urbanspringside

Application for Permit Variation

Permit N° 53997 (New Tip)

Document NTPV 04 (C2)

Closure Plan and supporting documents

- Remediation and restoration of 'New Tip' planning consent 10/12/1110; Condition 2 (R1635-R07-v2)
    - *Contamination desk study*
    - *Site investigations*
    - *Remediation Strategy*
- Closure Plan (R1635-R08-v6)

Contaminated Land
Air Quality
Environmental Audit

Partnership No: OC 300776

urbanspringside

FORMER SPRINGSIDE MILLS SITE, BELMONT, LANCASHIRE

REMEDIATION AND RESTORATION OF NEW TIP
PLANNING CONSENT 10/12/1110; CONDITION 2

Contamination Desk Study, Site Investigations, and Remedial Strategy

For: Urbanspringside Ltd.

November 2017

R1635-R07-v1

Smith Grant LLP, Station House, Station Road, Ruabon, Wrexham, LL14 6DL
tel: 01978 822367 fax: 01978 824718 e-mail: consult@smithgrant.co.uk web: www.smithgrant.co.uk
Members: A F Smith (Chairman), K E Hawkins, B J Thomas

DOCUMENT CONTROL SHEET

Report Title:	Former Springside Mill, Belmont Remediation and Restoration of New Tip; Planning Consent 10/12/1110; Condition 2 Contamination Desk Study, Site Investigations and Remedial Strategy
Client:	Urbanspringside Ltd.
Report Reference Number:	R1635-R07
Issue	Final
Version:	v2
Report Date:	November 2017

SILC SPECIALIST IN LAND CONDITION Anthony Smith Reg. No. 139s

Signed For Smith Grant LLP

	Name	Position	Signature	Date
Author	**A F Smith BSc PhD MCIWM SiLC**	**Member**		**13/11/2017**
Reviewer	**B J Thomas BSc MSc CEnv MCIWEM**	**Member**		**13/11/2017**

Document Revision Record:

Version	Report Status	Date	Details of Revision
v1	final	19/3/14	
V2	final	13/11/2017	Minor edits

CONTENTS

DRAWINGS

1. Introduction

1.1. Urbanspringside Ltd. (USL) acquired the former Springside Mill industrial site from Kruger Tissues Industrial Ltd. (KTI) in 2012 for the purposes of remediating the site for residential development, amenity and conservation purposes. The site was previously owned and operated by William Turner & Sons Ltd. before transfer to KTI. The site contains two adjacent closed industrial waste landfills that were operated by KTI primarily to receive effluent sludges from their paper recycling and paper-making processes. These are interchangeably referred to as the Old and New Tips or the Old and New Landfills.

1.2. KTI ceased operation of the plant in 2006. USL submitted a planning application (Ref: 10/12/1110) to Blackburn with Darwen Borough Council for the remediation and restoration of the former waste disposal site known as 'The New Tip' which lies within the area of the overall works, intended to form a first phase of the remediation of the overall site. Planning consent for this was granted on 21st February 2013, subject to a number of conditions. The application boundary actually takes in both landfills together with a section of steeply-sloping bank extending south from the New Landfill and a former filter bed, although the remediation and restoration works are specifically concerned only with the New Landfill and adjacent slopes.

1.3. The landfills have Environmental Permits issued to KTI and regulated by the Environment Agency; the Permits may only be surrendered when the landfills are demonstrated to present no significant risk to man or the environment. Urbanspringside has commissioned Smith Grant LLP (SGP) to prepare technical reports and recommendations to be submitted to the Environment Agency with the aim of transferring the Permits to Urbanspringside pending the restoration of both sites, and surrender of the current licences. These technical reports are currently being considered by the Environment Agency.

Table 1.1: Site Details

Address	Springside mills, Belmont Road, Belmont
Name	Kruger New Tip
National Grid Reference	369230, 415200
EA Permit No.	53997
Site Area	2,047m^2 (paper pulp area 1,536m^2)
Current Nature of Site	closed, unrestored
Site Access	from Springside Mill internal access roads

1.4. The Mill location is shown below, and the consent boundary is shown on Drawing 01:

Figure 1.1 Site Location

1.5. The approximate Environmental Permit boundaries for the Old and New Landfills are shown below (no definitive drawings have been found), together with the extents of actual waste filling:

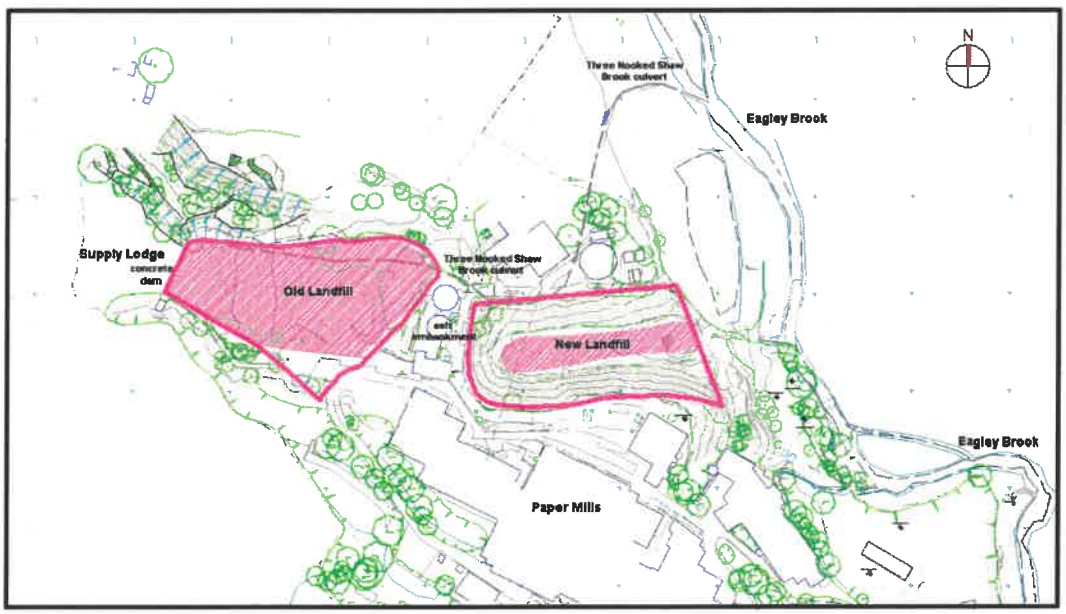


Figure 1.2 Permit boundaries, with extent of paper pulp filling hatched (not to scale - grid interval is 50m);

1.6. Because of the relatively small volume of controlled wastes placed by Kruger in the New Tip it has been determined that the most feasible method of securing the long-term beneficial use and management of the site will be to remove the existing paper waste and place engineered fills that will stabilise the slopes surrounding the New Tip (including the bank buttressing the Old Tip), and create a landscaped slope down to Longworth Clough. This is designed to merge with the slopes elsewhere in the valley and remove the artificially steep and unstable ash slopes that are currently present. Planning consent 10/12/1110 concerns the remediation and restoration of the New Tip by means of removal of the current unstable sludges, re-engineering of the current unstable slopes and associated dereliction, and infilling of the valley with inert materials to form a topography in keeping with the adjacent valley sides to Longworth Clough, with sympathetic restoration.

1.7. Condition 2 of the above consent is worded as follows:

Prior to the commencement of development hereby approved, the developer must submit to the Local Planning Authority for written approval:

(i) a comprehensive desk study report, including a preliminary conceptual site model (CSM) indicating sources, pathways and receptors in text, plan and cross-section form. Where necessary, detailed proposals for subsequent site investigation should also be included, clearly based on the CSM.

(ii) the findings of the approved site investigation work (where necessary), including an appropriate assessment of risks to both human health and the wider environment including off-site receptors, from contaminants in, on or under the land (including ground gas). The preliminary risk assessment shall identify all previous uses and potential contaminants associated with those use. If unacceptable risks are identified, a remedial options appraisal and detailed remediation scheme should be presented, along with an updated CSM. No deviation shall be made from this scheme without the written agreement from the Local Planning Authority.

1.8. This document presents the desk study summary of available information together with the conceptual site model, risk assessment and outline of the remedial strategy, as required by Condition 2. The report methodology follows the framework described in the EA / DEFRA Contaminated Land Report 11: 'Model Procedures for the Management of Land Contamination 2004'. No unacceptable risks from contamination have been identified that require specific remediation, although monitoring and assessment will be required prior to, during and following the works. Documents already submitted to the Local Planning Authority with the application include the Urbanspringside Method Statement and SGP Environmental Review and Mitigation Proposals (ref: R1635-R04-v3, November 2012) which constitute the remediation scheme.

1.9. It should be noted that extensive ground investigations have been carried out at the site over a period of over 19 years and have included investigations specifically requested by the Blackburn with Darwen Contaminated Land Officers to address certain issues prior to or in connection with

the submission of the current planning consent. In addition, routine water monitoring of the New Tip is carried out in connection with the Environmental Permit requirements. It is concluded that no further investigations works as referred to under part (ii) of Condition 2 should be required prior to the commencement of the development.

1.10. This report describes the physical environment of the site, the proposed site engineering works, potential for impacts on that environment, and proposed means of control and mitigation to prevent significant impacts (landscape and ecological surveys are reported separately by Appleton Group and ERAP respectively).

2. Information Sources

2.1. Previous Site Investigations

2.1.1. SGP has been provided with the following reports pertaining to the site and adjoining land, and which have been reviewed in preparation of this report.

Table 2.1: Previous Site Investigation Reports

Author	Title	Date and Reference	Content
Babtie Geotechnical	Charles Turner - Springside Paper Mill Assessment of Ground Environment, Interpretative Report	1995, BE15355	7 c/p boreholes to depths of 12.7m to 33m equipped for gas and groundwater monitoring, with various geophysical and chemical testing
Babtie Geotechnical	Charles Turner – Phase 1A Site Survey of Springside Paper Mills, Belmont, Bolton	February 2001, BJ6038	Desk study reviewing site details
Babtie Geotechnical	Charles Turner – Springside Mill IPPC Permit Application Phase 1A Site Survey	January 2001, BHE201548	Desk study reviewing site details and previous intrusive investigations
Babtie Group Ltd.	Charles Turner – Springside Mills IPPC Permit Application: Phase 2 Site Condition Report	June 2003, 0005979/R02	8 w/s boreholes to depths of 3.8 to 8m and 1 hand dug pit. Boreholes equipped for ground water monitoring, various soil and groundwater chemical testing

Author	Title	Date and Reference	Content
RPS Health, Safety & Environment	Phase II Contamination Assessment	June 2005, RCM4243-Final	10 w/s boreholes to depths of 4m. Boreholes equipped for gas and groundwater monitoring, various soil and groundwater chemical testing
Edge Consultants UK Ltd	Kruger Tissue Industrial Ltd. Springside Mills, Bolton; Review of Ground Conditions and Geoenvironmental Risks in Area of Licensed Landfills	July 2006, 535.2	8 c/p and 9 w/s boreholes to 4-20m depth equipped for gas and groundwater monitoring, with test results
Scott Wilson	Phase I report	July 2008, Ref: D118988	Desk Study
Scott Wilson	Kruger Tissue Industrial Ltd. Phase II IPPC Surrender Ground Investigation	August 2008, D118988	16 w/s boreholes to depths of 5.1m and 18 t/p to 3.4m, 11 boreholes installed for gas and groundwater monitoring, with various soil and groundwater test results
Scott Wilson	IPPC Site Surrender Report	October 2008, D118988	Review and statement of satisfactory condition
Scott Wilson	Kruger Tissue Industrial Ltd. Phase III Remediation Validation Report	November 2008, D118988	Collection of 6 validation samples following remediation of hydrocarbon hotspot as identified by Scott Wilson's Phase II SI
Coffey Geotechnics Ltd.	Groundwater and Gas Assessment, Kruger Tissue Industrial Ltd. Springside Mills, Bolton	May 2008, 535.2-080226-R1.1-GWGAS.doc	gas and groundwater monitoring update and risk assessment
Coffey Geotechnics Ltd.	Springside Mills, Old Landfill Ground Investigation, for Kruger Tissue Industrial	April 2011, 01505AA_R_001C_MH_MB waste investigation AR copy 1	3 boreholes to depths of 12-17m within the old landfill, equipped for gas and groundwater monitoring, with test results

notes: c/p – light cable percussion boreholes, typically 150mm diameter; w/s – window sampler boreholes, typically 50mm diameter; t/p – trial pit dug by hydraulic excavator

2.1.2. Most of the above reports address the whole of the KTI site including the New Tip. A further investigation by WS Atkins in 1989/90 around the perimeters of the Old and New Tips was referred to by Babtie, but no report has been found.

2.1.3. The New Tip waste contents are waterlogged and physically unstable, and have been investigated by Coffey, USL and SGP by means of probing, hand dug pits and core sampling to

determine waste depths and collect samples of the contents for laboratory analysis. Further samples have been collected and analysed by parties looking at the potential recovery and reuse of the sludges for composting and landspreading (soil amelioration). A description of the New Tip wastes is provided in the SGP report supporting the planning application for the New Tip restoration (ref. R1635-R04-v3, November 2012) and is summarised in this report.

2.1.4. Routine gas and groundwater monitoring, tip leachate discharge and surface water monitoring has been carried out in accordance with the landfill Environmental Permit requirements and has previously been reported in Coffey (2008 and 2011). Historical data are summarised in SGP reports R1635-R01 (controlled waters risk assessment) and R1635-R02 (landfill gas risk assessment). Since acquisition of the site by USL, SGP has carried out quarterly gas and water monitoring in accordance with the Licence requirements, and the Environment Agency undertakes routine monitoring of leachate discharged to the TNSB culvert under a separate Consent. Additional monitoring from 3 new boreholes has been undertaken in response to concerns raised by local authority officers regarding potential landfill gas migration from the Old Landfill south and southeast towards the paper mill; this work was described in SGP letter report R1635-L05, 4th February 2014.

2.1.5. All SGP reports are summarised below.

Table 2.2: Other Smith Grant LLP Reports

Title	Content and purpose	Reference and date
Springside Mills, Belmont, Lancashire; Licensed Landfills Environmental Permit Nos. 53658 and 53997 Hydrogeological Risk Assessment Report	For Environment Agency Permitting Purposes - review of previously reported data, risk assessment and review of tip leachate management options	R1635-R01-v3, Final, 4th March 2014
Springside Mills, Belmont, Lancashire; Licensed Landfills Environmental Permit Nos. 53658 and 53997 Landfill Gas Risk Assessment Report	For Environment Agency Permitting Purposes - review of previously reported data, description of preliminary flux box testing on Old Tip, and review of landfill gas management options	R1635-R02-v2, Final, 24th December 2013
Springside Mills, Belmont, Lancashire; Licensed Landfills Environmental Permit Nos. 53658 and 53997 Ground Stability Risk Assessment Report	For Environment Agency Permitting Purposes - review of slope stability around and within landfills, and settlement data on Old Tip, with review of Old Tip restoration options.	R1635-R03-v1, Draft, 5th March 2014
Restoration of the New Tip at the former Springside Mills Site, Belmont; Environmental Review and Mitigation Proposals	Review of site environmental setting and waste contents, with risk assessment and remedial options review	R1635-R04-v3, Final, November 2012

Former Springside Mill, Belmont Contamination Desk Study and Preliminary Risk Assessment	Desk study report to support main site remediation and development planning application	R1635-R05-v2, Final, 27th September 2013
Springside Mills, Belmont, Lancashire; Preliminary Ground Investigation adjacent to the Former Filter Bed and Landfill, Northern Area	Preliminary geotechnical and environmental investigation around lower northern part of site including residual wastes in filter bed and adjacent re-vegetated landfill	R1635-R06-v1, October 2013 Letter Report - Draft
Former Springside Works, Belmont; Proposed Site Remediation for Residential-led Development; Additional Landfill Gas Monitoring	Additional ground investigation and gas monitoring in response to concerns raised regarding desk study assessment of main site	R1635-L05/afs, 4th February 2014 - Letter report - Final

2.1.6. All previous recorded investigation locations are shown on Drawing D02.

2.2. Background Information

2.2.1. The principle sources of background information on the area that have been consulted in the preparation of this report include:

Table 2.3: Information Sources

date and reference	author and source	purpose and information content
Topography, geology, hydrogeology and hydrology		
Landranger 109, Manchester & surrounding area	Ordnance Survey (OS), Explorer Map, 1: 50,000	general mapping information including topography, ground features, rights of way, communications, water features etc
Sheet 76, Solid and Drift Edition, Rochdale	British Geological Survey (BGS), 1: 50,000	distribution of geological units at surface and bedrock including drift and artificial deposits; faults and mineral outcrops; distribution of geological units at depths
Google Earth (imagery dated December 2005)	aerial photography	site setting
Information review		
www.environment – agency.gov.uk; June 2013	Environment Agency	general information on source protection zones, flood risk zones, pollution hazards, current and historical landfills, water quality information
www.magic.gov.uk; June 2013		web-based interactive map containing information on nature conservation areas

3. Development History and Current Status

3.1. Processing Plant and Effluent Plant

3.1.1. Historical mapping shows the site to have been occupied by the paper mill sometime prior to 1849, with anecdotal evidence suggesting that tissue manufacture did not begin until after the Second World War. Further anecdotal evidence reported within Babtie's 2003 report (ref: 0005976) state that it is believed that a bleaching and dye works occupied the site sometime prior to 1837.

