestone Coal Formation of the Upper Carboniferous Period, which generally comprises cyclic sequences of sandstones, siltstones, mudstones, coals, blackband and clayband ironstones and seatrocks. To the south-west is the Lower Limestone Formation of the Lower Carboniferous Period, which generally comprises mudstones with sandstones, siltstones, marine limestones, thin coals and clayband ironstones.

Summary of Water Conditions

The Site is located close to and drains into Lin Burn, which enters the River Gryffe downstream of its confluence with Dargavel Burn. The River Gryffe is a tributary of Black Cart Water, which flows into the River Clyde. Surrounding the landfill on the north, east and southern sides are drainage ditches.

Summary of Chemical Ground Conditions

The analytical results recorded no exceedences above commercial / industrial assessment criteria. Therefore should the materials be exposed due to final design levels of the motorway carriageway, it is considered that the soil will not pose any significant chronic risks to human health.

Summary of Groundwater and surface water conditions

The water quality up and down stream of the settlement ponds is comparable and the water leaving the ponds is not having a detrimental effect on receiving waters.

Ammoniacal nitrogen has been recorded in soil leachability samples, the groundwater and the surface water, both upstream and downstream. This may be as a result of the landfill site, but given the concentrations recorded and the fact that higher leachable concentrations were observed in the natural soil it is possible that this is naturally occurring.

Concentrations of some metals in groundwaters and surface waters sampled are generally less than the reporting limit with rare and marginal exceedences of the assessment criteria for lead, mercury and zinc.

PAHs and some SVOCs have been detected in the groundwater. The concentrations recorded marginally exceed the stringent assessment criteria and the landfill and local ash deposits are considered the likely sources. PAHs in surface waters were detected marginally above the reporting limit from one location SW5. From the data obtained, the Site appears to be having a negligible effect on the water environment.

Summary of Soil Gas conditions

Elevated levels of methane were recorded within monitoring points (gas vents) along a line of monitoring positions parallel to, but further up hill of the proposed road alignment within the landfill. Levels of methane in GV04 and GV08 – GV11 are above the Lower Explosive Limit (LEL) for methane of 5% by volume. The two combined gas and leachate monitoring points; LW2 and LW3, close to the alignment of the proposed road however did not record any methane.

Elevated levels of carbon dioxide were recorded in GV10 and GV11 in excess of the guidance value of 1.5% by volume (WMP No.27). However no such levels were recorded in LW2 or LW3. Monitoring was carried out in BH8 and BH10, however no flow or soil gas concentrations were recorded, indicating that the site poses little risk to human health from soil gas.

Conclusions

Based on the available data from this investigation it is considered that once the road has been constructed, the Site will not pose a significant risk to human health or the environment.

Recommendations

Mitigation proposals have been recommended regarding the motorway junction construction. These include measures to minimise run off to prevent silting and local water course pollution; minimising disturbance to the beds of the watercourses; minimising dust and ensuring any landfill waste excavated during construction is removed and transported to a suitable treatment or storage facility.

Although it is considered that the landfill gas does not pose a significant risk to either the construction of the proposed road layout, or the long term safety of the road, it would be advisable to monitor gas levels throughout the construction phase in the vicinity of the landfill as a precaution and install appropriate gas vents if cutting through the landfill waste.

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1. INTRODUCTION

1.1. Instruction

Redrow Group Services Ltd (RGS) commissioned BAE Systems Environmental under Order No. PDH/TT/282 dated 29th March 2006 to carry out an investigation of an area of land located at the proposed motorway junction between the current M8 and A8 carriageways.

1.2. Definitions

The term 'Site' refers to an area of land adjacent to or within the boundaries of the former WH Malcolm Southbar Landfill at Bishopton, Renfrewshire, and the former slip road from the M8 to the A8 carriageway, as well as farm land to the north of the A8 near Craigmuir Farm, and to the east of the M8 opposite the landfill.

It should be noted that the Site does not incorporate the full extent of the former landfill. Refer to Figures 1 and 2 for details of the Site's Location and Site boundaries.

1.3. Background

As part of the redevelopment of the former Royal Ordnance Factory (ROF) at Bishopton, a new motorway junction has been proposed between the M8 and A8 carriageways, east of Bishopton. A planning application is to be submitted to Renfrewshire Council for the construction of this proposed new junction. This investigation has been carried out to provide supporting information for the above planning application.

RGS appointed Dougal Baillie Associates as the highway design consultant for this project, who in turn appointed Terrenus Consulting Ltd as the geotechnical design consultant for this project. BAE Systems Environmental were in overall control of the siteworks element of the project, with Terrenus providing engineers for site supervision purposes as well as acting as the geotechnical engineer's representative on Site. Exploratory hole locations are shown on Figure 6.

Prior to conducting the investigation, consultations were carried out with the following bodies to obtain comments on the design of the proposed siteworks and highway construction project and in particular in relation to whether an Environmental Impact Assessment (EIA) was required.

- Scottish Environmental Protection Agency (SEPA)
- Scottish Natural Heritage (SNH)
- Renfrewshire Council (RC)
- Scottish Water

Whilst the conclusion of the screening opinion was that an EIA was not required, comments were made in relation to some specific concerns to be addressed as part of the planning process.

The responses from the consultations and the requirements to be achieved by the project as a whole are summarised below with copies of the responses presented in Appendix 7:-

SEPA - A representative of SEPA visited the Site on two occasions during the site investigation. It is considered by SEPA that a standard development control consultation would be required rather than an EIA. However they expect to receive the following as part of this report:

- A study to determine “whether or not contaminants are entering or are likely to enter controlled waters and at what concentrations”.

Renfrewshire Council – RC require a site investigation to be carried out, with reporting which should include:

- Nature, extent and types of contamination on the Site;
- Proposed measures to treat/remove contamination;
- Proposed measures to deal with contamination during construction;
- Condition of the Site on completion of the works.

In the time since the screening opinions were received, the design of the off ramp has been altered and it is now considered appropriate that the planning application be supported by a full Environmental Impact Assessment (Cass Associates, 2006).

1.4. Objectives

The objective of this investigation, part of the highway construction project, was to address SEPA's and RC's requirements relating to land contamination as well as to support the Environmental Statement. In particular, to gain sufficient information to:

- Accurately delineate the waste associated with the former landfill in the vicinity of the proposed junction, in order to determine how much landfill waste, if any, would be encountered as part of the development;
- Provide an initial characterisation of the waste if any is to be encountered as part of the development;
- Provide information on the physical and chemical ground conditions beneath the Site in order to provide information for the design of the proposed development.
- Accurately determine whether or not contaminants are entering or are likely to enter controlled waters and at what concentrations.
- Provide information on contamination such that the potential impact can be assessed.

This report presents the findings of the intrusive investigation and should be read in conjunction with the Bishopton STAG II Desk Study (A504-00-R1-1) see Appendix 9.

This assessment has been conducted in accordance with current industry good practice guidance documents and within the UK legislative and policy framework.