3.1.2. Ownership of the site has changed over the years with records showing purchase of the land by KTI in 2003 from Charles Turner and Sons Ltd. (CTSL), who in turn purchased the site from Burgess of Bolton in 1956.

3.1.3. Development on the site has changed very little with historical mapping showing no significant changes to the site between 1894 and 1929 where the site was occupied by three large detached buildings, six reservoirs and several outbuildings in the south.

3.1.4. An embankment is mapped in 1894 crossing the TNSB valley and forming the future eastern boundary to the Old Tip; this feature has been referred to as the ash dam in some reports, although it was not constructed for this purpose but to gain access to the northern side of the TNSB valley; the embankment was constructed from coal ash and clinker produced from the works boiler house.

3.1.5. Only two of the original reservoirs remain on the site in 1963 mapping with the remaining four being infilled. An expansion of the mill took place with the construction of a fourth large building in the west and the labelling of a refuse tip in the northeast of the site; alongside Eagley Brook and an effluent treatment plant; this is the historical works landfill which occupies low ground adjacent to the former effluent settling tanks, and which received effluent sludges from the adjacent filter beds. The filter beds are included at the eastern extremity of the consent area as it is proposed to refurbish and re-use these as silt settling ponds to receive runoff during the construction of the new embankment.

3.1.6. Two boiler houses have been historically located on site; the old boiler house located in the northern wing of the current paper mill building on the location of the new paper-making machine No.5 building, and the new boiler house in the south. The original boiler house was coal-fired and generated the large volume of ash fills that are evident forming the steep slopes around the sides of the lower TNSB valley / New Tip, and extending east into Longworth Clough. The northern edges of the ash-filled slopes are included in the consent boundary as it is proposed to reduce these in height to improve the stability of the slopes and to merge with the new embankment.

3.1.7. When in operation by KTI (2003), Spingside Paper Mill produced approximately 23,000 tonnes of

tissue a year, with four paper machines in operation, producing tissue from waste paper and wood pulp. The process undertaken on site within the manufacture of tissue was for waste paper to be pulped with water and chemicals (including antifoams, detergents, flocculants, dyes, dispersents and biocides) to form a stock. The stock fibre was then screened and refined before water was extracted from the paper stock, the ensuing wet tissue was then passed through a selection of presses and dryers before the dried tissue was reeled, cut and packed. A list of the chemicals used on site is reproduced within Appendix A.

3.1.8. The site operated its own effluent treatment plant where it treated effluent from the various site process areas (including wastewater from the surface drains and leachate pumped from the landfill drains). Babtie (2001) reported that treated wastewater was discharged (under consent) from the lagoon overflow channel and ultimately into Eagley Brook whilst waste sludge was taken off site for composting.

3.1.9. The main source of solid waste produced from the manufacturing of tissue paper was effluent treatment sludge (referred to as paper sludge, although cellulose fibre is a minor constituent). During operations by KTI, 98% of the waste was used for composting. This involved the mixing of paper sludge with peat and soil which was allowed to decompose and then used as topsoil for reclaimed mineral mining land; as of 2001 approximately 2% produced went to landfill according to the Babtie (2001) report (Ref: BJ6038)

3.2. IPPC Permit

3.2.1. In 2001, Babtie prepared an Integrated Pollution Prevention and Control (IPPC) permit application to the Environment Agency including limitations on discharge of effluent to Eagley Brook and processing activities on the site (Permit No BW2439 endorsing BJ6038). Under the IPPC Permit, KTI was permitted to carry out activities relating to the manufacturing of recycled paper based products.

3.2.2. When KTI operations ceased in 2006, Scott Wilson was commissioned to prepare the necessary reporting to allow surrender of the IPPC Permit. The reporting included a Phase I report (July 2008, Ref: D118988) and Phase II (intrusive site investigation) Report (August 2008, Ref: D118988).

3.2.3. Results from the Phase II report identified an area of hydrocarbon contamination which was attributable to site activities during the operation of the Permit; accordingly, this required remediation for KTI to be able to surrender the Permit. Scott Wilson subsequently supervised the necessary remedial actions and produced a Remedial Validation Report (November 2008, Ref: D118988). The formerly impacted area lies over 60m to the south of the consent boundary and is considered unlikely to be an issue with respect to contamination.

3.2.4. Information regarding the Permit Surrender from the Environment Agency has not been seen, however the Planning Inspectorate confirmed the successful surrender of the Permit with effect from 9th January 2009 in a planning inquiry relating to the construction of security fencing around the works.

3.2.5. Key operational areas of interest with respect to potential ground conditions are shown on a works diagrammatic drawing (figure 3.1) and in the table below; areas lying inside the current consent boundary are highlighted:

Table 3.1: Key operational areas on the site

Area	Operations	Reference
North	Effluent waste storage area (cylindrical tank position)	RPS (2005)
	The New Tip	RPS (2005)
Centre	Boiler house and boilers (removed when this part of the site was redeveloped for Paper Making (machine No.5)	Babtie (2003)
	Storage workshops (including paper making machinery No. 1-5)	Babtie (2003)
	Storage areas	Babtie (2003)
South	Pulp store	Babtie (2003)
	Diesel tank (AST)	RPS (2005)
	New boiler house	Babtie (2003)
	IBC storage area	RPS (2005)
North-east	**Settling tanks**	Babtie (2003)
	Janitorial department	Babtie (2003)
East	Transformer and substation	Babtie (2003)
	Storage areas	Babtie (2003)
South-East	Drum storage area	RPS (2005)
South-West	IBC storage area	RPS (2005)
West	Possible paraffin and diesel tanks (ASTs)	Babtie (2003)

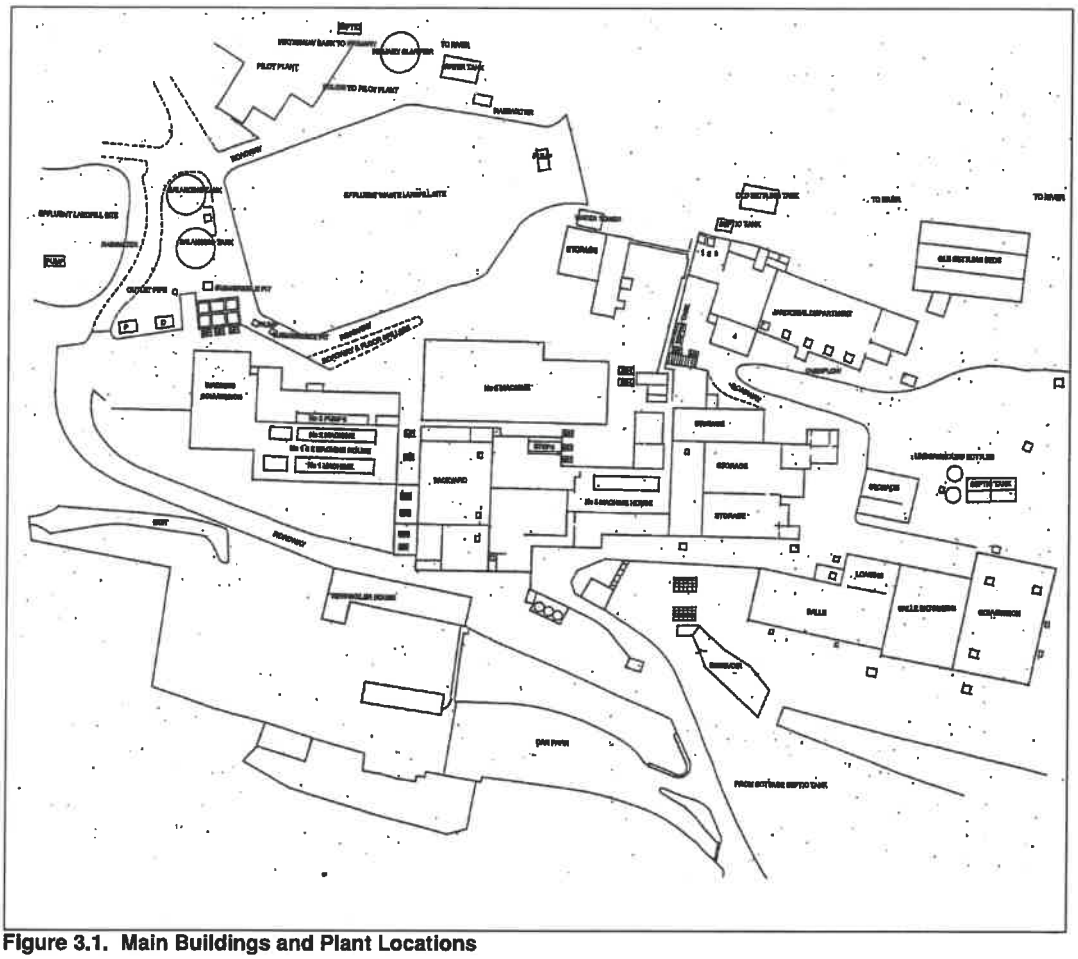


Figure 3.1. Main Buildings and Plant Locations

3.3. Original Landfill in south-east

3.3.1. The earliest known area of effluent sludge disposal took place on a roughly level area of ground between the former filter bed and Eagley Brook. This area lies largely outside the consent boundary and will remain unaffected by the proposed works. The area has been subject to limited investigation due to the difficulty of access through the woodland, undesirability of disturbance of the ecological habitat (including well-developed moss carpet), and proposals to leave this area undisturbed.

3.3.2. Investigations in this area are summarised below:

Table 3.2: Summary of Investigations in former Northeast tip area

Reference	Consultant and date	Strata (depth to base)	Contamination
WS9/03	Babtie, 2003	0.7m stone, ash brick 1.4m grey 'peat' (paper sludge), on gravelly clay (natural strata)	no significant contamination

Reference	Consultant and date	Strata (depth to base)	Contamination
WS119/06	Edge 2006	0.1m peaty soil 0.7m ash 0.9m grey ash and paper sludge 2.0m gravelly clay (logged as made ground but possible natural)	no results found
WS9/08	Scott Wilson, 2008	0.8m ash and brick 2.2m grey paper sludge (logged as peat) on sandy gravelly clay (natural strata)	no significant contamination
HA5/12	Smith Grant 2012	2.0m paper sludge and sandy gravel 2.3m grey silt 2.4m gravelly sand	no test
TP4/13	Smith Grant 2013	0.3m peaty turf 1.3m grey effluent sludge with rare ash, brick and scrap metal inclusions, blackened and slightly odorous below 0.6m, on clayey gravel (natural strata)	elevated chromium, copper and zinc recorded in sludge sample, possibly associated with de-inking residues (ref R1635-R06)

3.4. The Old Tip

3.4.1. The Old Tip, located upstream of the main plant within the base of the TNSB valley, was first licensed in 1977 under Waste Management License No. 23 to accept 4,000 tonnes per annum of effluent treatment sludge by-product from the site's manufacturing of paper, although the start of tipping possibly predated 1977. The sludge is believed to have arisen primarily as the settled solids from paper recycling and tissue manufacture, comprising inert fillers of clay and limestone and short fibres of cellulose, hemi-cellulose and lignin. Works documents sometimes refer to the Old Tip as a Pulp Lagoon, indicating the semi-solid nature of the sludges when originally placed there. The Old Tip was intended to be used when alternative recycling methods such as composting or land-spreading for agricultural improvement were unavailable (demand for land-spreading is seasonal, and is dependent upon cropping cycles and farmland accessibility during dry weather). There are records that the Old Tip functioned as a Waste Transfer Station (i.e. as a temporary storage area for materials awaiting use for landspreading which is a seasonal activity.

3.4.2. The tip was also licensed for the disposal of other site-generated wastes and in particular construction and demolition materials. Sections of the landfill in the east adjacent to the ash embankment include approximately 50% infilling with demolition materials including brick and concrete, boiler ash and soot, and stabilisation of the waste facilitated the use of the eastern part of the tip for storage purposes in the later years before site closure; it seems likely that the rubble from the demolished original boiler house and chimney was placed across the upper part of the Old Tip to create additional open air storage and parking. It has also been suggested that bonded asbestos cement demolition wastes were also placed within the tip, and probable asbestos sheet fragments were recorded by Coffey in one of their 2011 boreholes.

3.4.3. The tip is approximately 70m wide and 145m in length, is unlined and rests on natural strata within the valley sides and base, and is retained by the Lodge dam to the west and the ash embankment to the east. Depths range from 7m at the west end to 15m at the east end near to the ash embankment, and tapering out along the north and south sides.

Old Tip, SGP trial trench to establish northern boundary of fill near to BH105/06, showing uncapped waste resting on natural boulder clay adjacent to natural seepage line from hillside

Old Tip, SGP trial pit in north east to establish boundary, showing layers of soil, rubble, ash and brick with paper waste, over natural boulder clay

3.4.4. A leachate drainage system is in place adjacent to the Supply Lodge dam to pump leachate to the effluent plant, however standing water levels are typically similar on either side of the dam, showing that pumping here simply draws water through or around the dam from the Supply Lodge (see photos below).

Old Tip standing water alongside Supply Lodge Dam, at same level as lodge

Supply Lodge Dam water level controlled by 42" culvert outlet; note naturally peaty content of water

3.4.5. The Old Tip effectively ceased to receive effluent treatment sludges following the construction of the New Tip, and was considered to be fully closed to all wastes before 2002. The last recorded use was for the temporary storage of sludges in September 2001 prior to their removal from the site.

3.4.6. Intrusive investigations were undertaken by Babtie in 1995, Edge Consultants in 2006 and Coffey Geotechnical in 2011 within the Old Tip through the drilling of boreholes which were equipped with gas and groundwater monitoring installations. Quarterly monitoring of ground gas and groundwater of up/downstream boreholes is currently on-going.

3.4.7. The Old Tip is included within the consent boundary as it is proposed to utilise the area of hardstanding in the east for the purpose of temporary stockpiling of sludge removed from the New Tip pending recovery and re-use of the material in restoration.

3.5. The New Tip

3.5.1. The New Tip, located in the valley area between the eastern face of the ash embankment and the convergence with Eagley Brook was constructed in 1991 to provide additional capacity for the storage of effluent treatment sludges, and is permitted under Waste Management License No. 140 to accept up to 6,000 tonnes per annum of paper sludge by-product. Actually, the quantity of waste landfilled is estimated to be about 3,000m^3 and which appears to be entirely paper effluent treatment sludge.

3.5.2. The tip is lined with a butyl membrane to prevent migration of solid material, gas and leachate. A basal drainage system was also installed to manage groundwater and residual flow along the valley floor. Leachate generated within the New Tip is collected in a sump and returned to the TNSB outlet, however pumping from the leachate chamber is unable to effect dewatering of the adjacent wastes due to their cohesive nature and high-water retention (see photos).

New Tip Leachate Chamber; standing water level is controlled by overtopping of liner in wet weather

New Tip Leachate Chamber after pumping out, showing minimal inflow from surrounding waterlogged wastes

3.5.3. The tip depth is currently up to about 3m deep, and largely fills the existing limits of the liner system.

3.5.4. The tip was considered to be closed by 2002. Quarterly monitoring of ground gas and groundwater of up/downstream boreholes is currently on-going.

3.6. Current Status

3.6.1. The site is currently in a state of closure and disrepair since the manufacturing of tissue by KTI ceased in 2006 with all buildings, and much of the water pipework and plant within buildings remaining.

3.6.2. The only remaining above ground storage tanks (ASTs) are a pair of fuel tanks located within a brick bund at the northern end of the former New Boiler House area; these are empty, with no evidence of fuel spillage. No underground storage tanks (USTs) are known at the site, although a couple of septic tanks are known to be present and have received foul drainage from the site. None of these features lie within the current consent boundary.

3.6.3. Three large cylindrical water treatment tanks (two located on the ash embankment and one to the north of the New Tip) have been demolished for safety reasons following purchase of the land by USL. Otherwise most of the buildings and plant have remained undisturbed since closure of the works, and many buildings are in a dangerous condition that precludes access due to the risk from roof collapse.

Bases to former water treatment tanks on ash embankment

3.6.4. A steel palisade fence has been constructed around the factory boundary, encompassing approximately 13 ha of land with 24hr monitoring with CCTV cameras for safety and security reasons. The wider land holding extends beyond the security fence and includes farmland and wooded river valleys.

3.6.5. Rough scrubland dominates site areas where hard-standing is not present, with Himalayan Balsam widespread in the valleys during the growing season and localised areas of Japanese Knotweed adjacent to the ash embankment. The Old Tip is partly vegetated with scrubland, with the eastern edge of the tip flooded where the waste slopes down towards the Supply Lodge Dam. The ground is generally soft on the western slope, and during periods of wet weather can become excessively soft and waterlogged. The New Tip is partially vegetated with marshland reeds, particularly in the west around the pumping chamber.

3.7. Adequacy of Information

3.7.1. Whilst there are some gaps in the historical map coverage, and there is limited information on historical industrial processes at the site, it is considered that the information provided in the previous reports gives adequate coverage of the site and immediate surroundings. The records of recent industrial processes provide a reasonable basis for assessing potential contamination; it should be noted that the paper-making process (and preceding bleaching / dyeing activities) were heavily dependent upon water-based processes, and that typically, most potentially polluting substances such as dyes, bleaches, pulping agents, and water treatment chemicals were flushed away in the effluent discharges.

4. Site Characterisation

4.1. Topography and Site Setting

4.1.1. The site is located approximately 2km to the south-east of Belmont village, alongside Longworth

Clough.

4.1.2. Surrounding land is predominantly pastoral farmland with sloping fields falling into main valleys, which are largely wooded. Three water supply reservoirs are located within 0.5km of the site; Springs and Dingle reservoir are both located approximately 0.2km to the south, and Delph reservoir 0.5km to the north-east. These are managed by United Utilities.

4.1.3. The topography of the site is relatively severe with steep slopes and valleys. Ground levels vary considerably across the site, falling from approximately 220m AOD in the south to approximately 173m AOD in the north-east. There are a number of masonry and brick retaining walls, both external and internal to buildings.

4.1.4. The site is split into two main levels with the main mill buildings located on the upper valley side and elevated at approximately 200-215m AOD, some 10-15m above the original base of the TNSB valley. All drainage from the site either converges upon the TNSB valley or flows directly to Eagley Brook.

4.2. Ground Conditions and Geology

4.2.1. Published BGS mapping shows the majority of the site to be underlain by Superficial Deposits comprising of glacial till (clay) with an average thickness likely to exceed 30m everywhere within the site. Deposits of glacial sand and gravel over the glacial till are recorded on the high ground to the west, generally outside the proposed residential area.

4.2.2. Bedrock is mapped as Marsden Formation, Millstone Grit of the Namurian Series with recorded angles of dip from the sequence within the site of ten degrees to the south-east.

4.2.3. Faulting is indicated on the southern edge of the site where a west south west to east north east trending fault with the downthrow site to the south is located. The eastern edge of the site is also bordered by a fault with downthrows in the north-west.

4.2.4. Previous intrusive investigations carried out on the site have involved a total of 67 boreholes to varying depths and 23 trial-pits, allowing a good spatial coverage to characterise the shallow and deeper ground conditions underlying the site.

4.2.5. Extensive intrusive investigations have identified a layer of made ground to be present across the site. Depths are variable but are typically in the order of 1.5-3.5m thick although deeper deposits are noted in the area between the new and old tip where ashy made ground deposits were placed, referred to as the 'ash embankment. The 2006 intrusive investigation by Edge Consultants encountered made ground thickness of 15.5m thick in BH114/06, located within the ash embankment over the original valley floor.

4.2.6. Made ground encountered outside of the ash embankment typically comprised fine to coarse sandy gravel with inclusions of ash, clinker and cobbles to fragments of brick.

4.2.7. Natural ground encountered during previous investigation was found to be mainly glacial clay tills with discontinuous horizons of sands and gravels. The clays were described as generally firm to stiff with some localised areas of softer deposits.

4.2.8. Peat was described in four locations, outside the current consent boundary, generally at the base of fill and top of natural strata, as follows:

Scott Wilson, 2008	TP02/08, >0.35m thickness at 2.8m depth
	TP05/08 - 0.6m of peaty clay at 1.2m depth
	TP18/08 - 0.4m layer at 1.8m depth in made ground
Edge Consultants, 2006	WS113/06 - 0.7m layer at 1.8m depth

4.2.9. Materials described as a dark grey plastic pseudo-fibrous peat were logged in Babtie 2003 WS09/03 as a 1.4m layer at 0.7m depth, and in the nearby Scott Wilson WS09/08 as a 1.4m layer at 0.8m depth. Both entries lie within the area of the historical paper sludge deposition area alongside the original effluent treatment plant, and the material described as peat is likely to be consolidated paper waste. More recently, SGP excavated a trial pit TP4/13, into the side of the fill area, confirming the presence of effluent treatment sludge containing paper fibre and mineral fillers 1.3m deep overlying natural ground of a sandy gravel alluvium.

4.2.10. Granular materials of sand and gravels were encountered to the south of the main processing area in two entries (WS1 from Babtie's 2003 investigation and WS10 from the RPS 2005 investigation).

4.2.11. Work undertaken by Coffey Geotechnics in 2011 involved the drilling of 3 boreholes (BH1/11-BH3/11) through the full thickness of the Old Tip to identify depths of waste paper pulp deposits. Made ground comprising coarse sand with ash, fragments of brick and occasional concrete were encountered in BH1/11 and BH2/11 to a maximum depth of 3.4m bgl before encountering amorphous paper waste, described as very soft clay; paper waste was encountered from the surface in BH3/11. Generally, the paper waste was found to become increasingly firm with depth, no doubt due to drainage of water and natural consolidation.

4.2.12. Natural ground was reached within the old landfill investigation at depths of 15.6m bgl (BH2/11) and 9.2m bgl (BH3/11) where firm to stiff clay with coarse gravel and pockets of sand and organic remains were described.

4.2.13. Bedrock was not encountered within any of the recent intrusive entries; however historical drilling records from the 1920s included one borehole adjacent to the ash embankment in the base of the original TNSB valley (BGS archive log SD61NE 21) which recorded a depth of drift of about 45m over shale bedrock. The glacial till is therefore of considerable thickness below the site and fills in the buried pre-glacial valley of Longworth Clough.

4.3. Site Drainage and Hydrology

4.3.1. The nearest watercourse to the site is the culverted TNSB which flows through the site. This watercourse had been engineered sometime prior to 1849 (as indicated by historical mapping) with a series of man-made features to provide a controlled water supply to the mill.

4.3.2. The original course of the brook flowed in a west to east direction through the north of the site and ran below subsequent locations of the old and new tip before joining Eagley Brook. The original TNSB has now been diverted to run in a culvert across the north side of the former valley at a higher level before discharging to Eagley brook upstream of the site.

4.3.3. The current EA water quality descriptions in relation to the Water Framework Directive (WFD) for Eagley Brook and the Northern Manchester Carboniferous Aquifer are summarised below:

Table 4.1. General Water Quality

	Eagley Brook	**Northern Manchester Carboniferous Aquifer**
water body ID	GB112069064570	GB41202G101800
current chemical quality	good	poor (no upward trend)
predicted 2015 chemical quality	good	poor
current ecological quality	moderate potential	-
predicted 2015 ecological quality	moderate potential	-

4.3.4. The surface water analysis conducted in 2012 and 2013 for Eagley Brook and TNSB indicates generally unpolluted slightly alkaline water, but with evidence of influence from mineralised spring discharges and severely reduced oxygen levels in summer months, probably resulting from low mixing within the upstream reservoirs. The only substances found to regularly exceed water quality criteria have been for iron and manganese which are likely to be associated with the reducing conditions revealed by redox tests; these are most likely to arise from spring discharges from the iron-rich gritstone and shale strata or nearby Coal Measures, and from drift deposits containing the same parent material. The BGS archived borehole logs from 1919-20 frequently refer to the shale bedrock adjacent to the site containing iron nodules. There is no evidence of significant changes to water quality in Eagley Brook downstream of the TNSB culvert or old tunnel discharges.

4.3.5. The site itself is not located within an indicative flood zone, however Eagley Brook flowing to the north-east and east of the site is located in a flood zone with a 1 in 100 greater chance of a flood happening each year although this is some 15m below the lowest operation building on the site. Flood risk is further considered by Michael Lambert Associates for USL.

4.3.6. Drainage of surface water on the site is by both run-off into a series of surface drains in areas of hard-standing and by infiltration into exposed soils which are present around the site. During periods of extreme precipitation where surface drains may be overwhelmed, surface-run off into Eagley Brook is likely.

4.3.7. In 2001 an IPPC permit application (Permit No. BW 2439 endorsing No. BJ6038) was prepared and accepted including a Discharge Consent for all effluent from the factory processes to be discharged to Eagley Brook once the effluent had been treated.

4.3.8. During the period when the IPPC was being surrendered, temporary permission was granted by the EA to allow discharge of the surface and groundwater from the tips. Following the surrender of the IPPC Permit a new discharge consent was applied for to allow the discharge of said waters; the consent relates to a discharge point in the TNSB culvert within the consent boundary. Recent test results have shown that the water is sufficiently clean to be discharged directly into Eagley Brook without processing; discharges are currently undergoing regular monitoring at three monthly intervals by SGP. It is proposed to relinquish the discharge consent following restoration of the New and Old Tips.

4.4. Groundwater Conditions / Hydrogeology

4.4.1. The bedrock has previously been classified by the EA as a Secondary A Aquifer, and the site does not lie within a source protection zone. The EA has classified the groundwater as having poor chemical status due to natural mineralisation. BGS describes the Millstone Grit as a multi-layered aquifer in which the thick, massive grit and sandstone horizons effectively act as separate aquifers with the intervening mudstones and shales acting as aquitards or aquicludes. Due to cementing of the rock, most groundwater resides within fractures caused by joint and faulting, and typically at less than 200m depth.

4.4.2. The glacial till generally has low permeability and is regarded as an aquitard or aquiclude. Pockets and lenses of sands and gravels may contain limited amounts of groundwater however these are typically discontinuous. Previous investigation of the site (Babtie 1995) noted groundwater strikes and apparently increased permeability within laminated clays at depth within the glacial till. The distribution of laminated clays or silts appears to be localised, representing minor deposits, and it is unclear why these should have significantly higher permeability than the surrounding deposits unless there are fine sand layers present in the partings; in this case localised increased horizontal permeability, but very low vertical permeability would be expected.

4.4.3. Babtie from their investigations and testing suggested permeabilities values of 1.0 - 8.0 X 10^{-8} ms^{-1} for the general cohesive glacial till, 2.2 X 10^{-7} ms^{-1} for the laminated clays, and 1.6 X 10^{-5} ms^{-1} for the granular horizons. However, it is likely that given its preponderance, the overall permeability of the formation will be dictated by that of the general cohesive glacial till. This is considered to be negligibly permeable.

4.4.4. A number of ferruginous springs are visible in the valley sides of Eagley Brook apparently associated with the outcrop of the Marsden Formation upstream of the Paper Mill and on the steep eastern bank of Longworth Clough where the drift cover has thinned or is absent due to erosion. The Mill used to operate a supply borehole located over 150m north of the New Landfill at an elevation of 181 m aod. The water level in the well was reported to be close to surface however the supply was said to have been limited in recent years due to silting or clogging of the pumps or filters, presumably due to ochre precipitate. The source of the iron is natural mineralisation within the Namurian and Carboniferous Strata. Older boreholes drilled in the valley in the 1920s encountered artesian flows from the bedrock.

Natural ferruginous seeps from east bank of Eagley Brook adjacent to the site

Natural ferruginous seeps from east bank of Eagley Brook upstream of the site

4.4.5. In general groundwater levels, as monitored in boreholes around the site, lie at or close to the glacial till surface, confirming the negligible permeability of this formation and importance of seepage flows within the shallow soils and permeable fills. These seeps converge on the TNSB lower valley and discharge to Eagley Brook to the east of the New Tip.

4.4.6. The interpolated average surface water and groundwater levels have been used to construct a groundwater contour plan for the site, as shown below:

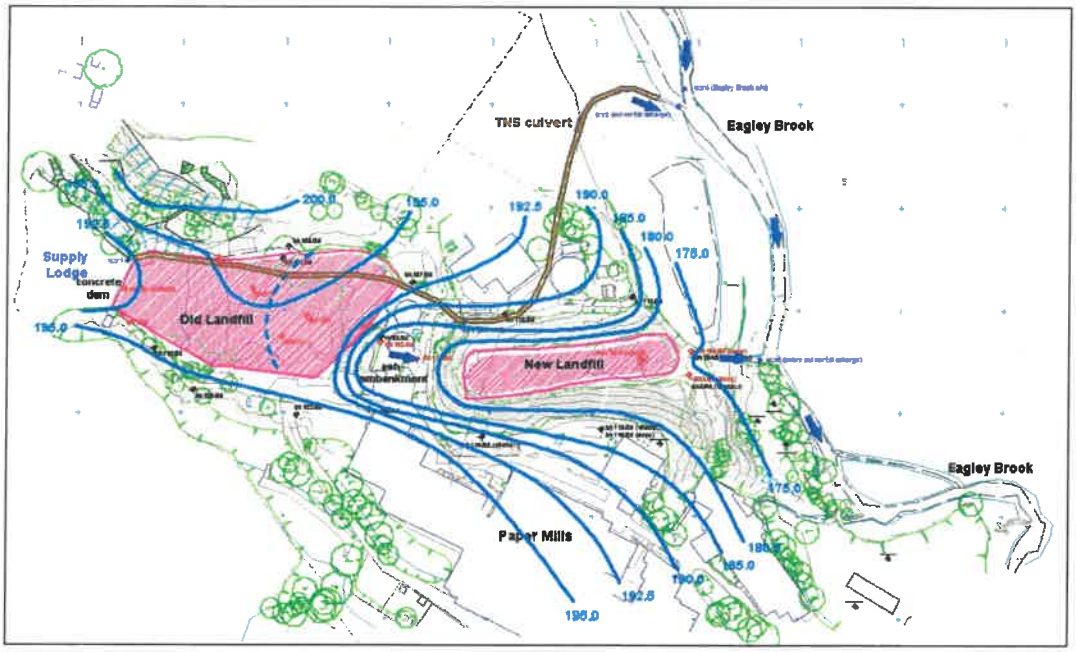


Fig 4.1. Interpolated groundwater contours and stream flows (contours in m aod)

4.4.7. Current groundwater abstractions for public supply take place from boreholes within the gritstones to the west of the site; the source protection zones for these lie outside the site. The water levels are probably at greater elevation than groundwater at the site (the rest water level in the Springs borehole on the west side of Springs Reservoir was measured at 200.8m aod), and the supply boreholes are not hydraulically linked to the landfill sites due to the clay drift. It is understood that due to high natural mineral concentrations the public borehole supplies have to be mixed with reservoir water to achieve acceptable quality standards.

4.4.8. Babtie (1995) reported that according to information from Blackburn Borough Environmental Health Divisions there were no private water supplies in close proximity to the site.

4.5. Nature Conservation

4.5.1. The site has no identified species or habitats of acknowledged value, and is impacted by the invasive weeds Himalayan Balsam and Japanese Knotweed.

4.5.2. The site approaches to 20m from the Longworth Clough Site of Special Scientific Interest. This is designated on the basis of its lowland deciduous woodland plant communities; however, both banks of Eagley Brook are currently adversely affected by Himalayan Balsam.

4.5.3. There are also local non-statutory conservation sites in the vicinity which include part of the New Tip site; further details are included in the specialist ecological report.

4.5.4. Although the site lies close to designated and protected conservation sites, these are hydrologically isolated from the site and not at risk from any potential release of pollutants.

5. Soil Contamination Review

5.1. Previous Intrusive Investigations

5.1.1. Extensive intrusive investigations have taken place across the wider Paper Mill site since 1989 with records available for approximately 66 boreholes and 23 trial-pits, allowing a good spatial resolution to characterise the site's ground conditions. Widespread sampling has taken place with approximately 109 water samples and 154 soil samples collected and reported within the aforementioned ground investigations. These include samples analysed from the three identified areas of paper waste disposal within the site, and the ash deposits and general made ground below and adjacent to the industrial plant.