1.5. Reporting Conditions

The report refers to the conditions present at the Site at the time of the study. No liability can be accepted by BAE Systems Environmental for any future changes of Site conditions. It should be noted that BAE Systems Environmental has relied on the accuracy of the information contained in the documents consulted and is in no circumstances responsible for the accuracy of such information or data supplied.

This report has been specifically prepared for the purposes stated in section 1.4 and therefore should not be used for any other purpose without prior consultation with BAE Systems Environmental.

2. SITE CHARACTERISTICS

2.1. Site Details

Address	Land around where the A8 crosses the M8 to the east of Bishopton
Map Reference	NS 449 693
Area	Approx 40,500m ²
Elevation	Landfill area ranges from Approx 9m–10.5m AOD Farm land on the east of the M8 ranges from 7.5m–11.5m AOD The former slip road from the M8-A8 ranges from 9-10.5m AOD The farmland between the A8 and Craigmuir Fm ranges from 9-9.5m AOD
Neighbours	N – Craigmuir Farm E – Farmland S – Wooded area between M8 carriageway and Glasgow-Greenock railway, and farm land on the east of the M8 W – Southbar Landfill, former ROF at Bishopton, and farmland.
Access	Farm access gate from A8 west of the M8, track to Craigmuir Farm, and non-gated access to fields on the east of the M8.

Table 1 – Site Details

A Site Location Map is presented in Figure 1.

2.2. Site Description and History

The Site and its immediate surroundings are shown on Figure 2.

The Site description is based upon visits by a BAE Systems Geo-Environmental Engineer in April 2006 and throughout the siteworks. Part of the western half of the Site is made up of an area of Southbar Landfill that is approximately centred at grid reference NS 446 693 and is now closed and restored, although there is still a current Waste Management License operated by WH Malcolm. The landfill slopes up to the west at approximately 1:3, while the area covered by the former slip road is generally flat with a slight slope to the northwest.

Prior to WH Malcolm's occupation, the Site is understood to have been used as a council tip for mixed wastes with anecdotal information suggesting the tipping of mainly ash based materials. Information provided by SEPA suggests that the ash materials were excavated at the time of the extension to the M8 motorway and used in the construction of the road. Anecdotal information also suggests that boreholes constructed along the southern boundary of the landfill encountered ashy materials.

The eastern half of the Site is predominantly flat farmland consisting of rough grazing and crops. The Lin Burn is also found in the eastern half of the Site, as it starts at the confluence of two ditches/smaller burns.

The land between the A8 and Craigmuir farm was not studied in detail as part of the Desk Study (Ref: A504-00-R1-1) as the original design for the road layout did not include this area. However as a result of design changes it is now part of the site. This part of the site is currently flat pasture with no obvious features. It appears to have

been under its current land use since 1858 or earlier and the only noteworthy change being that in 1897 a circular structure appeared to the east of Craigmuir farm buildings. In 1966 it was labelled as a pond and by 1978 it was an area of marsh. There is currently no visual evidence on the surface of any marsh or pond at that location.

A more detailed description of the Site can be found in the Desk Study (A504-00-R1-1) see Appendix 9, where the Site is referred to as 'Site D' (east side of the M8) and 'Site C' (west side of the M8).

2.3. Published Geology

Made ground is known to be present in the part of the Site associated with the former landfill, as well as at locations within the Site close to the A8 and M8 carriageways. The part of the site associated with the landfill and former M8-A8 slip road is indicated to be underlain by made ground comprising man-made materials on original ground surface.

The Site is indicated to be underlain by Late Devensian glaciomarine deposits comprising intertidal and subtidal clay and silt of the Linwood and Paisley Formation. These in turn overly glacial diamictions of the Wilderness Till Formation; boulders and stones in a hard to stiff sandy silt and clay matrix. An area of Peat is indicated to the east of Craigmuir Farm.

Bedrock across the Site is indicated to consist of two formations of Carboniferous age. To the northeast is the Limestone Coal Formation of the Upper Carboniferous period, which generally comprises cyclic sequences of sandstones, siltstones, mudstones, coals, blackband and clayband ironstones and seatrocks. To the southwest, Lower Limestone Formation of the Lower Carboniferous Period is generally shown to comprise mudstones with sandstones, siltstones, marine limestones, thin coals and clayband ironstones.

Refer to Figures 3 and 4 for extracts of the geological maps.

2.4. Aquifer Classification

The Bedrock Aquifer Productivity Map (BGS, 2004) indicates that the Carboniferous sedimentary rocks are indicated to be moderately productive (1 – 10 l/s) comprising both fracture and intergranular flow. The Superficial Deposit Aquifer Productivity Map (BGS, 2004) indicates that the superficial deposits are moderately productive and flow is intergranular.

The Groundwater Vulnerability Map of Scotland (SNIFFER, 2004) classifies the Site as 'vulnerability category 2', which is defined as 'vulnerable to some pollutants, but only when continuously discharged/leached'.

Refer to Figure 5 for extracts of the hydrogeological maps and groundwater vulnerability map.

2.5. Hydrology

The Site is located close to and drains into Lin Burn, which enters the River Gryfe downstream of its confluence with Dargavel Burn. The River Gryfe is a tributary of Black Cart Water, which flows into the River Clyde.

Surrounding the landfill on the north, east and southern sides are drainage ditches. The northern and eastern ditches drain into the treatment lagoons, which are situated, between the toe of the landfill area and M8 carriageway. The ponds discharge to a sampling chamber at the confluence with surface water from the southern ditch. These in turn discharge under the motorway to the Lin Burn.

A drainage ditch is present on the north side of the A8. This ditch drains to the east towards the M8 and is culverted under the M8 and drains into the Lin Burn on the east side of the M8.

The Lin Burn and two tributaries are present on the eastern side of the motorway. These watercourses are shown on Figure 2.

3. INVESTIGATION RATIONALE

3.1. Objectives

The objective of this investigation, part of the highway construction project, was to address SEPA's and RC's requirements relating to land contamination and to inform the Environmental Statement. In particular, to gain sufficient information to:

- Accurately delineate the waste associated with the former landfill in the vicinity of the junction;
- Provide an initial characterisation of the waste in the area of interest;
- Provide information on the physical and chemical ground conditions beneath the Site.
- Accurately determine whether or not contaminants are entering or are likely to enter controlled waters and at what concentrations.

3.2. Potential Pollutant Linkages

Based on the information contained in the desk study, see Appendix 9, (Ref: Bishopton STAG II Desk Study, BAE Systems Environmental, A0504-00-R1-1, February 2006) the following potential sources of contamination and the receptors that could be affected have been identified:

Source of contamination	Receptors
Contaminants associated with the landfill or made ground from the previous road.	Maintenance workers, nearby livestock
	Groundwater
	Various surface waters including the Lin Burn
	Structures (Road)
	Nearby crops

Table 2 – Potential Sources of Contamination and Receptors

It should be noted that the receptors are based on the developed site and not the site in its current condition.

The situations described above are illustrated pictorially in Figure 7 – The Conceptual Site Model. The intrusive investigation was designed to investigate plausible pathways between sources and receptors as well as to provide sufficient data to determine the existence and significance of the sources of contamination. Particular emphasis was placed on the potential for impact to the water environment, namely groundwater and surface waters (Lin Burn). Figure 7 has been updated to reflect the findings of the site investigation, showing deep groundwater, the approximate extents of the landfill waste and ground conditions encountered.