5.1.2. Intrusive investigations drawn upon within this report, the objectives of the investigation, and the areas targeted are summarised in the table below:

Table 5.1. Summary of historical intrusive investigations

Author & Date	Date & Reference	Objectives	Location
Babtie Geotechnical (1995)	BE15355	Environmental assessment of the ground assets of the Springside Paper Mill to address certain requirements for site valuation and waste management licensing	Targeting areas of ash embankment, perimeter of old tip and downstream of the new tip
Babtie Group Ltd. (2003)	0005979/R02	Establish the presence and extent of potential contamination as part of the IPPC Permit Application in June, 2003	Targeting areas of potential contamination, ash embankment, roadway and floor spillage area, boiler house, machine house (No.3)
RPS Health, Safety & Environment (2005)	RCM4243-Final	Intrusive investigation to determine the extent of potential ground contamination at the site	Targeting areas IBC storage area, diesel tank, janitorial department, drum storage area, roadway and floor spillage area, outside paper storage area and ash embankment around effluent treatment tanks
Edge Consultants UK Ltd (2006)	535.2	Intrusive investigation with the intention of meeting assessment criteria appropriate to the site CSM	Perimeter of the new and old tip with some boreholes located within the old tip. Entries present within the ash embankment between both tips

Author & Date	Date & Reference	Objectives	Location
Scott Wilson (2008)	D118988	Targeted Phase 2 ground investigation to inform an IPPC Site Surrender Report prior to the disposal of the site	Potential contamination areas such as drum storage area, diesel tank, boiler house, storage areas, machine house areas, location of 2 tanks labelled as 'p' and 'd' (possibly petrol or paraffin and diesel), ash embankment
Coffey Geotechnics Ltd. (2011)	01505AA_R_001C _MH_MB waste investigation AR copy 1	Collect additional information on the existing ground and groundwater conditions within the old tip in order to allow the EA to grant permission to empty the old landfill of its waste which was considered a possible remedial option by KTI at the time	The Old Tip

5.1.3. Overall, the various contamination investigations are considered to have been undertaken professionally to the standards appropriate for the time and purpose, generally in accordance with BS5930:1999 and BS10175:2001, and were used to meet the requirements of the Environmental Regulator at the time. The range of analyses conducted, and quality controls appear to be appropriate, and SGP is not aware of any significant deficiencies. The spacing of entries, principally within the RPS and Scott Wilson Investigations over the main process areas of the plant, averages about 40m, and investigations were constrained by the operational nature of the site at the time. Much closer spacings were achieved around the identified contamination hot-spots.

5.1.4. For the purpose of this contamination assessment report, review of historical investigation will focus on the results of soil, groundwater and ground gas analysis and monitoring within and adjacent to the consent boundary. Comprehensive review and assessment of groundwater results relating to the licensed tips has been reported within SGP's Hydrogeological Risk Assessment (R1635-R01-v3), summarised in section 6 of this report. Historical and current landfill gas results are discussed in detail within the Landfill Gas Risk Assessment Report (R1635-R02-v2), summarised in section 7 of this report. An assessment of contamination and risks to receptors from areas of the main works site outside the current consent boundary is given in the SGP desk study report for the main site (R1635-R05-v2).

5.1.5. Reported concentrations of substances have been compared against relevant screening assessment criteria for a residential land use. For the protection of human health, these are published DEFRA/Environment Agency Soil Guideline Values (SGVs), or generic assessment criteria (GACs) described in other authoritative reports and generated using the CLEA risk assessment model. For the protection of vegetation from phytotoxic metals, MAFF guidance has

been referred to. BRE SD1(2003) guidelines are referred to for sulphate potential aggressiveness for concrete.

5.2. Ground Investigation Limitations

5.2.1. No entries were terminated on obstructions:

5.2.2. The following entries failed to penetrate the full thickness of made ground due to the limitations of the methods used:

Babtie, 2003 -	WS02/03 - >8.0m
	WS03/03 - >8.0m
	WS04/03 - >8.0m
RPS, 2005 -	WS08/05 - >4.0m
Edge, 2006 -	WS117/06 - >4.5m
	WS120/06 - >1.0m (adjacent to eastern boundary of site)
Scott Wilson, 2008	TP10/08 - >2.6m
	TP11/08 - >2.4m
	TP12/08 - >2.6m
	TP13/08 - >2.5m
	TP14/08 - >2.6m
	TP16/08 - >2.3m
	WS02/08 - >2.5m
	WS02A/08 - >5.1m
	WS03/08 - >5.1m
	WS04/08 - >5.1m

5.2.3. In all cases outside the permitted landfills and historical landfill adjacent to Eagley Brook, the made ground materials were principally either tipped boiler ash or apparently reworked natural materials or brick and masonry. Given the general sparseness of contamination indicators recorded in the logs it is concluded that the site investigations have provided sufficient information for a reasonable characterisation of soil contamination to be carried out. Detailed reviews of the findings of each investigation are provided below.

5.3. Babtie Geotechnical (1995)

5.3.1. An intrusive investigation targeting the periphery of the old tip and downstream of the new tip was carried out to determine the effectiveness of waste tip containments and identify the potential for off-site migration of contamination. The investigation was limited in respect to the analysis carried out and focused mostly on the geotechnical properties of the soils, hydrogeology and ground gas generation.

5.3.2. Seven cable and percussion boreholes were extended to a maximum depth of 33m bgl, although one borehole (BH1/95) terminated at 1.1m bgl due to an obstruction and was relocated as BH1A/95.

5.3.3. Limited chemical analysis was carried out, with only soluble sulphate and pH analysis completed on two samples, one of black ashy fill (5m bgl) and another of glacial till (15.5m bgl). pH values ranged from 7.7 to 8 with soluble sulphate (2:1) 0.12-0.8 g/l.

5.3.4. No contamination was identified other than the potential for pollution arising from the coal ash embankment although this impact was limited to shallow groundwater.

5.4. Babtie Group (2003)

5.4.1. A second intrusive investigation was carried out by Babtie to obtain further information to enable the production of an initial site report to be submitted in conjunction with a permit application to operate a Part A installation under the Pollution Prevention and Control (PPC) Regulations 2000.

5.4.2. The investigation comprised 8 window sampler boreholes and a single hand-dug pit mostly located adjacent to the landfills, with the collection of soil and groundwater samples; all boreholes were installed within gas/groundwater monitoring wells. The suite of chemical analysis scheduled was based on information present in the DoE Industry Profile for Pulp and Paper Manufacturing Works and which included metals, petroleum hydrocarbons, phenols, sulphate, sulphide and alkalis.

5.4.3. During the site investigation one borehole (WS2/03) within or adjacent to the consent boundary exhibited visual or olfactory evidence of contamination. Borehole WS2/03 encountered a 20cm thick horizon of white clayey material within made ground fill at 6.5m bgl, however chemical testing did not identify the presence of elevated determinants, probably indicating that the substance was china clay filler or lime for water treatment.

5.4.4. A single slightly elevated concentration of zinc was observed in WS3/03 within the ash embankment at 4.0m depth, with a concentration of 361 mg/kg exceeding the residential land use criteria of 300 mg/kg (for protection of sensitive plants).

5.4.5. Sulphate concentrations within two entries (WS3/03-WS4/03) exceeded the BRE guideline concentration for concrete protection of 2,400 mg/kg, with a maximum concentration of 7,415 mg/kg. It is likely that elevated sulphate was due to the presence of concrete fragments which were identified within the made ground.

5.5. RPS (2005)

5.5.1. RPS was commissioned by Rutter Johnson to conduct a Phase II contamination assessment in order to determine and quantify the current ground contamination on the site as a baseline against which future assessments for IPPC purposes could be referenced.

5.5.2. Only one window sampler borehole was located inside the consent boundary, WS8/05 adjacent to a clarifier tank on the ash embankment. Analysis of samples for a range of contaminants including metals, cyanide, water soluble boron, semi-volatile organic compounds (SVOC's), volatile organic compounds (VOC's), total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH). A total of 22 soil samples and 3 groundwater samples were collected and 3 rounds of ground gas monitoring were carried out.

5.5.3. Elevated concentrations of copper, lead and zinc were recorded above SGVs / GACs within the shallow soils.

5.5.4. TPH in a sample, from 0.5m bgl, was found to be elevated, at 1,180 mg/kg; speciated banding was not carried out on this sample, meaning that comparison against current human health screening values could not be carried out.

5.6. Edge (2006)

5.6.1. Edge Consultants carried out an intrusive investigation detailing the ground conditions and geo-environmental risks associated with the two permitted landfills on the site.

5.6.2. The ground investigation was undertaken by specialist contractor Ian Farmer Associates Ltd. (IFA) and included the drilling of 9 boreholes with a tracked window sampler rig, 4 boreholes with a hand-held window sampler and 8 boreholes with a cable percussion rig where a maximum depth of 20m bgl was achieved. Boreholes were installed with groundwater and gas monitoring standpipes.

5.6.3. Chemical analysis was limited to leachate analysis on samples of waste from both the Old and New Tips with results compared to relevant environmental quality standards (EQS), UK Drinking Water Standards or World Health Authority (WHO) standards for drinking water quality.

5.6.4. The results of the chemical analysis within the New Tip identified exceedances of EQSs for arsenic and copper, and the exceedance of WHO standards for antimony and selenium.

5.6.5. A greater frequency of exceedances were reported within the Old Tip, where five EQS values were exceeded (ammonia, copper, iron, manganese and zinc), one UK-DWS (calcium) and one WHO standard (selenium). Results are discussed in greater details within the SGP Hydrogeological Risk Assessment (R1635-R01-v3).

5.7. Scott Wilson (2008)

5.7.1. Scott Wilson Ltd. was commissioned to undertake a targeted Phase 2 Ground Investigation to aid and to inform an Integrated Pollution Prevention and Control (IPPC) Site Surrender Report prior to the disposal of the site. The purpose was to provide a current ground and chemical analysis,

to compare to original baseline data obtained during previous works in 2003 (Babtie) to support the original IPPC licence application. Most of the entries were within the main mill area outside the current consent boundary, however 7 trial pits and 3 window sampler boreholes were located within the boundary.

5.7.2. Representative soil samples were collected by a suitably trained engineer and submitted for laboratory analysis. Soil samples were submitted for analysis for a range of contaminants including:

- inorganic – arsenic, barium, cadmium, chromium, copper, nickel, zinc, lead, mercury, free cyanide, sulphur, sulphate and asbestos
- organic – TPH (with carbon banding), PAHs, SVOCs and VOCs

5.7.3. Scott Wilson concluded that for metals and other inorganics in soils, the elevated concentrations of metals at 2003 and 2008 result from the historical presence on site of ash and clinker fill within the made ground, and represent variation in concentrations present across the site prior to the IPPC permit.

5.7.4. Concentrations of metals/metalloids elevated above their respective generic screening criteria based on a conservation/amenity land-use are summarised below:

- copper (MAFF for plant protection 200 mg/kg):
  - WS2A (205 mg/kg at 1.0m bgl)

5.7.5. Minor exceedances of PAHs above residential screening criteria for the protection of human health were observed in a number of locations, in particular:

- benzo[a]pyrene (GAC 0.83 mg/kg)
  - TP10 (2.0 mg/kg at 0.4m bgl)
  - TP10 (1.1 mg/kg at 1.2m bgl)
  - TP11 (1.7 mg/kg at 0.8m bgl)
  - TP14 (1.9 mg/kg at 2.5m bgl)
  - TP16 (0.9 mg/kg at 0.5m bgl)
- naphthalene (GAC 1.5 mg/kg)
  - TP10 (1.8 mg/kg at 0.4m bgl)
  - TP12 (3.2 mg/kg at 1.1m bgl)
- dibenzo[a,h]anthracene (GAC 0.76 mg/kg)
  - TP14 (0.8 mg/kg at 2.5m bgl)

5.7.6. With the exception of naphthalene, the PAH exceedances are all likely to be associated with coal combustion residues in the boiler ash made ground. The occurrence of naphthalene in TP10 and TP12 is likely to be associated with the observation of strong hydrocarbon odours in the upper 1m of made ground. Residential screening criteria are highly conservative for the planned

landscaping end-uses, however a proposed future change of use to parts of the site would introduce residential receptors.

5.7.7. Exceedances of residential screening criteria for hydrocarbons occurred within the aliphatic ranges, typically between C8-C21 range and suggested evidence of a hydrocarbon hotspot between the Old and New Tip. Potentially significant concentrations of TPH (C6-C40) in this area were recorded in:

TP10 (2,993 mg/kg at 0.4m bgl)
TP11 (2,067 mg/kg at 2.4m bgl)
TP14 (2,788 mg/kg at 1.8m bgl)
WS2 (4,716 mg/kg at 0.5m bgl)
WS2 (1,045 mg/kg at 2.5m bgl

5.7.8. For hydrocarbons in the ash embankment, Scott Wilson's opinion was that the elevated levels present were associated with site activities from before the IPPC application and therefore did not represent a degradation of ground conditions within the area as a result of site operations within the lifetime of the Works Permit.

5.8. Coffey (2011)

5.8.1. The scope of works conducted by Coffey in 2011 targeted the Old Tip, where previous intrusive assessments failed to extend entries through the full depth of waste and to fully characterise the chemical composition of the waste. Following discussions with the Environment Agency the requirements for further works within the old tip were stated as follows:

- obtain samples of both the paper waste and construction waste contents for additional contamination testing and assessment;
- confirm the depth of the landfill;
- characterise the underlying natural ground including contamination testing;
- monitor the water level and quality within the old landfill;
- obtain additional information on the soil gas regime

5.8.2. Three cable percussion boreholes (BH1/11-BH3/11) were drilled on the old tip, two sunk through the construction waste to depths of 15m bgl and one sunk through the paper waste to a depth of 12m bgl. All entries were installed with groundwater monitoring installations and gas monitoring valves.

5.8.3. Drilling arisings were screened on site with a photo-ionisation detector (PID) measuring VOCs. The maximum detected level of VOCs was 17.9ppm in BH1/11 at 4m bgl, from a sample of paper waste.

5.8.4. Approximately one soil sample for every 2m of drilling was tested, equating to around 7 soils samples per borehole and 21 in total.

5.8.5. Concentrations of metal and inorganic compounds were below the SGV/GAC thresholds for all determinants assessed. Therefore, the old landfill site does not appear to contain levels of metal type contamination of concern to human health.

5.8.6. Samples analysed for methyl tertiary butyl ether (MTBE), benzene, toluene, ethylbenzene and xylene (BTEX), chloroalkanes, alkenes and chlorobenzenes were below their respective threshold criteria when compared to GACs for a residential land use.

5.8.7. Three GAC exceedances occurred for the GRO compounds within carbon banding C10-C12; these were 606mg/kg (BH3/11 at 3m), 563mg/kg (BH3/11 at 5m) and 671mg/kg (BH3/11 at 7m) when compared against the GAC at 6% SOM of 346mg/kg. There were 9 GAC exceedances within carbon banding C12-C1, 11 GAC exceedances with carbon banding C16-C21 and 12 exceedances within the C21-C35 banding. The maximum concentrations within each banding occurred within the same sample, BH3/11 at 7m. Caution should be used in interpreting the banded TPH results since it is known that natural organic matter including cellulose carbohydrates can provide false positive results in the normal TPH test method.

5.9. Smith Grant 2013

5.9.1. In conjunction with GRM, geotechnical consultants to USL, 5 trial pits were excavated in August 2013 in the area north and east of the former mill race, adjacent to the former filter beds, in or adjacent to the south-eastern part of the current consent boundary. These enabled inspection of the ground and collection of soil and groundwater samples from a location down-gradient of the former Janitorial Department, workshops and drum store (TP2/13), and soil samples from the 1960s landfill (TP4/13), and from the disused filter beds (TP5/13).

5.9.2. No contamination was encountered in a sample of ashy sand from TP2/13 apart from slightly elevated copper at 301 mg/kg. Groundwater flowed rapidly into the pit from the granular fills and was sampled as this may represent water draining from previously identified potential hot-spot(s) further up the hill at WS07/03 and WS7/08. However, the concentrations of hydrocarbon fractions and speciated VOCs were all below laboratory detection limits.

5.9.3. The effluent sludge samples from the tip and filter bed contained some elevated metal concentrations not reflected in results from the more recent Old and New Tip sludges, but also not represented in other samples previously collected from the 1960s landfill which were uncontaminated. Unusually the sludge sample from TP4/13, outside the consent area, contained elevated hexavalent chromium at 356 mg/kg, together with barium at 2441 mg/kg, and copper at 576 mg/kg. With the absence of similar contamination in other landfill samples from this part of the site, the results appear to be unrepresentative of the wider landfilled materials; this area is to be left undisturbed and lies outside the current planning consent.

5.9.4. No recent groundwater monitoring has been carried out in the 1960s landfill area, however a previous groundwater sample obtained by Scott Wilson from WS9/08 was uncontaminated apart from slightly elevated zinc.

5.9.5. A sludge sample collected from the former filter bed (TP5/13) contained 22.3 mg/kg of hexavalent chromium, together with zinc at 2,206 mg/kg. Further testing will be undertaken in order to determine the significance of these results and options for treatment of the sediment as it is proposed to refurbish the filter bed for use as a settling lagoon for storm runoff during the consented remedial works.

5.10. Contamination Summary (Land outside the Old and New Tips)

5.10.1. Contamination, by fuel residues, has been identified from the investigations within the consent boundary. This is located below an area of former bulk fuel stores at the southwest end of the ash embankment.