In order to establish whether the Site is causing or likely to cause significant pollution of the water environment, it is continuing entry of contaminants that must be considered. Leachability testing was used as it gives an idea of the mobility of contaminants and hence their likelihood to impact on the water environment.

Groundwater levels were taken during the drilling process, however artesian groundwater was encountered in all 4 No. boreholes in the first phase of the site works

and 3 No. boreholes in the second phase. As a result only 2 No. boreholes were installed and therefore no indication of groundwater flow direction could be ascertained.

3.3. Investigation Locations

The locations of each of the exploratory holes were chosen to investigate the sources detailed in Table 2, as well as to provide geotechnical information for the design of the road.

Based on the topography of the whole Site, and information supplied by W H Malcolm with regard to the nature and extent of landfill; the formation of 10 No. cable percussion boreholes and 20 No. trial pit were scheduled with design depths of 20 m and 4.5 m, respectively. In addition to this, 11 No. cone penetration tests (CPTs) were carried out across the Site to give greater coverage of geotechnical information.

The following table summarises the rationale for each of the exploratory locations:

Exploratory Hole	Purpose
BH1 and BH2	To investigate the nature and extents of the made ground and landfill material and provide information on the underlying natural deposits. To investigate groundwater occurrence and quality.
BH3 and BH4	To investigate the nature and extents of the made ground and provide information on the underlying natural deposits. To investigate groundwater occurrence and quality.
BH5-8	To investigate the nature of the ground conditions and the ground water occurrence within the area of the site between the A8 and Craigmuir farm.
BH9 and BH10	To investigate the nature of the ground conditions and the ground water occurrence within the area of the site to the east of the M8.
TP's1-6	To investigate the nature and extents of the made ground and landfill material.
TP7-11	To investigate the nature of the ground conditions within the area of the site to the east of the M8.
TP12-14	To investigate the nature of the ground conditions within the area of the site between the M8 and the landfill.
TPTP15-19	To investigate the nature of the ground conditions within the area of the site between the A8 and Craigmuir farm.
TP20	To investigate the ground conditions beneath or adjacent to the former slip-road between the M8 and A8.
CPT locations	To provide further geotechnical information on the underlying natural deposits.
SW1 and SW2	To obtain water quality data up stream of the settlement ponds
SW3	To obtain water quality directly down stream of the settlement ponds
SW4	To obtain water data from the water course to the south of the landfill
SW5	To obtain water quality data from the water course directly prior to it feeding into the Lin Burn.

Table 3 – Rationale Behind Exploratory Point Locations

The Exploratory Points are shown on Figure 6. Detailed descriptions of the strata encountered at each exploratory point, as well as a record of the type and frequency of samples recovered are given on the Exploratory Hole Records presented in Appendix 2.

4. SITWORKS

4.1. Scope of Works

Siteworks took place in two phases, firstly between the 8th April and 10th May 2006 with the groundwater sampling taking place on the 26th April, 3rd, 8th and 10th May 2006, and secondly between the 30th of August and 14th of September 2006.

All siteworks were conducted by BAE Systems Environmental and its approved sub-contractors under the supervision of a suitably qualified BAE Systems Environmental Geo-Environmental Engineer and a Geotechnical Engineer from Terrenus Consulting Ltd.

All the siteworks were carried out in accordance with BAE Systems Environmental's Safety, Health and Environment Plan (ref: A0567-00-R1-B) containing the service plans for the Site, which were consulted prior to the investigation. Before the cable percussion boreholes, CPT holes and trial pits were started; inspection pits were dug to 1.2 m to ensure that all services were avoided. No unexpected services were encountered.

The site works involved the following:

- Formation of 10 No. cable percussion boreholes (BHs). Due to the ground conditions encountered it was not possible to complete each borehole with a combined gas/groundwater installation as intended, see Section 4.5, however 2 boreholes, BH8 and BH10 were installed as gas/groundwater monitoring wells;
- Formation of 20 No. trial pits (TPs) that were backfilled upon completion;
- Completion of 11 No. cone penetration test holes (CPTs), 3 No of which were completed with 'Push-in' installations for groundwater monitoring;
- Recovery of representative soil samples for both chemical and geotechnical analytical testing
- Site visits for groundwater and surface water sampling;
- Surveying of all exploratory locations (by Loys Surveys Ltd).

Exploratory point positions were agreed between BAE Systems Environmental and Terrenus Consulting Ltd. prior to the commencement of Site works in conjunction with the landowners.

The exploratory holes were located to give as wide a Site coverage as possible and in particular to give an indication of the extents of the landfill waste.

Sampling strategies and methodologies were designed in accordance with current industry guidance referenced at the end of this report. Representative samples were taken from specific strata and depths for the purpose of determining the chemical composition of the sub soil in specific locations as well as the general characterisation of all strata encountered including the landfill waste. The selection of samples for geotechnical testing and scheduling of geotechnical testing was carried out by Terrenus Consulting Ltd. This is the subject of the separate report by Terrenus Consulting Ltd (Ref: 1012-091).

4.2. Cable Percussion Boreholes

Cable percussive drilling techniques were employed to investigate the vertical extent of both the made ground and natural deposits and to provide information on the chemical contents of the strata as well as their physical characteristics.

4.3. Trial Pits

Trial pits were excavated to provide samples of the material that makes up the landfill; including the capping layer, the waste and the immediately underlying drift or liner as well as to determine general ground conditions in other areas.

4.4. CPT Locations

Cone Penetration Tests were conducted in 11 No. locations across the Site to provide extra information regarding the physical nature of the strata. Soil samples were taken from the inspection pits of 3 No. of the CPT locations.

4.5. Monitoring Installations

It was intended that combined gas and groundwater monitoring wells were to be installed in each borehole upon completion. BH4 was initially installed and as a result of the artesian water that was encountered during the drilling operations the installation was removed at the end of the site works and the borehole reinstated to prevent any continued leakage of groundwater to surface.

BH1, 2, 3, 5, 6, 7, and 9 were reinstated immediately after completion to prevent any possible leakage of groundwater to surface, and to ensure that a pathway for contaminants to affect groundwater was not created.

BH8 and BH10 were installed with combined gas and groundwater monitoring installations, details of which can be seen on the exploratory hole logs in Appendix 2.

4.6. Soil Sampling

Representative disturbed samples were obtained from all exploratory holes before being sent for chemical and/or physical analysis.

Each sample was taken for a specific purpose, either to determine the nature of contamination or to confirm that underlying strata could be regarded as uncontaminated.

Samples were subject to strict Quality Assurance/Quality Control (QA/QC) protocols. Samples were placed in the correct receptacle and stored/transported in cooled conditions and under a chain of custody regime. This ensured sample integrity for any subsequent laboratory testing.

4.7. Water Sampling

Groundwater and surface water monitoring visits were carried out on the 26th April, 3rd, 8th, 10th May and 15th September 2006. Surface water monitoring took place on the 8th and 10th of May. Sampling was carried out by BAE Systems Environmental personnel who have been trained to undertake such sampling and monitoring. Monitoring records for the ground and surface water monitoring visits are included in Appendix 3.