5.10.2. Indications of contamination by way of hydrocarbon or chemical odours or appearance were recorded in logs as follows:

Table 5.2 Summary of Logged Contamination Observations

Report	Area	Entry	Contamination Indicator
Scott Wilson, 2008	South side of ash embankment	TP10/08	0.25 - 0.50m - strong hydrocarbon odour, fill includes rubbish
		TP11/08	0.25 - 1.60m - strong hydrocarbon odour, fill includes rubbish
		TP12/08	0.25 - 1.10m - hydrocarbon odour and sheen on groundwater seepage at 0.4m
		TP13/08	0.25 - 1.50m - hydrocarbon odour and sheen at 0.4m with groundwater entry and sheen from 0.6m depth
		TP14/08	hydrocarbon odour in ash deposits at 0.25-0.60, and 0.80 - 2.60m (limit of excavation)
		TP16/08	mild hydrocarbon odour in ash and brick gravel at 0.50-1.60m depth

area of former fuel tanks in foreground; water tank bases to rear

5.10.3. The contamination hot-spot is associated with former paraffin and diesel storage tanks and pump plant in the area between the ash embankment and Old Landfill. Scott Wilson (2008) entries TP10/08 - TP16/08 recorded hydrocarbon observations, although WS02/08 in the same area did not. Chemical analysis however showed generally moderate or low levels of fuel residues and indicating weathering of diesel residues.

5.10.4. There is no evidence to suggest contamination of effluent within surrounding soils of the effluent treatment tanks.

5.10.5. Elevated concentrations of metals and PAHs were sporadically present across the site within the made ground, with concentrations exceeding residential assessment criteria. Concentrations were typical of those within old industrial sites and are likely to be due to the presence of ash and clinker within the made ground, and associated with low availability and mobility of the contaminants.

5.10.6. Some of the highest concentrations of metals, including hexavalent chromium, have been identified in the old effluent treatment and disposal area in the northeast of the site, adjacent to the former millrace and Eagley Brook. The significance of these results is unclear, and they do not affect the proposed filling operations, however further sampling will be required before the settling tanks can be cleared and refurbished for re-use as a settlement lagoon.

5.11. New Tip Sludge Analysis

5.11.1. The New Tip sludges are to be removed in their entirety from the landfill prior to restoration. The analysis of the materials is therefore pertinent to their removal and temporary storage pending their recovery and reuse or disposal off-site.

5.11.2. The comprehensive Edge Consultants analyses showed generally insignificant concentrations of metals and inorganics, or undetectable levels of VOCs, SVOCs and biocides, with the following exceptions:

- chloroform was detected in both leaching test samples at 1.4 and 1.5 µg/l, compared to the river EQS of 12 µg/l, indicating that these results are not significant;
- bromodichloromethane was detected in one leaching test sample at 1.2 µg/l, compared to the Drinking Water Standard for trihalomethanes of 100 µg/l, indicating that this result is not significant;
- gamma hexachlorohexane (Lindane) was detected in one leaching test sample at 0.006 µg/l, compared to the EQS of 0.020 µg/l, indicating that this result is not significant;

5.11.3. In response to consultation with the local authority, an agreed programme of additional sampling of the New Tip waste was undertaken by SGP. Six samples were collected on 20th December 2012 from 3 locations (NT1 - NT3) along the central axis of the site, representing upper (west), middle, and lower (east) parts of the landfill. Two samples were collected at each location characteristic of the upper (0.5 - 1.0m depth) and lower (2.0 - 3.0m depth) waste fills. Samples were collected by hand auger and were stored in containers provided by the laboratory, placed in a cool box and delivered to Jones Environmental Laboratory within 24 hours of collection.

5.11.4. All samples were of similar appearance, being a light grey soft clayey silt with fine plant fibres but little odour. Samples were tested for a standard range of potentially toxic (CLEA) and common alkali metals, ammoniacal and total nitrogen, chloride, sulphate and sulphide, pH and organic matter. Two samples representing the deeper deposits (NT2-2 and NT3-2) were also analysed for volatile and semi-volatile organic compounds to cover a broad range of potential toxic contaminants. All results are presented in SGP report R1635-R05.

5.11.5. All samples showed close similarity in composition, indicating that the New Tip waste infill is homogeneous and was produced solely from sludge removed from the nearby effluent settlement tank at the mill. The natural moisture content of the samples ranged from 152 - 213%, meaning that the average dry solids content is 35%; the density of the material appeared to increase slightly towards the east, downhill part of the landfill.

5.11.6. The results show that the dry solids comprise by weight a mixture of fine calcium carbonate filler (~50%), cellulose / hemi-cellulose and lignin fibre (~16%), and other minerals (magnesium/potassium/iron carbonates and sulphates ~1%). The residue will comprise clay (kaolin filler) at ~ 33%, in common with experience of other similarly produced paper mill sludges / "fibre clay" wastes.

5.11.7. Low concentrations of a range of aromatic compounds were detected, including toluene (up to 42 mg/kg), 1,2,4 trimethylbenzene (up to 11.6 mg/kg), and butylbenzene (up to 9 mg/kg). These

substances will be strongly absorbed to the organic matter within the waste, and have not been detected in leachate or groundwater associated with the New Tip over several years of monitoring. The substances may originate from solvent use in the paper-making process, for pulping or paper-coating and cleaning. The concentrations do not give rise to any short or long-term human health risk, and are considerably below published Contaminated Land Soil Guideline Values or Generic Assessment Criteria for commercial and industrial land-uses.

5.11.8. The carbon:nitrogen ratio of the waste is calculated to be at least 12, indicating that the organic content will slowly degrade, and that the waste may be suitable for use in soil restoration or improvement, although fertilizer additions would be required. The ammonia content is within the normal range for a soil-forming material, and would not be expected to give rise to a polluting leachate. This is consistent with the long-term monitoring of leachate from the New Tip which has recorded low concentrations of dissolved ammonia.

5.11.9. Materials underlying the basal liner of the New Tip are indicated on a design drawing to be regraded boiler ash, however there remains a possibility of other wastes being present, or sludge having entered the sub-base via any failure of the liner. This area has not and cannot be investigated until the sludges are removed. The underlying materials will be inspected for contamination, and an assessment made of the need for any change to the existing remediation and restoration plans.

6. Water Pollution Review

6.1. Monitoring

6.1.1. A detailed account of monitoring results and risk assessment for controlled waters is provided by SGP report R1635-R01-v3, March 2014, produced in connection with the Environmental Permits for the landfills that constitute the majority of the current consent area. The following information gives a summary of the assessment and conclusions to be drawn from an extended period of monitoring of tip leachates and controlled waters around the consent site, together with relevant information drawn from previous site investigations within other, up-gradient sections of the larger paper mill site.

6.1.2. Leachate from the landfills is routinely monitored in accordance with regulatory requirements set down by the EA. Currently leachate is pumped from the tips to a discharge into Eagley Brook under the terms of an EA Discharge Consent. The excess water arising from seepages into the landfills and infiltrating rainwater that is not removed by pumping drains into the base of the TNSB valley and exits via a short length of culvert from the toe of the valley. The stream bed between the culvert mouth and Eagley Brook is ochre-stained; however, the ferruginous material is likely to be derived either from iron minerals in the natural drift deposits or leachable iron within the

boiler ash deposits surrounding the lower TNSB valley.

6.1.3. Numerous boreholes have been constructed around the landfills in the period 1995 to 2011 for the purposes of investigation and monitoring, including 6 boreholes within the body of the Old Landfill; there are no boreholes within the New Landfill, however the depth profile of the waste in this has recently been confirmed by hand probing. Representative borehole observations for wells including those currently used by agreement with the EA for periodic gas and groundwater monitoring are summarised below:

Table 6.1. Groundwater / Leachate Monitoring Wells

borehole	response zone (m bgl)	strata monitored	groundwater levels (m aod)	notes
External to Old Landfill				
BH105/06 (197.15m aod)	4.00-6.00	0.50m of sand and gravel above 1.50m of clay till	195.09 av. (194.51 - 195.69 range)	no water observations during drilling
BH110/06 (194.52m aod)	1.00 - 3.50	clay till	194.36 av. (194.10 - 194.52 range)	no water observations during drilling
BH4/95 (194.89m aod)	14.50 - 25.00	clay till	181.64 av. (178.46 - 183.52 range)	no water observations during drilling
BH103/06 (194.79m aod)	2.00 - 16.00 (upper) 18.00 - 20.00 (lower)	ash fill to 13.75m on 1.75m of sand and gravel clay till	183.50 av. (183.12 - 184.01 range)	strike at 13.00m rising to 12.90m after 20 min.
Within Old Landfill				
BH101/06	1.00 - 8.00	waste to 6.10m on clay till	198.68 av. (198.38 - 199.08 range)	no water observations during drilling
BH118/06	no installation	waste to >6.00m	199.83 (1 reading)	strike at 0.50m
BH1/11	1.00 - 14.00	layers of construction and paper waste	193.47 av. (193.35 - 193.63 range)	strike at 5.5m at top of construction waste layer
BH2/11	1.00 - 12.00	layers of construction and paper waste	194.15 av. (193.97 - 194.33 range)	strikes at 4.50m and 7.00m in coarse granular construction waste layers
BH3/11	1.00 - 9.00	paper waste	195.29 av. (194.51 - 196.20 range)	no water encountered

borehole	response zone (m bgl)	strata monitored	groundwater levels (m aod)	notes
External to New Landfill				
BH114/06 (194.25m aod)	2.00 - 16.00	mixed fill and ash to 15.5m on clay till	183.59 av. (183.13 - 185.21 range)	strike at 14.00m rising to 13.00m after 20 min.
BH104/06 (181.07m aod)	2.00 - 10.00 (upper) 16.00 - 20.00 (lower)	sandy gravel made ground to 9.20m on clay till; clay till	175.45 av. (175.35 - 175.59 range)	no water observations during drilling
BH5/95 (180.95m aod)	5.80 - 7.00 (upper) 26.3 - 28.0 (lower)	base of made ground and alluvial clay; 0.8m layer of sandy gravel within clay till and laminated silt	175.50 av. (175.35 - 175.76 range)	strike at 24.7m (at top of laminated silt), rising to 23.3m and continuing to rise

6.1.4. All groundwater levels lie above the Eagley Brook river level, with BH5/95 and BH104/06 placed at the lowest height, around 2-2.5m above the Brook. In general groundwater levels lie at or close to the glacial till surface, confirming the low permeability of this formation and importance of seepage flows along the contact between the glacial till and overlying permeable soils and ashy fills.

6.1.5. As both landfills lie within the TNSB valley, the eastwards orientation and gradient of the original valley floor is the dominant factor controlling the local hydrogeology. Eagley Brook is the principal receptor for any unmanaged groundwater flows from the landfills; pumped discharges of leachate from the landfills are currently discharged to the TNSB culvert which then flows into Eagley Brook upstream of the original confluence. The present pumping regime merely serves to extend the travel time for leachate to reach Eagley Brook, whilst removing any possibility of attenuation within the ground between the landfills and river bank.

6.2. Results

6.2.1. The Old Landfill contains mixed industrial waste generated from paper effluent treatment (settled solids largely comprising inert mineral fillers and cellulose fibre) together with other mill wastes including boiler ash and soot, construction and demolition wastes generated from plant renewal at the mill, and localised occurrences of cleaning solvent, in particular toluene. The wastes are generally non-hazardous, although disposal of bonded asbestos cement sheet is believed to have occurred. The remaining construction and demolition waste is expected to be effectively stable inert material largely comprising brick, concrete and masonry.

6.2.2. No exceedances of Priority Substances Values, as set down in The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010, have been detected during the monitoring of leachate, groundwater and surfaces waters linked to the two landfills, with the following exceptions:

- cadmium has been detected in BH110/06, BH114/06 and BH5/95(d) in excess of the EQS, reflecting slightly elevated natural background levels in the glacial drift;
- mercury has been detected in all monitoring locations on one occasion (June 2012) probably signifying a systematic laboratory error, and as exceptional slight exceedances of the standard for the upstream TNSB (SW1 - 0.06 µg l^{-1}), New Tip leachate (0.06 µg l^{-1}), BH110/06 (0.053 µg l^{-1}), and BH4/95(d) (0.055 µg l^{-1}); also, a relatively high concentration was recorded on one occasion (December 2009) in SW5 at 12 mg l^{-1} - that result cannot be checked but has not been repeated since, and may be erroneous; the average results are considered not to be of significance.

6.2.3. No concentrations of process chemicals, biocides, industrial solvents or fuel residues have been detected in the monitored discharges of leachate or in the receiving watercourse.

6.2.4. As the landfill decomposition products are essentially gases and water, the paper sludge wastes have a low potential to generate polluting leachate. The main potentially polluting substances detected in the tip leachates have been ammoniacal nitrogen / dissolved ammonia (typically generated either from the breakdown of proteins or the reduction of nitrates), and dissolved reduced iron and manganese. The paper sludge would not normally contain significant concentrations of these metals; hence they are probably derived from co-disposed boiler ash or from natural mineral sources, mobilised as a consequence of the reduced conditions. Some elevated concentrations of calcium and potassium have been recorded however these do not confer any environmental risk at the levels present; the former will be associated with the lime (calcium carbonate) filler used in paper-making. Concentrations of some petroleum hydrocarbons, notably toluene in BH3/11, have been detected within the old landfill however no evidence of the escape of these substances has been found, and the materials concerned have a strong affinity for organic matter and are also readily degradable.

6.2.5. The Old Landfill wastes have been present for a period of between about 15-45 years, excluding the original pre-licensing disposal of boiler ash to the valley. The New Landfill wastes have been present for about 10-20 years, although these are contained within a valley that has been heavily modified by the tipping of boiler ash over a period of at least 100 years. The cellulose content of the paper effluent sludges is likely to be continuing to slowly degrade as a result of bacterial decomposition (as evidenced by the emission of methane gas in the Old Landfill), and the wastes contain a high moisture content, and therefore cannot be regarded as having stabilised. With respect to leachate volumes and flows, the environment of both tips may be deemed to be in a semi-equilibrium, with effectively full saturation of the wastes, but with slow settlement and

consolidation occurring due to the drainage of the high pore water content in the waste. No long-term risk from a future release of any hazardous substances is predicted, and the monitoring of groundwater and surface water around both sites indicates stability in terms of chemistry and flows.

6.2.6. The New Landfill contains only paper effluent treatment sludges, with the degradable content again being cellulose fibre. No List 1 / Priority Substances other than the previously discussed occurrence of mercury slightly in excess of the EQS have been detected in the leachate, which appears to be fully contained within a modern impermeable liner, although excess wet weather inflows are known to have resulted in regular over-topping of the liner without apparent detriment to the groundwater down-gradient or to Eagley Brook.

6.2.7. It is noted that paper mill effluent sludges are frequently used with Environment Agency approval as soil amendments on agricultural land to replace soil organic matter lost during cultivation, as a substitute for agricultural lime, to improve the physical characteristics of the soil and to provide a short-term nitrate buffer and long-term nitrogen source. Stockpiling of paper wastes for land-spreading on farmland is often carried out for periods of up to 6 months to suite cultivation patterns, and leachate released from the stockpiles has been found to be non-polluting when monitored.

6.3. Other Industrial Sources

6.3.1. Monitoring of groundwater away from the landfills, and outside of the consent boundary has been limited to single occasions associated with the Babtie, RPS and Scott Wilson site investigations. RPS (2005) found no exceedances of water quality standards other than 2 minor exceedances of the EQS for copper in WS9/05 and WS10/05, both of which were located up-gradient of the works. Scott Wilson (2008) also recorded slight exceedances of the EQS for copper in WS1/08, WS13/08 and WS14/08, however given the distance to surface water, and possible natural origin of the mineral, the results are not considered to be of significance.

6.3.2. Trace concentrations substantially less than EQSs were recorded for ethylbenzene in WS6/08, WS7/08 and WS14/08, and for xylenes in WS6/08, WS7/08, WS12/08, WS13/08 and WS14/08. Also recorded in WS13/08 was a single occurrence of the plasticizer di(2-ethylhexyl)phthalate (DEHP) at 13 µg/l, 10X the surface water EQS for this Priority Substance. The isolated nature of the result, low water solubility of the substance, and distance to Eagley Brook, at >150m suggests that the result is unlikely to be of significance, but the result indicates that further assessment will be appropriate in this part of the site, which lies over 30m outside the consent boundary. As noted in 5.9.2 recent analysis of groundwater down-gradient of the Janitorial Department failed to detect any significant organic contaminants.

6.3.3. Elevated hydrocarbons were recorded by Scott Wilson (2008) in several borehole groundwaters

outside the consent boundary, in particular WS14/08 (3,320 µg/l) and WS12/08 (1,446 µg/l). The hydrocarbons were largely aliphatic C21-C35 fractions, representing very low solubility / low mobility lube oil or tar fractions which are unlikely to pose any significant risk to controlled waters. However, traces of petrol-range hydrocarbons were recorded in WS1/08 (10 µg/l aliphatic C6-C8 fraction) and in WS14/08 (44 µg/l aliphatic C8-C12 fraction); WS1/08 was located adjacent to the New Boiler House fuel store prior to remediation, whilst WS14/08 is down-gradient, possibly indicating plume migration, albeit at low concentration; both locations are remote from the consent boundary.