All instruments used are maintained and calibrated by the manufacturers in accordance with BAE Systems Environmental ISO accredited Quality Management System.

4.8. Geotechnical Sampling

Representative disturbed and undisturbed samples were obtained from the 10 No. boreholes before being sent for laboratory analysis. Selection of samples and the scheduling of the laboratory analysis was carried out by Terrenus Consulting Ltd and will be described in more detail in their report. All sampling was carried out in accordance with BS5930:1999.

4.9. Survey

The position of all exploratory holes was determined relative to the National Grid system with the levels of the locations determined relative to Ordnance Datum as part of the topographic survey of the whole Site.

Loys Surveys Ltd. carried out the survey on the 23rd of May and 18th September 2006 under the supervision of a BAE Systems Environmental engineer. The co-ordinates and ground levels for each location are included on the final logs presented in Appendix 2.

5. ANALYTICAL LABORATORY TESTING

5.1. General

A programme of analytical testing was conducted to determine the chemical characteristics of the soil and groundwater beneath the Site, and the adjacent surface waters. The analytical schedule was based on the findings of the desk study. Guidance was also taken from relevant industry profiles and CLR8, as referenced at the end of this report.

5.2. Soils

Soils analysis was conducted by BAE Systems Environmental's in-house laboratory operating under the requirements of ISO17025 and using UKAS and MCERTS accredited methodologies. Some analysis was, however, subcontracted to Bodycote Testing Ltd. The table below provides a summary of the actual analytical schedule for the soil samples taken during the investigation. The results are presented in Appendix 4.

Soils Determinand	units	MRL	No. of Analyses			Lab	UKAS/ MCERTS
			BH	TP	CPT (starter pits)		
As	mg/kg	1	13	46	3	UKAS	BAE
Cd	mg/kg	0.3	13	46	3	UKAS	BAE
Cr	mg/kg	5	13	46	3	UKAS	BAE
Cu	mg/kg	3	13	46	3	UKAS	BAE
Ni	mg/kg	5	13	46	3	UKAS	BAE
Zn	mg/kg	3	13	46	3	UKAS	BAE
Pb	mg/kg	3	13	46	3	UKAS	BAE
Hg	mg/kg	0.1	13	46	3	UKAS	BAE
Se	mg/kg	0.3	13	46	3	UKAS	BAE
Hex. Cr	mg/kg	0.3	11	22	3	UKAS	BAE
VOC	mg/kg	0.025	3	2	2	MCERTS	BAE
TPH-GCFID	mg/kg	0.01	4	16	-	UKAS	Bodycote
SVOC	mg/kg	1 to 4	3	2	2	UKAS	BAE
WSB	mg/kg	0.3	13	46	3	UKAS	BAE
Total cyanide	mg/kg	0.5	11	22	3	MCERTS	BAE
Total sulphate	mg/kg	50	13	46	3	MCERTS	BAE
Sulphide	mg/kg	5	11	22	3	MCERTS	BAE
pH	pH units	0.01	13	46	3	MCERTS pending	BAE
PAH (speciated)	mg/kg	0.1	13	46	3	MCERTS	BAE
Asbestos	-	-	11	46	3	UKAS	Bodycote
Leachability	N/A	N/A	9	27	3	N/A	Bodycote

Table 4 – Soil Analysis

MRL = Minimum Reporting Limit

5.3. Waters

Water analysis was undertaken by Bodycote under instruction from BAE Systems Environmental. The table below provides a summary of the analytical schedule. The results are presented in Appendix 5.

Waters Determinand	units	MRL	No. of Analyses
As	µg/l	1	6
B	µg/l	10	5
Cd	µg/l	1	6
Cr	µg/l	1	6
Cu	µg/l	1	6
Hg	µg/l	0.1	6
Ni	µg/l	2	6
Pb	µg/l	4	6
Se	µg/l	0.1	6
Zn	µg/l	8	6
Free cyanide	mg/l	0.05	4
Total cyanide	mg/l	0.05	6
pH	pH units	0.01	6
Phenols	mg/l	0.03	6
Sulphide	mg/l	0.1	6
Sulphate	mg/l	5	5
S	mg/l	1	4
Ammoniacal. N	mg/l	0.04	6
Chloride	mg/l	5	6
PAH (speciated)	µg/l	0.01	6
TPH	µg/l	10	6
VOCs	µg/l	5	6
SVOCs	µg/l	0.1	6

Table 5.1 – Groundwater Analysis

Waters Determinand	units	MRL	Analysis
As	µg/l	1	9
B	µg/l	10	9
Cd	µg/l	1	9
Cr	µg/l	1	9
Cu	µg/l	1	9
Hg	µg/l	0.1	9
Ni	µg/l	2	9
Pb	µg/l	4	9
Se	µg/l	0.1	9
Zn	µg/l	8	9
Free cyanide	mg/l	0.05	5
Total cyanide	mg/l	0.05	9
pH	pH units	0.01	9
Sulphide	mg/l	0.1	9
Sulphate	mg/l	5	9
Ammoniacal. N	mg/l	0.05	9
Cl	mg/l	5	9
PAH (speciated)	µg/l	0.01	9
COD	mg/l	5	9
BOD	mgO ₂ /l	3	9
Nitrate	mg/l	1	5
Suspended Solids	mg/l	10	9

Table 5.2 – Surface Water Analysis

6. SUMMARY OF GROUND CONDITIONS

6.1. General

For the purpose of this report we have classified the material encountered into four categories; capping material above the landfill, landfill waste, other made ground and natural deposits.

6.2. Capping Material

The capping material, which covers the landfill, varied in thickness and in places was not clearly distinguishable from the landfill waste itself. However, where identifiable, it was described as firm to stiff, brown gravelly silt/clay with the gravel being angular, medium and of mixed lithologies and occasional blaes. Where clearly identified, the capping material varied in thickness from 0.25 to 0.70 m. This material was encountered over the waste in TP1, TP2, and TP4, and over natural deposits in TP3, TP6 and TP14.

6.3. Landfill Waste

Landfill waste was encountered in BH1, BH2, TP1, TP2, TP4, and TP5 and varied in thickness from 1.75 to 3.20 m. In general, the waste encountered was described as brown gravelly silt with whole bricks, concrete blocks, road cobbles, fragments of metal, plastic and wood.

Leachate from within the landfill was encountered in TP4, TP5 and BH1 and BH2. This was described as having a sheen of Light Non-Aqueous Phase Liquid (LNAPL) with a strong hydrocarbon odour and a 'scum' on the surface.

As a result of the site investigation a preliminary interpretation of the extents of the landfill waste has been carried out. It is considered that the waste does not extend as far down the slope as the settlement ponds or the water courses and the approximate line of its limit is marked by the 9m AOD contour line. Figure 6 shows the interpretation of the extents of the landfill waste in relation to the rest of the site.