6.3.4. The surface waters likely to receive surface runoff and leachate discharges either directly or indirectly are:

- Three Nooked Shaw Brook (at Supply Lodge and in culvert; a tributary to Eagley Brook)
- Eagley Brook (part of the River Irlam catchment).

6.3.5. No flow data is available for either watercourse adjacent to the site.

6.3.6. Both landfills lie within the former Three Nooked Shaw Brook (TNSB) valley, with all drainage of leachate taking place either to the TNSB culvert by the Supply Lodge dam and then to Eagley Brook, or via the base of the former TNSB valley and old tunnel discharge to Eagley Brook from the lower end of the valley. The leachate discharges are of similar quality to the upstream water in the receiving watercourses.

6.3.7. No significant groundwater bodies are impacted by leachate. The Secondary A aquifer within the Millstone Grit bedrock is protected from leachate by the intervening barrier of low permeability boulder clay (proven as >20m in the BGS borehole at eastern end of the Old Landfill, and >10m at eastern end of New Landfill - BH104/06). The sites do not lie within source protection zones. No groundwater abstractions are at risk from tip leachate.

6.3.8. The boulder clay underlying both landfills is effectively an aquiclude although saturated discontinuous sand and gravels lenses may be present. A springline exists at the contact of the boulder clay and an overlying sand and gravel deposit above the level of the Old Tip, confirming the low permeability of the boulder clay formation. No natural springs have been observed within the outcrop of the boulder clay within the valley sides around the site. The boulder clay is not used for groundwater supply within the area.

6.4. Pathways

6.4.1. Pathways for landfill leachate egress and estimates of their relative significance in terms of flows are as follows:

Table 6.2. Summary of Leachate Pathways

Old Landfill		**Significance**
1	runoff and seepage from waste body to west directly into standing water adjacent to and connected with Water Supply Lodge and TNSB upstream culvert	may account for ~60% of Old Tip drainage based on surface area and slopes (6,883m^2); assuming annual effective rainfall of 1,000 mm, the average discharge would be 11.3 m^3 d^{-1} however this does not include spring discharges that enter the landfill from adjacent slopes to south and north; given the absence of significant pollution in leachate monitored at the west end of the site compared to boreholes within the waste body it appears that most incident rainfall is likely to flow over the surface of the low permeability paper effluent wastes
2	seepage to east into base of ash embankment, thence down valley across the boulder clay surface, below the basal liner of the New Tip, to discharge into the Old Tunnel and Eagley Brook	may account for ~40% of Old Tip drainage based on surface area and slopes (6,883m^2); assuming annual effective rainfall of 1,000mm, the average discharge would be 7.5 m^3 d^{-1}
3	managed pumping to TNSB culvert	intermittent pumping - maximum consented discharge 20 m^3 d^{-1} - assumed to include a mix of leachate and Supply Lodge surface water seeping through dam
New Landfill		
4	over-topping of basal liner to flow down through "rock dam" into Old Tunnel and discharge to Eagley Brook	episodic, during wet weather when pumping ineffective; previously a significant volume >80 m^3 d^{-1} due to entry of TNSB culvert leakage into lined cell
5	seepage through any imperfections in the basal liner into underlying ash drainage layer and alluvium, flowing across boulder clay surface to discharge into the Old Tunnel and Eagley Brook	unknown contribution to augment pathway 2 flow from Old Tip plus general area drainage, in particular leakage from TNSB culvert; Old Tunnel discharge estimated at average ~100 m^3 d^{-1}
6	managed pumping to TNSB culvert	intermittent pumping - maximum consented discharge 10 m^3 d^{-1}

6.4.2. With respect to the Old Landfill, the central leachate monitoring wells, in particular BH3/11 contain leachate with the potential to cause pollution outside the site, in particular with respect to ammonia and toluene. However, the external monitoring wells have recorded no occurrence of toluene above detection limits, and ammonia has only been recorded in slightly elevated concentrations immediately adjacent to the down-gradient (east) end of the landfill within the base of the ash dam. Given the common presence of ammonia in excess of the surface water EQS concentration in groundwater due to a variety of sources in the catchment (including natural deposition, agriculture, forestry, domestic sanitation, and industry), the concentrations recorded adjacent to

the landfills over recent years, in the order of 2-3 mg l^{-1} are not considered to indicate significant risk.

6.4.3. Ammonia concentrations are reduced downstream and monitoring of the Old Tunnel discharge (SW5), which is considered to represent a significant pathway to Eagley Brook, has shown generally low levels of potential pollutants with the exception of iron. The Old Landfill is uncapped and unlined, with waste deposition ceasing over 10 years ago, and is considered to be in a state of equilibrium whereby future increased releases of water-borne pollutants appears to be very unlikely.

6.4.4. The New Landfill leachate monitoring and discharges have not been shown to be significantly polluting. No change in this situation is predicted, and given that it is proposed to remove the degradable waste contents in the near future, then ongoing risks will reduce further. The potential for residual leachate within the landfill basal drainage (ash layer) or natural strata appears to be negligible given the absence of any detectable pollutants in down-gradient monitoring wells, however any degradable residues encountered during the preparatory works will be removed prior to infilling of the valley.

6.4.5. The proposal of temporary storage of the New Landfill sludges on part of the Old Landfill (subject to EA approval) would be associated with some drainage of leachate which has been demonstrated to have negligible pollution potential and which is currently discharged under consent to the TNSB watercourse. The options are either for containment and collection of this leachate for treatment and disposal, or, if it can be demonstrated that the leachate is non-polluting, then infiltration to the Old Landfill may be acceptable.

7. Landfill Gas Review

7.1. Sources

7.1.1. The principal recognised source of ground gas at the site is the presence of biodegradable wastes, principally within the Old Tip. Coffey estimated the volume of paper effluent treatment sludge at 19,500 m^3, which, given the high-water content, probably means a similar figure expressed as a tonnage. The surface area of the Old Tip where paper sludge is present is estimated to extend to 6,255 m^2.

7.1.2. Anaerobic degradation of the paper fibre (cellulose / hemi-cellulose) content of the fills will produce the landfill gases methane and carbon dioxide, typically in a ratio of about 65:35 (Environment Agency: Guidance on Landfill Gas Flaring, version 2.1, 2002). Analysis of the effluent sludges has shown variable concentrations of degradable organic content, typically averaging 9.7% but with a maximum of 48.6% recorded in a sample of paper sludge. More recent

analysis of New Tip effluent sludge by SGP found an average organic matter content of 16%, equivalent to a total organic carbon (TOC) content of about 9% or less, depending upon the proportion of the cellulose polysaccharide (formula $\{C_6H_{10}O_5\}_n$) in the overall organic matter. Gassim 2.5 suggests default degradation rate constants for this type of organic matter in a saturated state of 0.046 – 0.013, resulting in degradation half-lives of between 15 and 53 years.

7.2. Monitoring

7.2.1. I A detailed account of monitoring results and risk assessment for landfill gas is provided by SGP 1635-R02 (landfill gas risk assessment), produced in connection with the Environmental Permits for the landfills that constitute the majority of the current consent area. The following information gives a summary of the assessment and conclusions to be drawn from an extended period of monitoring of monitoring wells and surface emissions around the consent site, together with relevant information drawn from previous site investigations within other, up-gradient sections of the larger paper mill site.

7.2.2. In accordance with Permit requirements a programme of gas monitoring has taken place from borehole standpipes located around both landfills. This was commenced in June 2006, at approximately monthly intervals up to 2009, and thereafter, by agreement with the EA, approximately quarterly. Monitoring was carried out on behalf of KTI by Edge Consultants, who were taken over and became Coffey after 2008. Results were forwarded to the EA; SGP has copies of most of the individual monitoring reports, and summary tables of results produced by Coffey.

7.2.3. Eight rounds of gas monitoring have subsequently been completed by Smith Grant since Urbanspringside acquisition of Springside Mills (March, June, September and December 2012, March, June, September and December 2013). Summary reports by SGP are attached as Appendix B. Smith Grant has also carried out flux box testing and a walkover survey of ground level methane concentrations on the surface of the old landfill to provide an indication of the range of gas emission rates to the atmosphere. Details of this investigation are provided in Appendix C.

7.2.4. In total, gas monitoring records for locations around the landfills amount to a maximum of 41 rounds, covering 7 years. Whilst the data are inevitably subject to variations in monitoring methodology and the damage, loss or replacement of some wells, overall the dataset is considered to provide an adequate basis for assessing trends in the gassing regime and for risk assessment for existing receptors. It should be noted that the monitoring data may need to be supplemented for the purposes of determining remedial requirements with respect to future changes of uses and development that introduces new receptors and potential pathways for gas migration.

7.2.5. Details of the Environment Agency specified gas monitoring locations and other monitored installations are provided below:

Table 7.1. Gas Monitoring Wells

Location	Borehole well	EA specified (2007)	Response zone (m bgl)	Response stratum over typical water table (m)	monitored to January 2012 by Edge Consultants / Coffey Geotechnics	monitored since January 2012 by Smith Grant
within Old Landfill body	BH101/06	x	1.0 - 8.0	waste onto clay till, saturated to near ground level	up to Nov 2007	lost
	BH105/06	x	4.0 - 6.0	sand and gravel over clay till, saturated to near ground level	x	x
	BH1/11		1.0 - 14.0	waste, water table at ~4.5	x	x
	BH2/11		1.0 - 12.0	waste, water table at ~5.0	x	flooded, lost December 2012
	BH3/11		1.0 - 9.0	waste, water table at ~3.0	x	x
north of Old Landfill	BH106/06	x	1.0 - 4.0	sand and gravel, water table in 1.0 - 1.5m range	x	x
	BH117/07		0.8 - 4.0	clayey sand on water table at ~2.2m	x	
	BH118/07		2.0 - 5.0	sand, gravel and silt on water table at ~3.0	x	
	BH119/07		2.0 - 6.0	sand on water table at 5.0	x	
	BH120/07		1.5 - 5.5	sand and gravel on water table at ~2.5	x	
south of Old Landfill	BH1/95		17.7 - 24.7	clay till below water table	x	not found
	BH102/06	x	18.0 - 20.0	clay till below water table	x	x
	BH109/06	x	0.5 - 6.0	clay till, water table in surface - 0.5 range	damaged	not found
	BH110/06	x	1.0 - 3.5	clay till, water table in surface - 0.3 range	x	x
in ash embankment between Old and New Landfills	BH4/95	x	14.5 - 25.0	clay till, saturated	x	x
	BH6/95		1.3 - 13.0	granular fill, water table at ~12.0	x	
	BH103/06 (s)	x	2.0 - 16.0	granular fill over clay till at base, water table at ~12.0	x	x
	BH107/06	x	1.0 - 4.8	granular fill to 1.4 over predominantly clay till with clayey sandy gravel layers, water table ~2.5	x	x
	BH108/06	x	1.0 - 6.0	predominantly granular fill with water table in 3.0 - 3.5 range	x	x
	BH114/06		2.0 - 16.0	predominantly granular fill with some more cohesive bands, water table in 10.0 - 11.5 range	x	x
	WS8/05	x	0.9 - 4.0	granular made ground, unsaturated	x	x

Location	Borehole well	EA specified (2007)	Response zone (m bgl)	Response stratum over typical water table (m)	monitored to January 2012 by Edge Consultants / Coffey Geotechnics	monitored since January 2012 by Smith Grant
north of New Landfill	BH112/06		1.0 - 4.3	predominantly cohesive fill to 1.6 over clay till, water table in 1.0 - 1.6 range	x	x
	BH113/06		1.0 - 5.0	cohesive fill to 1.8 over 0.7 peat band and clay till, water table in 2.5-2.7 range	x	x
south of New Landfill	BH115/06 (s)		2.0 - 6.0	granular fill onto clay till at base, water table in 4.0-5.0 range	x	x
	BH115/06 (d)		10 - 20	clay till, water table in 10.0 - 12.0 range	x	
	BH116/06 (s)		2.0 - 14.0	granular fill, water table in 12.0 >14.0 range	x	x
	BH116/06 (d)		16.0 - 20.0	clay till, saturated	x	x
east of New Landfill	BH5/95(s)		5.8 - 7.0	base of granular fill onto alluvial clay, saturated	x	x
	BH104/06 (s)		2.0 - 10.0	granular fill with clay till at base, water table in 5.0 - 5.5 range	x	x

7.3. Results

7.3.1. Results from boreholes in cells shaded orange in Table 7.1 are considered unrepresentative of soil gas due to the saturation zone lying above the well response zone. They can however provide information on headspace equilibrium above the water table where dissolved methane may be present. Boreholes within saturated degradable waste may accumulate gas from bubbles rising directly into the borehole headspace (BH101/06 and 105/06).

7.3.2. The Old Tip is a known source of landfill gases (methane and carbon dioxide), but the gassing regime is unlikely to be affected by the proposed works, involving temporary storage of New Tip sludges pending their recovery and reuse in restoration or disposal off-site.

7.3.3. The Old Tip fills are largely water saturated, cohesive and anaerobic, and landfill gas generation has effectively displaced any residual oxygen from the ground. Gas concentrations have been measured at up to 74% methane (BH105/06), with an average of 61% methane. Flow rates are variable but have been monitored at up to a typical maximum of 25 l/hr from boreholes under worst case conditions (BH105/06). Using the Pecksen correlation (Ground Gas Handbook, 2009), this could equate to a maximum surface emission rate of 2.5 l/m²/hr (1.8 l/m²/hr methane). Surface flux box testing by SGP found a maximum surface emission rate of methane of 1.0 l/m²/hr from the Old Tip surface (see SGP report R1635-R02). Emission rates of this order have been recorded on natural swamps.

7.3.4. Volatile organic compounds (VOCs) have been detected in the Old Tip, with toluene appearing to be the most widespread substance in previous tests, at up to 380 mg/kg. Overall VOC levels in the borehole gas were monitored by Coffey who found concentrations of up to 2.2 ppm, which is regarded as a low concentration.

7.3.5. Given the mobile and readily degradable nature of the VOCs, it is likely that concentrations will have declined substantially since original deposition. Also detected has been hydrogen sulphide at concentrations that have produced noticeable odours in boreholes and during drilling works in the tip.

7.3.6. With respect to the monitoring wells surrounding the New Landfill, monitoring results are summarised in the following tables.

Table 7.2. Ash embankment west of New Landfill

Borehole	Methane		Carbon dioxide		Oxygen		Flow	No. of records*
	maximum	average	maximum	average	minimum	average	maximum	
BH4/95	5.4	0.6	4.5	1.1	16.8	19.6	12.1	27
BH6/95	8.3	2.4	18.5	10.1	0.3	9.6	0.0	12
BH103/06(s)	16.3	7.4	24.8	16.2	0.0	4.4	1.0	32
BH103/06(d)	7.7	1.8	17.3	6.2	2.1	13.5	3.5	17
BH107/06	32.3	3.7	14.7	4.9	0.0	12.7	0.2	34
BH108/06	0.6	0.1	2.5	0.6	14.9	19.5	7.6	31
BH114/06	0.7	0.1	7.7	4.5	12.4	15.6	0.4	33
WS8/05	46.1	18.6	37.5	17.7	0.0	8.5	0.2	31

concentrations in % volume, flow in l hr^{-1} (peak – no borehole recorded sustained flow)

Table 7.3. Land north of New Landfill

Borehole	Methane		Carbon dioxide		Oxygen		Flow	No. of records*
	maximum	average	maximum	average	minimum	average	maximum	
BH112/06	1.0	0.1	5.0	1.8	14.9	18.7	6.7	33
BH113/06	0.7	0.1	13.7	6.9	1.0	9.7	3.6	34

concentrations in % volume, flow in l hr^{-1} (peak – no borehole recorded sustained flow)

Table 7.4. Land south of New Landfill

Borehole	Methane		Carbon dioxide		Oxygen		Flow	No. of records*
	maximum	average	maximum	average	minimum	average	maximum	
BH115/06(s)	0.5	<0.1	2.9	1.7	15.8	18.5	2.4	31

BH115/06(d)	2.5	0.2	3.2	1.4	7.5	15.9	5.8	25
BH116/06(s)	0.5	<0.1	1.5	0.5	18.7	20.1	0.5	33
BH116/06(d)	0.6	<0.1	1.9	0.6	18.7	19.9	0.9	29

concentrations in % volume, flow in l hr^{-1} (peak – no borehole recorded sustained flow)

Table 7.5. Land east of New Landfill

Borehole	Methane		Carbon dioxide		Oxygen		Flow	No. of records*
	maximum	average	maximum	average	minimum	average	maximum	
BH5/95(s)	3.3	0.2	1.8	0.3	18.9	20.2	83.0	29
BH5/95(d)	0.6	0.1	1.2	0.3	16.3	20.0	5.4	16
BH104/06(s)	0.5	0.1	1.7	0.6	18.7	20.1	1.6	30
BH104/06(d)	0.7	0.2	3.1	1.8	18.7	19.5	43.0	16

concentrations in % volume, flow in l hr^{-1} (peak – no borehole recorded sustained flow)

7.3.7. The new landfill occupies an engineered containment; inspection of exposed sections of the welded butyl liner by Smith Grant has found that the liner is in excellent condition, with no evidence of punctures, brittleness or stress cracking, or weld failure in spite of exposure to the atmosphere and solar radiation. The effluent sludge fill is waterlogged, and there is no evidence for leachate egress via the liner or pathways of gas migration laterally into the adjacent ash fills. Any gas generated as a result of cellulose decomposition, or rotting of dead vegetable matter in the surface of the landfill / sludge lagoon is most likely to disperse entirely via the landfill surface. Lateral migration out of the New Tip is considered to be highly unlikely given the waterlogged condition of the landfill within its containment system, and for the purposes of risk assessment for the consented development, the existing waste source within the New Landfill may be discounted since this is to be removed in its entirety before re-engineering and stabilisation of the lower TNSB valley.

7.3.8. Gas monitoring to the north of the New Landfill takes place in BH112/06 and BH113/06, located at the top of the slope above the landfill. BH113/06 and BH112/06 are 55m and 115m respectively east of the Old Landfill. BH112/06 penetrates a largely cohesive part-saturated fill over clay till. Infrequent minor concentrations of methane up to 1% and carbon dioxide to 5.0% associated with moderate oxygen depletion are likely to be attributable to sources within the local fills or buried natural soil, given their apparent low permeability and shallow potential pathway from the remote landfill sources.

7.3.9. BH113/06 recorded a maximum of 0.7% methane, elevated carbon dioxide up to 13.7%, and significantly depleted oxygen. Average carbon dioxide and oxygen levels appear to have been lower and higher respectively since 2010, but still show occasional peaks and lows. The borehole

log records peat mixed into made ground and a natural peat/buried soil surface over clay till, and it seems most likely that this accounts for the monitored gas conditions. Flows in both boreholes were largely absent, with positive flows probably being attributable to groundwater level changes or atmospheric pressure drops.

7.3.10. Gas monitoring south of the New Landfill occurs through a deep bank of granular ash fill extending out into the lower TNSB valley. This is 5.6m deep at BH115/06, and 14.5m deep at BH116/06, and extends laterally towards both the New and Old Landfills. Both boreholes have dual installations with response zones in the ash and underlying clay till. The upper response zones in both wells are largely unsaturated and monitoring has shown consistently aerobic conditions in both, although moderate oxygen depletion, down to 15.8% and carbon dioxide up to 2.9% has been recorded in BH115/06(s). Methane concentrations have been low in both wells, with none being detected since March 2007.

7.3.11. Monitoring in BH116/06 of the deep response zone (effectively monitoring the headspace above groundwater in contact with the boulder clay) showed near-normal atmospheric conditions. However, BH115/06(d) showed fluctuations from a near-normal atmosphere to moderately raised methane and carbon dioxide (up to 2.5% and 3.5% respectively). The borehole on occasion recorded water levels below the top of the response zone, however no plausible gas migration pathway from the landfills via the glacial till has been identified, and it may be that the gassing conditions can be ascribed to natural minerals (e.g. carbonaceous mudstones) within the till. The boreholes lie between 20 and 25m north of infilled former reservoirs now below the newer paper mill buildings. Where these former reservoirs have been investigated they have shown only inert fills, and there is no evidence at this time for them acting as separate sources of ground gas, although further investigation will be required following demolition.

7.3.12. Gas monitoring to the east of the New Landfill takes place via wells located through the bund structure crossing the lower end of the former TNSB valley at its' junction with Longworth Clough (BH5/95 and BH104/06). Both boreholes have shown consistently aerobic conditions with methane only detected at above 1% on one occasion in BH5/95(s), at 3.3% in January 2009. The response zone in BH5/95 covers the base of a largely cohesive fill over alluvial clay which is unlikely to represent a potential gas migration path from the New Landfill; the gas levels are more likely to be attributable to natural organic matter degradation in the alluvium or groundwater. Substantial fluctuations in flows (positive and negative) have been recorded for BH5/95 which are certainly due to groundwater above the response zone pressurising the headspace.

7.3.13. Significant gas sources or monitored concentrations have not been found elsewhere within the consent site boundary. A further potential external source of gas is the waste landfill located in the area of the old effluent treatment lagoon in the east of the site, extending to the bank of Eagley Brook. This area of waste deposition probably dates from the 1950-60s and site investigations

have recorded a relatively thin (up to 2m deep) deposit of ash and clayey sludge with paper fibre. These materials are also exposed in the eroded edge of the deposit alongside the river bank and public footpath. Given the age and thickness of the deposit, this area of waste deposition is considered unlikely to be a significant source of landfill gas, however no monitoring has been conducted on or adjacent to the deposit. Any gas generated by these deposits is most likely to disperse to atmosphere and no impact upon the current consent area is predicted.

7.4. Receptors

7.4.1. The most sensitive receptors are residential dwellings and their occupants near to the site. The closest of these are at:

- Lower Folds Farm – 100m minimum to northwest;
- Upper Folds Farm – >300m to southwest
- Springside Cottages - >300m to southeast

7.4.2. Of these, only Lower Folds Farm is considered to be potentially at risk from gas migration due to proximity and the presence of potentially gas-permeable glacial sands and gravels within the ground between the source and receptor.

7.4.3. Existing industrial buildings at the site are currently unoccupied and are largely open, well-ventilated structures.

7.4.4. Future development proposals envisage new residential developments set back at least 25m from the edge of the Old Landfill where the properties will rest on made ground to the east and south, and at least 20m to the north where the properties will rest on natural boulder clay with low permeability to gas. Development is contemplated for the upper surface of the emplaced fills within the restored lower TNSB valley, but this will be subject to future ground gas monitoring, contamination verification and stability assessments, and the current consent provides only for restoration to amenity / conservation uses.

7.4.5. Footpath Users within Longworth Clough pass at nearest 10m from the New Landfill, however this route is an unofficial diversion due to erosion on the official route, and it is planned to rectify the situation, increasing the distance between the footpath and New Landfill. In any case, walkers are not exposed to odours or gas hazards from either landfill.

7.4.6. No evidence for vegetation stress or death from landfill gas has been found surrounding both landfills. Where sludges are physically stable then vegetation has established on the waste surface.

7.5. Migration Pathways

7.5.1. The Old Tip has no engineered containment, and any gas generated and present within the fills will migrate along pressure and concentration gradients towards the tip exterior. Due to the largely saturated, sponge-like and cohesive nature of the sludge fills, this largely entails migration upwards to the tip surface and dispersion within the atmosphere, but lateral migration into the permeable ash fills surrounding the eastern end of the landfill, particularly within the ash embankment, is known to have occurred, and appears to be a continuing process. Although the sludge wastes are largely cohesive and saturated, and are not readily dewatered, the ash within the embankment alongside is unsaturated and granular, allowing gas to pass from the sludge into the adjacent ground.

7.5.2. The possibility of lateral migration northwards into the glacial sand and gravel appears to be very limited given the shallow and discontinuous nature of this pathway adjacent to the landfill, and presence of shallow groundwater around the landfill margin in this area.

7.5.3. Localised migration into the unsaturated strata on the northern edge of the Old Tip has been recorded in BH 106/06 at up to 70% methane (average 44%), with occasional reversions to aerobic conditions in the borehole; this indicates a fluctuating gas regime which responds to atmospheric pressure variations. The borehole log shows 1.0m of ashy rubble over 2.7m of glacial sand and gravel, on boulder clay; groundwater was present in the sand and gravel at 1.8m depth, giving a shallow unsaturated zone in which the migration could occur.

7.5.4. No evidence for significant gas migration has been found in boreholes further to the north and northwest in the direction of the closest residential receptor at Upper Folds Farm (BH117/07 to BH120/07). These wells were installed at the instigation of the EA within the potential gas migration pathway towards Lower Fold Farm.

7.5.5. Migration of gas into the ash embankment to the east of the site has also been demonstrated, although some adjacent boreholes have shown varying conditions suggesting that discrete migration pathways may be present. Evidence for methane oxidation, as demonstrated by the presence of oxygen, reduced methane and increased carbon dioxide concentrations, is apparent within some boreholes, in particular those located within ashy made ground about 50m from the ash embankment to the north (WS113/06) and south (BH115/06) of the lower TNSB valley.

7.5.6. In terms of risk from methane gas to proposed residential development, the gas screening value (maximum methane concentration X maximum total sustained gas flow at the monitoring wells) and maximum methane concentrations have been compared to the NHBC and CIRIA C665 / BS8485 classification schemes, as summarised below:

Table 7.6. Summary of Methane Concentrations and Development Risk Classification

Area	Borehole	Maximum methane concentration (% v/v)	Maximum borehole flow (l/hr)	Gas Screening Value (l/hr)	CIRIA characteristic situation	NHBC traffic light classification
Old Landfill (not to be developed)	BH105/06	73.7	12.9	9.5	CS4 (moderate to high risk)	Red
Ash embankment	BH4/95	5.4	<0.1	<0.07	CS2 (low risk)	Amber 2
	BH6/95	8.3	<0.1	<0.07	CS2 (low risk)	Amber 2
	WS8/05 (<10m from Old Tip)	46.1	<0.1	<0.07	CS2 (low risk)	Red
	BH103/06	16.3	<0.1	<0.07	CS2 (low risk)	Amber 2
	BH114/06	0.7	<0.1	<0.07	CS1 (very low risk)	Green
	WS107/06 (<10m from Old Tip)	32.3	<0.1	<0.07	CS2 (low risk)	Red
	BH108/06	0.6	<0.1	<0.07	CS1 (very low risk)	Green
Other areas	BH102/06	0.8	<0.1	<0.07	CS1 (very low risk)	Green
	BH104/06	0.7	<0.1	<0.07	CS1 (very low risk)	Green
	BH110/06	1.0	<0.1	<0.07	CS2 (low risk)	Amber 1
	WS112/06	1.0	<0.1	<0.07	CS2 (low risk)	Amber 1
	WS113/06	0.7	<0.1	<0.07	CS1 (very low risk)	Green
	BH115/06	2.5	<0.1	<0.07	CS2 (low risk)	Amber 1
	BH116/06	0.6	<0.1	<0.07	CS1 (very low risk)	Green

7.5.7. The above results indicate that remediation to prevent gas migration from the Old Landfill into the ash embankment will be necessary in order to permit any future development on or adjacent to the embankment, however such works lie outside the scope of the current planning consent. The monitoring results do not indicate any significant risk to the consented infilling of the lower TNSB valley with inert materials. The infilling with inert materials should, by definition, not result in the creation of significant new ground gas sources, and will be a regulated activity, subject to monitoring during and following completion of the earthworks.

8. Conceptual Site Model and Risk Assessment

8.1. Approach

8.1.1. The conceptual model for the site describes the potential contamination sources, pathways and receptors. Development of a conceptual model is required in order to evaluate potential risk to receptors, and the plausible sources, pathways and receptors are outlined below. Risks associated with groundwater and ground gas have been discussed by SGP in previous reports (R1635-R01-v3 and R1635-R02-v1) and are only considered in summary within this report.

8.2. Sources of Contamination

8.2.1. Contamination sources are listed as follows:

1. Metals / metalloids:

including arsenic, cadmium, lead, copper and zinc associated with in the ashy made ground in excess of residential garden assessment criteria; deposits of ash are greatest in the north of the site, forming the ash embankment and margins to the lower TNSB valley adjacent to the New Tip nearest the former boiler house; the above substances were detected in one or more samples in concentrations above residential assessment criteria although concentrations were typical of those encountered within former industrial sites; and may be dealt with through use of clean soil cover for the final restoration landscaping; an isolated occurrence of hexavalent chromium has been identified associated with old effluent sludge in an old filter bed in the northeast part of the site; the significance of this result appears to be limited but further sampling will be undertaken prior to the refurbishment of the bed to serve as a settling lagoon for storm runoff.

2. Fuel hydrocarbons:

associated with localised accidental spillages and/or leaks from drum storage areas or fuel tanks found restricted to the made ground; the fuel sources no longer remain on the site; contamination associated with former storage tanks at the southern end of the ash embankment are having no impact on Controlled Waters, and will remain undisturbed throughout the consented works;

3. Sporadic localised sources of organic chemicals:

a single occurrence of the plasticizer DEHP was recorded in groundwater below the central paper-making area; elevated TCE within the shallow soils has been identified in the south-east of the site around a former storage area however the finding was restricted to the shallow made ground; none of these are considered likely to have general impact upon the consented development area;

4. Asbestos:

asbestos cement sheeting and lagging on pipework is present throughout the site buildings outside the consent area, however no asbestos fibres have been identified within samples of made ground submitted for screening; asbestos containing wastes may be present within the Old Landfill, however asbestos contamination will have no impact upon the consented restoration of the New Tip;

5. Landfill Gas:

the Old Landfill is the only identified source of significant concentrations and volumes of landfill gas on the site; although other areas of landfilling are present these generally contain inert materials or are well-degraded, shallow or isolated from the proposed development areas and unlikely to pose a significant future risk; biodegradable sludges within the New Landfill will be removed and the area restored by infilling with inert wastes which by definition contain levels of organic materials that will not give rise to significant future landfill gas emissions; landfill gases of concern at and outside the Old Tip perimeter are methane and carbon dioxide; hydrogen sulphide has also been recorded within the landfill body but not in external boreholes, and toluene detected in the effluent sludge matrix has not been detected in soil gases or leachate.

8.3. Potential Targets

8.3.1. The principal vulnerable receptors, given development of the site for amenity and conservation uses, will be:

- construction workforce
- off-site building structures and infrastructure (unoccupied mill buildings, roadways, services)
- plants within gardens / soft landscaping areas
- shallow groundwater as pathway to surface watercourse (Eagley Brook)

8.4. Human Health Risk Assessment

8.4.1. None of the solid phase contaminants identified were recorded at concentrations that would be expected to pose a significant risk to human health, so risks to construction workers are considered minimal provided normal occupational hygiene measures are adhered to and adequate environmental controls are implemented within the earthworks operations.

8.4.2. The raised levels of PAHs and metals, and the potential presence of asbestos in demolition materials within the made ground across the industrial areas of the site may pose a risk to human health if left present within shallow soils in future soft landscaping areas, via the direct exposure pathways of ingestion / dust inhalation / dermal contact with the impacted soils. Given the physical nature of the source materials (ash and demolition rubble), and apparent absence of topsoil over most of the industrial area, there is a requirement to provide a suitable soil for the

restoration cover, thereby isolating the existing fills; these will be covered by substantial thicknesses of inert soil-forming materials throughout the fill areas; the Old Landfill and its immediate surrounds will be left undeveloped as a result of these works, however restoration of the landfill under the Environmental Permit is currently under discussion with the Environment Agency, and such restoration will be aimed at managing potential risks to man and the environment.

8.4.3. The site investigations to date suggest that any occurrences of other contamination will be localised, of limited significance, and readily dealt with during the site clearance and civil engineering works required to prepare the site for infilling and restoration.

8.4.4. Migration of ground gases from the organic sources identified in the Old Tip sludge deposits may be a possibility up to say 100m under worst case conditions from the source area via permeable made ground, including via service trench backfills. Risks to existing development around the site are likely to remain unchanged as a consequence of the consented works, and are considered to be negligible given the current use of the site, and distances to external residential receptors. The consented remediation and restoration of the New Landfill will not introduce significant new human receptors with respect to ground gas hazards.

8.4.5. The relocation of New Tip sludges to the Old Landfill, or direct loading and removal from the site, could result in temporary odour releases. Gas concentrations in the open air are likely to be low and will be readily dispersed. The distances to residential receptors indicates that odour nuisance is unlikely but may require management under the terms of the Environmental Permit.

8.5. Property Risk Assessment

8.5.1. Risks to property from potential accumulation and explosion of methane are discussed under human health risk assessment above.

8.5.2. The consented development of the site is limited to soft landscaping. Some of the metals identified in the made ground on the industrial site exceed standards derived for the protection of sensitive plant species, however this material is not a suitable growing medium in any case and would be replaced by clean soil cover.

8.5.3. Levels of leachable sulphate within the natural soils (BRE 2:1 sulphate) and groundwater appear to be low and no risks of aggressive conditions to concrete are indicated at this stage, although further testing will be required. No significant risks from other contaminants are indicated under the planned land use. It is acknowledged that should further permission be granted for residential development across parts of the current consent area, then specific further remediation of contamination on or adjacent to the site could be required. Any such remediation will not be constrained as a result of the currently consented development.