6.4. Other Made Ground

Other made ground deposits were encountered in BH3, BH4 and TP20. These deposits generally consisted of tarmac, blaes, ash, coal and pottery within a matrix of brown sandy, gravelly silt/clay. These deposits were found from the surface to be between 0.85 and 1.80 m thick and are likely to be associated with the road construction.

6.5. Superficial Deposits

Superficial deposits were encountered in all exploratory holes, excavated to a maximum depth of 21.60 m (-11.79 m.AOD) in BH2. Superficial deposits generally consisted of soft to firm brown-grey slightly laminated sandy gravelly clay (Linwood Fm) to a depth of between 4.25 and 6.75 m (5.28 and 2.6 m.AOD). Below this, soft brown brown-grey slightly gravelly silt (Paisley Fm) was encountered to a depth of between 15.80 and 21.40 m (-6.27 and -11.59 m.AOD). In General the stiff material (Wilderness Till Fm) was encountered at -11 – 4m AOD in the eastern and southern areas of the site, however in the northern areas of the site it was encountered at much shallower depths, generally between 1 m AOD and 5 m AOD.

6.6. Bedrock

Bedrock was not proven in any of the exploratory holes, however in the part of the site occupied by the landfill BH1 was terminated at an unidentified obstruction at 17.70 m depth (-8.35 m.AOD) and BH2 was terminated at 22.40 m (-12.59 m.AOD) after chiselling through 0.80 m of broken hard sandstone. In the area of the site between the A8 and Craigmuir farm BH5 encountered an obstruction at 8.6 m and TP17 encountered angular boulders from 2.5 m.

6.7. Groundwater

Groundwater was encountered in 8 No. of the boreholes. Groundwater levels were monitored during drilling operations and are given in the table below. However, in BH1-4 and BH9 the groundwater eventually rose to the top of the borehole indicating artesian conditions with a piezometric surface above ground level.

Location	Strike (m.AOD)	Level after 20 mins (m.AOD)	Stratum
BH1	-6.65	-1.35	SAND & GRAVEL
BH2	-11.59	-2.88	Sandy gravelly CLAY with cobbles
BH3	-6.27	3.13	SAND & GRAVEL
BH4	-7.37	-5.62	Sandy CLAY with occasional gravel
BH5	3.33	4.13	SAND & GRAVEL
BH6	3.41	8.91	SAND & GRAVEL
BH7	4.09	4.29	Sandy CLAY with gravel and cobbles
BH9	-10.71	-1.16	Sandy silty CLAY (Drillers description)

Table 6.1 Deep Groundwater Strike Details

Location	Strike (m.AOD)	Level after 20 mins (m.AOD)	Stratum
BH1	8.85	8.85	Made ground (landfill waste)
BH2	8.61	8.81	Made ground (landfill waste)
TP1	8.75	-	SILT/CLAY
TP2	7.93	-	Made ground (reworked natural beneath landfill waste)
TP4	10.07	-	Made ground (landfill waste)
TP5	9.24	-	Made ground (landfill waste)

Table 6.2 Shallow Groundwater/Leachate Strike Details

Location	Ground Water Level (m.AOD)	Stratum
BH8	9.59	Sandy CLAY
BH10	8.44	Sandy CLAY

Table 6.3 Ground water levels in installations

6.8. Soil Gas

As a result of the artesian groundwater conditions encountered, soil gas measurements were not taken in the part of the site occupied by the landfill. However, in order to provide an idea of the potential conditions on the landfill part of the Site, data held by SEPA was viewed and is included as Appendix 8, and summarised below. (The values given in Table 7 below are the averages recorded over 3 No. monitoring visits between June and August 2005):

Sample Location	Methane (% V/V)	CO ₂ (% V/V)	Oxygen (% V/V)
LW1	0.40	0.50	19.20
LW2	ND	ND	20.17
LW3	ND	ND	20.60
GV01	2.43	0.30	18.57
GV02	2.33	0.23	19.00
GV03	1.53	0.10	19.63
GV04	6.40	0.70	17.97
GV05	0.03	ND	20.43
GV06	0.07	ND	20.53
GV07	3.43	0.40	19.23
GV08	4.80	0.80	18.00
GV09	8.80	1.23	16.53
GV10	9.37	5.67	7.20
GV11	21.00	4.73	5.13
GV12	0.53	0.13	19.47
East PM8	ND	0.37	20.37
East PM9	ND	0.13	20.47
East PM12	ND	0.40	20.13
West PM2	ND	0.05	20.55
West PM3	ND	0.20	14.27
West PM4	ND	0.37	19.53
West PM5	ND	0.10	20.07
West PM6	ND	0.43	20.00
West PM8	ND	0.10	20.20

ND – Not Detected

Table 7.1 – Gas Monitoring Data from Southbar Landfill

During the second phase of site works 2 No. monitoring wells were installed in BH's8 and 10. The results of the monitoring visit on the 15th of September 2006 are given below:

Location	Methane (% V/V)	CO ₂ (% Volume)	Oxygen (% Volume)
BH8	ND	0.3	19.6
BH10	ND	0.1	20.6

Table 7.2 – Gas monitoring data

6.9. Visual and Olfactory Evidence of Contamination

Sheens of Light Non-Aqueous Phase Liquid (LNAPL) were noted in TP4 and TP5 together with hydrocarbon odours at 3.50 m.bgl and 2.40 m.bgl, respectively.

7. SUMMARY OF ANALYTICAL RESULTS

7.1. General

Representative samples were chosen from across the Site and concentrations of selected determinands were measured in soil and soil leachate. Leachate testing is designed to give an indication of the mobility of contaminants to aid in assessing the risk to the water environment. Testing was carried out on a total of 62 No. soil samples, 40 No. selected soil leachability analyses, 6 No. groundwater samples and 9 No. surface water samples.

Samples were selected for analysis through a combination of targeted and non-targeted sampling. The analytical suite for each sample was decided upon taking account of the following:

- The former activities carried out on the Site
- Any observations made during excavation or sampling

The results of the chemical testing are summarised below, only those determinands detected are shown here. For the purposes of presentation, the arithmetic mean has also been calculated. (Note: Where results have been returned as less than the reporting limit, the mean has been calculated as though the actual reporting limit has been detected).

Complete soil and leachate analysis results are included in Appendix 4; the groundwater and surface water test results are included in Appendix 5.

7.2. Summary of Soil Concentrations

Detected Determinands	Units	No of Samples	Min	Mean	Max
As	mg/kg	62	<1	9.2	45
Cd	mg/kg	62	<0.3	0.33	0.9
Cr	mg/kg	62	18	41	77
Cu	mg/kg	62	8	52	329
Ni	mg/kg	62	14	40	78
Zn	mg/kg	62	21	115	421
Pb	mg/kg	62	3	85	531
Hg	mg/kg	62	<0.1	0.26	1.1
Se	mg/kg	62	<0.3	0.48	1.4
WSB	mg/kg	62	<0.3	0.86	4.4
TPH-GCFID					
>C12-C16	mg/kg	20	<20	21.2	29
>C16-C21	mg/kg	20	<20	46.5	96
>C21-C40	mg/kg	20	<20	412	2130
Total sulphate	mg/kg	62	<250	498	1470
Sulphide	mg/kg	36	<5	151	1680
pH	pH units	62	6	7.5	9.1
Naphthalene	mg/kg	62	<0.1	0.37	4
Acenaphthylene	mg/kg	62	<0.1	0.10	0.2

Detected Determinands	Units	No of Samples	Min	Mean	Max
Acenaphthene	mg/kg	31	<0.1	0.39	3.5
Fluorene	mg/kg	31	<0.1	0.35	2.6
Phenanthrene	mg/kg	31	0.1	2.4	25
Anthracene	mg/kg	31	<0.1	1.6	6.9
Fluoranthene	mg/kg	31	<0.1	3.0	37
Pyrene	mg/kg	31	<0.1	2.6	34
Benz(a)anthracene	mg/kg	31	<0.1	1.3	16
Chrysene	mg/kg	31	<0.1	1.4	18
Benzo(b)fluoranthene	mg/kg	31	<0.1	1.2	14
Benzo(k)fluoranthene	mg/kg	31	<0.1	1.1	13
Benzo(a)pyrene	mg/kg	31	<0.1	1.4	17
Indeno(1,2,3-cd)pyrene	mg/kg	31	<0.1	0.89	11
Benzo(g,h,i)perylene	mg/kg	31	<0.1	0.93	12
Dibenz(a,h)anthracene	mg/kg	31	<0.1	0.25	2.5
Total PAH	mg/kg	31	1	17.83	215

Table 8 – Soil Analytical Results Summary

7.3. Summary of Leachate Concentrations

Detected Determinands	Units	No. of samples	Min	Mean	Max
Pb	mg/l	40	<0.004	0.006	0.046
Hg	mg/l	40	<0.0001	0.00012	0.0007
Cu	mg/l	40	<0.001	0.0019	0.009
Zn	mg/l	40	<0.008	0.009	0.038
Se	mg/l	40	<0.0001	0.0002	0.0014
B	mg/l	40	<0.01	0.021	0.09
Ammonia	mg/l	40	<0.04	0.39	2.4
Sulphate	mg/l	40	<5	9.9	39

Table 9 – Leachability Analytical Results Summary

7.4. Summary of Water Concentrations

Detected Determinands	Units	No. of samples	Min	Max
pH	pH units	6	7.7	8.3
Pb	mg/l	6	<0.004	0.013
Hg	mg/l	6	<0.0001	0.001
Cu	mg/l	6	<0.001	0.005
Se	mg/l	6	<0.0001	<0.0001
B	mg/l	6	0.24	0.66
Chloride	mg/l	6	69	255
Ammoniacal Nitrogen	mg/l	6	0.25	4.7
Free CN	mg/l	4	<0.05	<0.05

Detected Determinands	Units	No. of samples	Min	Max
Total PAH	µg/l	6	<0.2	15
Total Petroleum Hydrocarbons	µg/l	6	<0.01	2.79
SVOC's				
2+4 Nitrophenol	µg/l	6	<0.1	21
2,4-Dinitrophenol	µg/l	6	<0.1	3.4
Isophorone	µg/l	6	<0.1	0.7
Naphthalene	µg/l	6	<0.1	2.0
Dimethyl phthalate	µg/l	6	<0.1	0.5
Acenaphthene	µg/l	6	<0.1	0.3
Diethyl phthalate	µg/l	6	<0.1	20
Di-n-butyl phthalate		6	<0.1	39
1,2-Benzanthracene	µg/l	6	<0.1	1.1
Chrysene	µg/l	6	<0.1	1.1
Butyl benzyl phthalate	µg/l	6	<0.1	214
Bis(2-ethylhexyl)phthalate	µg/l	6	<0.1	157
Di-n-octyl phthalate	µg/l	6	<0.1	7.2
Benzo(b)fluoranthene/Benzo(k) fluoranthene	µg/l	6	<0.1	3.1
Benzo(a)pyrene	µg/l	6	<0.1	2.3
Indeno(1.2.3-C.D)pyrene	µg/l	6	<0.1	0.3
1,12-Benzoperylene	µg/l	6	<0.1	3.5

Table 10 – Groundwater Analytical Results Summary

Detected Determinands	Units	No. of samples	Min	Max
pH	pH units	9	7.5	7.9
Pb	mg/l	9	<0.004	0.01
Hg	mg/l	9	<0.0001	0.0017
Cu	mg/l	9	<0.001	0.01
Zn	mg/l	9	<0.008	0.178
Cr	mg/l	9	<0.01	0.01
B	mg/l	9	0.04	0.37
Sulphate	mg/l	9	38	265
Chloride	mg/l	9	36	93
Ammoniacal Nitrogen	mg/l	9	0.27	2.99
Acenaphthene	µg/l	9	<0.02	0.03
Fluoranthene	µg/l	9	<0.02	0.03
Pyrene	µg/l	9	<0.02	0.20

Table 11 – Surface Water Analytical Results Summary

7.5. Summary of Geotechnical Test Results

Below is a summary of selected geotechnical tests carried out by Raeburn Drilling relevant to this report. The full suites of results are included in the Terrenus report (Report No: 1012-091).

Material Type/ Analysis	Mean % Passing 425 µm sieve	Mean Passing 2mm Sieve	Mean sulphat content (g/l)	Mean pH	Mean Bull Density (mg/m ³)	Mean Dry Density (mg/m ³)
Capping Material	43	-		-	-	-
Other Made Ground	25	-		-	-	-
Superficial deposits (Linwood and Paisley Fm's)	52	99.8	0.27	7.38	1.85	1.37
Superficial deposits (Wilderness Till Fm)	40	-		-	-	-

Table 12 – Geotechnical Results Summary

8. RISKS TO HUMAN HEALTH

8.1. Risk from Soil

As detailed in Section 6 of this report the material encountered on Site can be divided into 4 No. distinct types for assessment purposes; capping material, landfill waste, other made ground and superficial deposits. Should the proposed new motorway junction expose any of these materials, the risk to human health needs to be quantified.

In the context of contaminated land the risks posed to human health is based on adverse effects resulting from long term exposure (chronic) to soil contamination as opposed to short term / occupational exposure (acute). Construction workers are receptors to contamination but the occupational risks are addressed by the Health and Safety at Work Act 1974 and related legislation such as the Control of Substances Hazardous to Health (COSHH) Regulations.

To assess the chronic risks to human health the analytical results for each material type have been reviewed in conjunction with industry guidance and compared to guidance values for the respective determinands.

In line with UK policy, where available, published Soil Guidance Values (SGV) were used as comparison. For other determinands in-house assessment criteria were calculated using the SNIFFER methodology with a hand calculation to take into account the dermal pathway based on CLEA Briefing Note 1 where appropriate. The SNIFFER methodology was considered to be the most appropriate alternative risk assessment model pending release of the CLEA UK model, as it was written to reflect the CLR guidance documents.

The proposed land use of a motorway junction does not fit any of the standard land uses currently available within the CLEA model. As a benchmark, the guidance values for 'Commercial/Industrial' end use have therefore been used. These values are considered conservative assessment criteria, as the resultant land use of a motorway junction will offer little or no access for the public, users and livestock to the underlying soil.

It should be noted that humans are not considered receptors for a number of sources of contamination, as detailed in CLR8. These include copper, zinc, boron and sulphate.

In assessing the risk from hydrocarbons, the approach and health criteria used are based upon the Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG) methodology and the framework document published by the Environment Agency (2005).

The TPH screening analyses undertaken on the majority of samples records concentrations by chain length, but the technique does not distinguish between aliphatic and aromatic compounds. However, as a conservative first screen, for each chain length the lower of the criteria for aliphatic and aromatics has been used in the Tier 1 assessment.

The outcome of our generic quantitative risk assessment is provided in Appendix 11. The assessment criteria used and their source has also been included. A summary of our assessment for each type of material is provided in the following paragraphs.

Capping Material

The capping material is the layer of clean, low permeability material deposited over the landfill waste upon reinstatement of the landfill. None of the soil samples analysed from this capping material recorded exceedences of the assessment criteria.

Landfill Waste

Following laboratory analysis of samples retrieved from the landfill waste, no exceedences of the assessment criteria for soil were recorded.

Other Made ground

Made ground was also encountered in BH3 and BH4 and TP20 adjacent to the current A8 carriageway. This is likely to be resulting from the former slip road between the A8 and M8 prior to the extension of the M8. No exceedences of the assessment criteria for human health were recorded in the made ground.

Superficial deposits

Following laboratory analysis of samples retrieved from the underlying superficial deposits, no exceedences of the assessment criteria for soil were recorded.

8.2. Risk from Landfill and Soil Gas

The following discussion of the landfill gas is based upon the monitoring results supplied by WH Malcolm to SEPA for the period June – August 2005. A summary of these results is shown in Table 7 of Section 6 and the full set of results included as Appendix 8.

Elevated levels of methane were recorded within monitoring points (gas vents) along a line of monitoring positions parallel to, but further up hill of the proposed road alignment within the landfill. In particular, levels of methane in GV04 and GV08 – GV11 are above the Lower Explosive Limit (LEL) for methane of 5% by volume. The two combined gas and leachate monitoring points; LW2 and LW3, close to the alignment of the proposed road however did not record any methane.

Elevated levels of carbon dioxide were recorded in GV10 and GV11 in excess of the guidance value of 1.5% by volume (WMP No.27). However no such levels were recorded in LW2 or LW3.

Monitoring was carried out in BH8 and BH10, however no flow or soil gas concentrations were recorded, indicating that the site poses little risk to human health from soil gas. For details of the monitoring records refer to Appendix 3.

8.3. Conclusions

The analytical results for all 4 No. material types recorded no exceedences above commercial / industrial assessment criteria. Therefore should the materials be exposed due to final design levels of the motorway carriageway, it is considered that the soil will not pose any significant chronic risks to human health.

During construction of the motorway, engineers and construction workers may be exposed to the 4 No. types of material encountered on Site. It is considered that appropriate mitigation measures such as Personal Protective Equipment (PPE) and

Respiration Protective Equipment (RPE) can be worn to mitigate any short-term exposure risks.

The monitoring data suggests that the landfill gas, in particular methane is collecting more towards the top of the landfill rather than existing throughout thus reducing the likelihood of significant quantities of gas being encountered in the area of interest with respect to the proposed road alignment. The soil gas across the rest of the site is considered to be providing no risk to the development or land users in general.

9. RISKS TO THE WATER ENVIRONMENT

9.1. General

To determine if any source of contamination on Site poses a risk to the water environment from the construction of the motorway junction, soil leachability data, groundwater and surface water quality data have been obtained and assessed using appropriate assessment criteria.

In order to establish whether the Site is causing or is likely to cause significant pollution of the water environment, it is the continuing entry of contaminants that must be considered. The NRA Leach test has been used to generate a concentration in 'pore water' for the assessment of metals, which has then been compared to appropriate assessment criteria as detailed below.

Where standard leachability tests are not considered appropriate for particular substances, i.e. organics, then initial assessment has been based upon the existing groundwater quality, and any water quality difference observed between upstream and downstream samples.

In the absence of any statutory water quality criteria for groundwater it is considered appropriate to use the lower of the Environmental Quality Standards (UK EQS) and the UK Drinking Water Standards (UK DWS).

Surface waters have been compared to UK EQS values. As the principal surface water course, the River Gryfe is believed to support salmonid fish, therefore the freshwater EQS for the protection of aquatic life has been chosen. Where an EQS is dependent on hardness, a range of 100-150 mg/l CaCO₃ has been selected, covering the typical range of values for the River Gryfe.

9.2. Leachability Analysis

Of the determinands detected in the leachability tests, presented in Table 7.3, none of the metals or sulphate exceeded their assessment criteria. Samples were selected from all 4 No. distinct material types encountered, especially from the landfill material itself.

Based on the leachability analytical results, any metals or sulphate within these strata are unlikely to have an adverse effect on the water environment.

8 No. samples taken from all material types detected leachable ammonia in excess of the assessment criteria (0.015 mg/l), ranging from 0.04 mg/l to 2.40 mg/l. It should be noted that the assessment criteria for ammonia is less than the minimum reporting limit of 0.04 mg/l therefore there may be more samples presenting elevated levels that are not reported.

On this basis, ammonia is a contaminant of concern and may be having an effect on the water environment.

9.3. Groundwater

Laboratory analysis was carried out on samples of water retrieved from each of the boreholes with the exceptions of BH8 and BH10, prior to boreholes being backfilled and the ground being re-instated. 2 No. water samples were retrieved from BH4, before and after installation of the temporary well.

Monitoring wells were not installed in BH1, BH2, BH3 and BH9, however bailed water samples were recovered from these boreholes from within the drilling rig casing. This method is not as per the British Standard guidance and as such the results of these samples may be compromised by contaminants associated with the drilling operations, such as lubrication oils. However, they do provide an indication of 'deep' groundwater quality in the area.

Metals and Inorganics

The concentrations of metals recorded in the groundwater are generally less than the reporting limit. Where detected, and on one occasion, BH3 recorded a level (0.013 mg/l) marginally exceeding the assessment criteria where UK DWS is 0.01 mg/l.

BH3 also revealed a concentration of chloride (255 mg/l), which marginally exceeds the assessment criteria (250 mg/l).

While sulphide concentrations were not detected above the reporting limit, this limit is higher than the EQS for sulphide and is particularly stringent. Given the absence of any other guidance value this EQS has been used.

Of the 6 No. samples taken, all detected concentrations of ammoniacal nitrogen in the groundwater exceeded the assessment criteria, ranging from 0.25 mg/l in BH9 to 4.7 mg/l in BH2. Elevated levels of ammonia were recorded in the leachate samples, although the concentrations recorded were less than those recorded for the groundwater.

Organics

PAHs were detected in Borehole Nos 1, 3 and 4. The concentrations of acenaphthene, phenanthrene and pyrene in BH3 only marginally exceeded the assessment criteria (0.1 µg/l). The highest concentration of the PAHs recorded is for naphthalene (8.18 µg/l) in BH1.

PAHs have been detected in the overlying soils, within the capping material, landfill waste, other made ground and superficial deposits. The highest concentration of naphthalene detected in the soils was at TP05, 4 mg/kg, at a depth of 0.15 m within the capping material.

The source of the PAHs recorded in the groundwater has not been ascertained. Anecdotal information suggested ash based materials were tipped in the landfill, and ash has been recorded in the 'other made ground' material type identified on Site. In addition, it is thought that the M8 motorway was constructed on ash sub-base. These combined sources may have affected local groundwater quality

A number of SVOCs (nitrophenols and phthalates) were detected in the groundwater for which there are no current EQS's or DWS's. 2,4 nitrophenol and 2,4 dinitrophenol were detected in BH3 and 4. The phthalates were detected in a number of the boreholes; dimethyl phthalate in BH4; diethyl phthalate in BH1 and 4, di-n-butyl phthalate in BH Nos 2, 3 and 4; butyl benzyl phthalate and bis(2-ethylhexyl) phthalate) in BH Nos. 1, 2 and 4. The source of these phthalates may be from the landfill site, although none of the soil samples analysed for SVOCs detected these determinands.

9.4. Surface Water

Surface water samples were taken from 5 No. locations around the Site. Samples SW1 and SW2 were taken upstream of the settlement lagoons, with SW3 taken downstream of the settlement lagoons but before the confluence. SW4 was taken on the southern drainage ditch of the landfill, while SW5 was close to where the surface drain on the Site flows into the Lin Burn. Figure 6 shows surface water sampling locations of which there were two rounds.

Laboratory analysis of these samples yielded 2 No. exceedences of the assessment criteria for mercury (SW3 8th May 2006 - 0.0017 mg/l) and zinc (SW4 8th May 2006 - 0.178 mg/l) down stream of the lagoons and the southern drainage ditch of the landfill, respectively.

Exceedences of the assessment criteria for ammoniacal nitrogen were detected in SW1, SW2 and SW4 in both samples. Similar concentrations were recorded up and downstream of the lagoons with no apparent pattern.

Other determinands were either less than the reporting limit or where detected significantly less than the assessment criteria.

9.5. Comparison Between Upstream and Downstream Results

In order to assess if the Site in its current state is having an impact on the water environment a comparison has been made between the results of the upstream samples and those taken downstream for the detected determinands.

Detected Determinand	Units	Upstream (Average)	Downstream of Site (SW3)	Comments
pH	pH units	7.7	7.8	No significant difference
Lead	mg/l	<0.004	0.006	Detected downstream
Mercury	mg/l	<0.0001	0.0017	Detected downstream
Copper	mg/l	0.004	0.004	No significant difference
Zinc	mg/l	0.012	0.015	No significant difference
Chromium	mg/l	<0.01	0.01	Detected downstream
Boron	mg/l	0.23	0.18	No significant difference
Chloride	mg/l	71	76	No significant difference
Sulphate	mg/l	49	46	No significant difference
Pyrene	mg/l	0.07	<0.02	Lower downstream
Ammoniacal Nitrogen	mg/l	1.41	0.37	Lower downstream
BOD	mgO ₂ /l	5	4.5	No significant difference
COD	mg/l	48.5	53	No significant difference

Detected Determinand	Units	Upstream (Average)	Downstream of Site (SW3)	Comments
Suspended Solids	mg/l	58	<10	Lower downstream

Table 13 – Comparison of Surface Water Data

From the surface water data presented above it shows that there is no significant difference between the upstream and downstream samples for the majority of determinands detected.

For the metals lead, mercury, zinc and chromium, the Site may be having a marginal effect on the surface water environment, as slightly increased concentrations of these metals were detected downstream.

For sulphate, pyrene, ammoniacal nitrogen, BOD and suspended solids, these determinands showed a decrease downstream compared with upstream concentrations. The decrease in suspended solids, BOD, sulphate and ammoniacal nitrogen is likely to be due to the attenuating capacity of the settlement ponds adjacent to the landfill.

9.6. Landfill Leachate

Slightly elevated concentrations of ammoniacal nitrogen are present in surface water up to 2.99mg/l. The actual landfill leachate concentration sampled and analysed by SEPA was less (0.91 mg/l). This indicates that elevated levels of ammoniacal nitrogen in groundwater samples are representative of background levels.

9.7. Summary of Water Data

It is considered that the water quality up and down stream of the ponds is comparable and that the water leaving the settlement ponds is not having a detrimental effect on receiving waters.

Ammoniacal nitrogen has been recorded in soil leachability samples, the groundwater and the surface water, both upstream and downstream. This may be as a result of the landfill site, but given the concentrations recorded and the fact that higher leachable concentrations were observed in the natural soil it is possible that this is naturally occurring.

Concentrations of some metals in groundwaters and surface waters sampled are generally less than the reporting limit with rare and marginal exceedences of the assessment criteria for lead, mercury and zinc.

PAHs and some SVOCs have been detected in the groundwater. The concentrations recorded marginally exceed the stringent assessment criteria and the landfill and local ash deposits are considered the likely sources. PAHs in surface waters were detected marginally above the reporting limit from one location SW5. From the data obtained, the Site appears to be having a negligible effect on the water environment.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1. Conclusions

During earth works it is unlikely that the landfill waste will be encountered given the inferred waste extents. Also earth works will predominantly involve the creation of embankments reducing excavation in the area.

Of the 4 No. soil types likely to be encountered no exceedences above commercial / industrial assessment criteria were found. Therefore should the materials be exposed due to final design levels of the motorway carriageway, it is considered that the soils will not pose any significant chronic risks to human health. It is further considered that appropriate mitigation measures such as Personal Protective Equipment (PPE) and Respiration Protective Equipment (RPE) can be worn to mitigate any short-term exposure risks.

It is noted that natural soils in particular may yield leachable ammoniacal nitrogen if exposed. In addition, there will be a requirement to control silt run off during any excavation works. However, such measures can be incorporated into the working practices employed. Based on the investigations to date, it is considered unlikely that the Site will cause significant pollution of the water environment once the road has been completed, providing drainage measures are incorporated in the final design.

10.2. Recommendations

The following mitigation proposals have been reached with regards to the construction of a junction between the M8 and A8 at Bishopton:

- During construction of the proposed road layout measures should be taken to minimise run off from all areas of the site to prevent silting and pollution of the adjacent watercourses.
- Where the proposed road alignment crosses the watercourses that exist on the Site care should be taken to ensure minimal disturbance to the bed of the watercourse.
- During construction of the proposed road layout measures should be taken to ensure that minimal amounts of dust and debris are allowed to leave the Site. This may be carried out through dampening the Site to minimise dust production and using a washing facility for vehicles leaving the Site.
- Any landfill waste and leachate excavated as part of the construction of the proposed road layout should be removed from Site and transported to a suitable treatment or storage facility.

Although it is considered that the landfill gas does not pose a significant risk to either the construction of the proposed road layout, or the long term safety of the road, it would be advisable to monitor gas levels throughout the construction phase in the vicinity of the landfill as a precaution and install appropriate gas vents if cutting through the landfill waste.