8.6. Controlled Waters Risk Assessment

8.6.1. The shallow aquifer within the glacial sand and gravel deposits is located in an elevated position relative to the industrial areas, and springs discharge into the site, including into the Old Landfill. The glacial sand and gravel aquifer is not therefore at risk from the consented development.

8.6.2. Monitoring of Eagley Brook up and down stream of the consent area and existing landfills has not found any impact from site contamination.

8.6.3. The bedrock aquifer is protected from potential contamination by a thick layer of cohesive boulder clay, and is, in any case, not considered to be sensitive due to natural mineralisation.

8.6.4. Existing drainage flows through the site below the existing liner of the New Landfill at the contact of the permeable fills and underlying cohesive boulder clay, to issue via an old culvert to Eagley Brook. Monitoring of this main discharge (the former TNSB stream outfall below the New Tip) has not shown any significant impact resulting from site-generated contamination. The proposed works to remove the New Landfill sludge wastes, stabilise the ash slopes and infill the valley with inert soils are designed to maintain the existing hydrological regime whilst reducing pollution risks to Eagley Brook.

8.6.5. It is concluded that the site does not impact Eagley Brook or any other controlled waters. The potential for contamination releases to the Brook during remediation / development works appears small given the restricted occurrence of potentially mobile pollutants, although silt erosion is an acknowledged risk that will require careful site management (containment and use of settling ponds to manage construction runoff).

8.7. Ecological Risk Assessment

8.7.1. Although the site lies in proximity to a SSSI and other sites of biological interest, these are not subject to drainage or runoff from the site and potential pollution pathways do not therefore exist. The development proposals, including habitat creation and management offer a positive impact upon the local environment.

8.8. Conceptual Site Model

8.8.1. The conceptual site model, based upon the findings of the various site investigations carried out to date and extensive landfill monitoring data is summarised in the table below and in plan and section forms in drawings 03 and 04.

Table 8.1: New Tip Remediation and Restoration - Conceptual Site Model

Receptor	Source / Contaminant	Pathway / Exposure	Pollutant Linkage (in absence of mitigation)	Further Investigation / Mitigation
1. humans – construction workers / future visitors	metals / metalloids / PAHs / localised organic chemicals or fuel residues within made and shallow soils	dermal contact / ingestion / inhalation – short term exposure	**Unlikely** – the concentrations recorded are unlikely to pose an acute health risk provided normal occupational hygiene and environmental controls are in place; following restoration, risks of exposure to contamination will be negligible;	further investigation of the ground underlying the New Landfill will take place following removal of waste sludges; the old filter bed will be subject to further testing of the contents pending consideration of the treatment of the existing sediments; arrangements for the restoration of the Old Landfill lie outside the current planning consent scope and are subject to discussions with the Environment Agency
	ground gas (methane, carbon dioxide) from organic wastes	accumulation within voids, confined spaces and service runs	**Possible** – high methane and elevated carbon dioxide have been identified at and in close proximity to the Old Tip	concentrations within the restoration area unlikely to be significant and no sensitive receptors will be present; risks to existing receptors as a consequence of the development are considered to be negligible; testing of fills and post-completion ground gas monitoring will be required
3. property / services	ground gas (methane, carbon dioxide) from organic wastes / buried topsoil / natural peat deposits	accumulation within voids, confined spaces and service runs	**Possible** – high methane and elevated carbon dioxide have been identified at and in close proximity to the Old Tip	concentrations within the restoration area unlikely to be significant and no sensitive receptors will be present; risks to existing receptors as a consequence of the development are considered to be negligible
	pH, sulphate and organic contaminants	Chemical attack of buried concrete and plastic materials	**Possible** – low concentrations of substances which could attack concrete have been recorded, however minor exceedances of water pipeline criteria have been detected	A water supply pipeline risk assessment should be completed if any pipelines are to be laid
4. vegetation / landscaping	leachable metals may be present in made ground	plant uptake	**Possible** – moderate concentrations of phytotoxic metals have been identified in ash fills	suitable cover soils will be required as part of the site restoration

Receptor	Source / Contaminant	Pathway / Exposure	Pollutant Linkage (in absence of mitigation)	Further Investigation / Mitigation
5. ecosystems / protected species & habitats	metals / metalloids / PAHs / localised organic chemicals or fuel residues within made and shallow soils	mobilisation via dustblow, leaching or silt runoff	**Unlikely** – no plausible pathways of significance assuming appropriate environmental management of development works	environmental management and monitoring plan required for preparatory and development works
6. surface waters	no evidence of significant pollution from extensive monitoring programme for landfills	migration via drains, seepages and surface runoff	**Unlikely** – mobilisation appears unlikely but risks may increase during preparatory and development works	environmental management and monitoring plan required for preparatory and development works
7. groundwater – Secondary Aquifer within superficial glacial and alluvial deposits	evidence suggests only minor leaching of ammonia, iron and manganese has taken place from Old Tip and ash embankment, with no discernible impact on receiving surface waters	infiltration through made ground into shallow aquifer / valley drainage	**Possible** – impacts likely to reduce as a consequence of works to restore valley and remove degradable waste fills	no action required
8. groundwater – Principal Aquifer within gritstone bedrock	Metals / PAHs / ammonia	no plausible pathway	**Unlikely** – bedrock aquifer is protected by substantial thickness of glacial clay, and groundwater gradient is likely to be from bedrock to Eagley Brook	no action required

9. Conclusions and Recommendations

9.1. The information available on the site via previous ground investigations and extensive gas and water monitoring provides sufficient spatial coverage and consistency to be able to draw reasonable conclusions as to the likely extent of soil and groundwater contamination.

9.2. The New Tip planning consent allows for the removal of existing effluent sludges and infilling with suitable materials to provide a landform which stabilises and restores the adjacent slopes to conservation and amenity uses. The proposed operations and permitted end use have a low sensitivity to contamination, and the works have been designed so as to minimise and manage any risks arising from the disturbance of existing contamination. Such contamination is limited to low levels of metals and arsenic in the ashy fills that extend across the slopes to be re-graded and filled against, and an area of old contamination by hydrocarbon fuels at the southern end of the ash embankment which will not be affected by the works. There are no significant pollutant linkages and no requirement to remediate this contamination under the current and future permitted land uses.

9.3. Conventional remediation measures to address elevated levels of metals/ metalloids associated with boiler ash are likely to be required wherever the industrial made ground remains at surface following the regrading works to be undertaken within the consented works. These measures will involve the placing of a soil cover system across the resulting open space areas to isolate any residual contamination from the future users and landscape vegetation.

9.4. The Old Tip and its close surrounds are subject to developing restoration proposals which will take place in accordance with the existing Environmental Permit. Similarly, the option of proposed temporary storage of New Tip sludges on part of the Old Tip will require Environment Agency approval and will need to be managed to ensure no adverse effects from leachate or landfill gas.

9.5. Further investigation is required with respect to the sediment contained in the old filter bed proposed for use as a settling pond, however this does not have any effect upon the development as any waste material generated as a consequence of the refurbishment of the filter bed is to be removed for treatment or disposal.

9.6. There is limited potential for the existence of unforeseen contamination, however the ground beneath the New Tip basal liner, believed to be coal ash, will be inspected following removal of the sludge contents. A 25m grid, or closer, layout of inspection and sampling points will be implemented, to check for the presence of significant contaminants and leakage of waste through the liner. If effluent treatment sludge residues are encountered, these will be removed along with the bulk of the sludge wastes, and the adjacent stripped soil surfaces will be subject to verification

inspection by an Environmental Consultant. Should any other unacceptable contamination with respect to potential gas or water pollution sources be encountered then a remedial strategy for these will be submitted to the Local Planning Authority for approval and implementation prior to infilling of that part of the valley. Subject to the findings, remediation through either ex situ treatment or off-site disposal or treatment are the most likely remedial options. Similar considerations will apply to any further discoveries of contamination resulting from further investigations or during the preparatory earthworks.

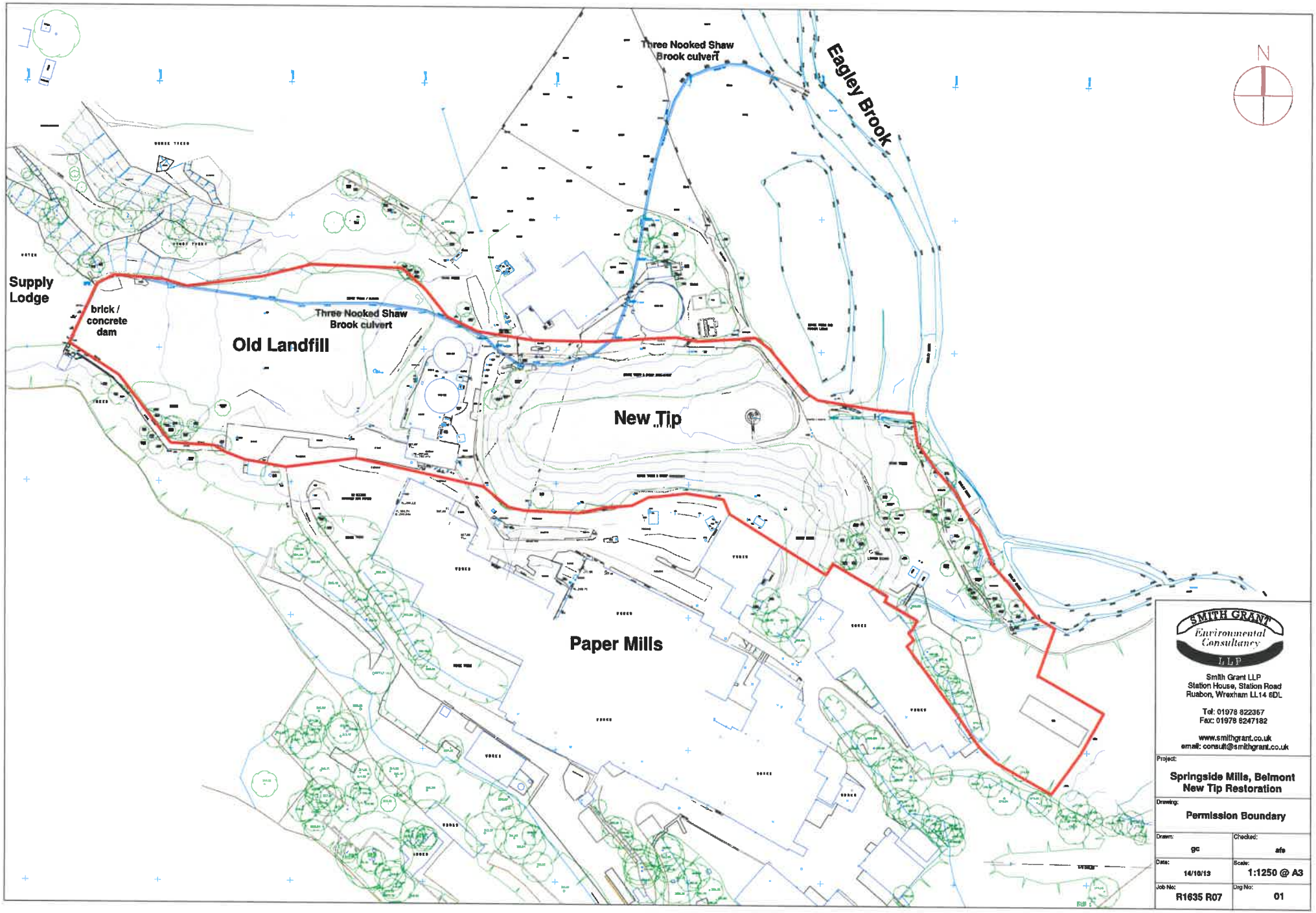
9.6.1. Subject to the above recommendations, including further investigations as outlined above, and any consequent remediation measures, the site is considered as being suitable for the proposed use by USL with respect to constraints from soil contamination.

9.7. Limitations

9.7.1. This report has been prepared by SGP for the sole and exclusive use of Urbanspringside Ltd. All reasonable skill, care and diligence has been exercised within the budget available, and in accordance with the technical requirements of the brief. Notwithstanding the efforts made by the professional team in undertaking the assessment and preparing this report, it is possible that other ground conditions and contamination as yet undetected may exist. Reliance on the findings of this report must therefore be limited accordingly. Such reliance must be based on the whole report and not on extracts which may lead to incomplete or incorrect conclusions when taken out of context.

9.7.2. SGP reserves the right to alter any of the foregoing information in the event of new information being disclosed or provided and in the light of changes to legislation, guidelines and responses by the statutory and regulatory authorities.

DRAWINGS

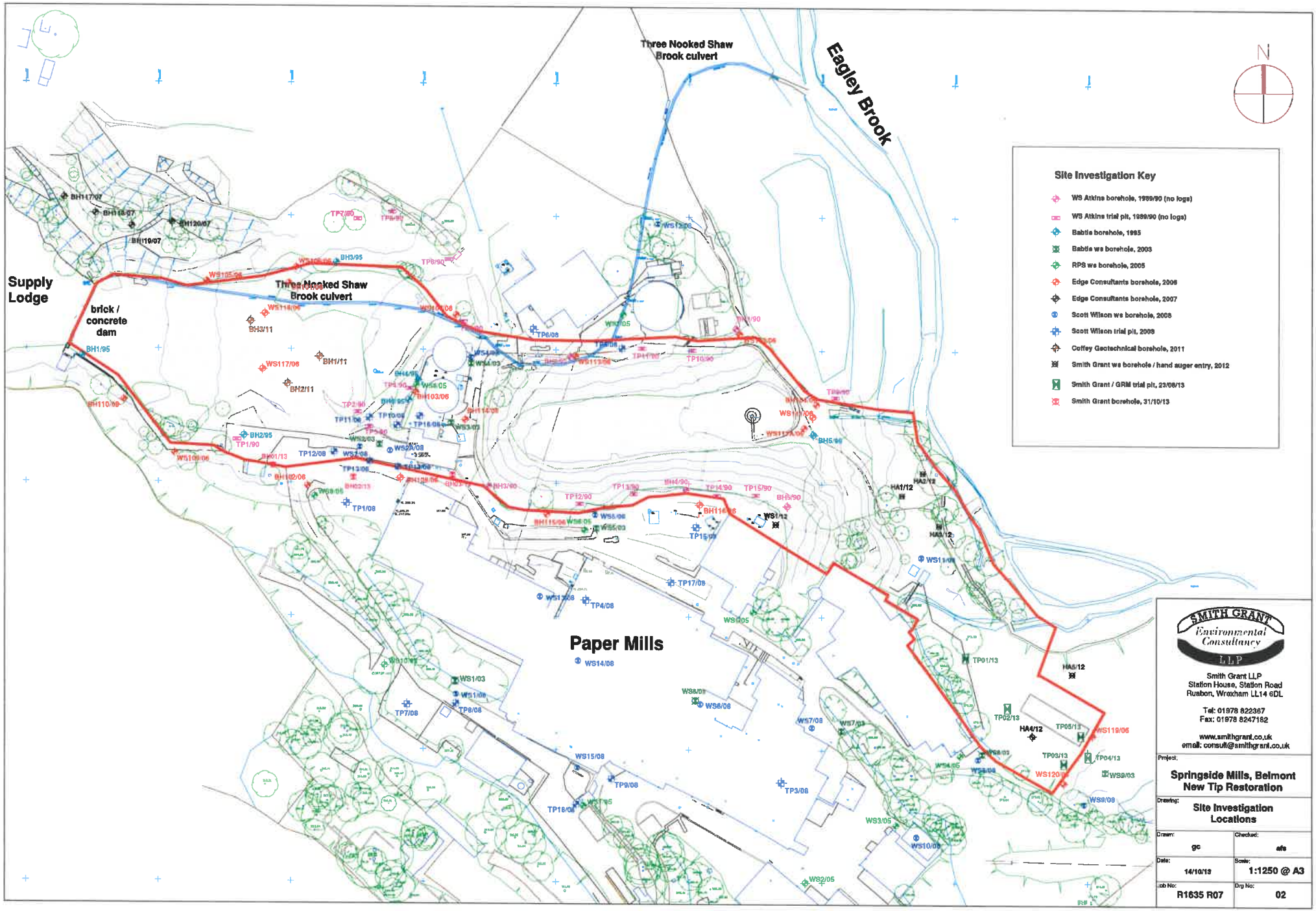


SMITH GRANT Environmental Consultancy LLP
Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL
Tel: 01978 822367
Fax: 01978 8247182
www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project: **Springside Mills, Belmont New Tip Restoration**

Drawing: **Permission Boundary**

Drawn:	Checked:
gc	afs
Date: 14/10/13	Scale: 1:1250 @ A3
Job No: R1635 R07	Drg No: 01

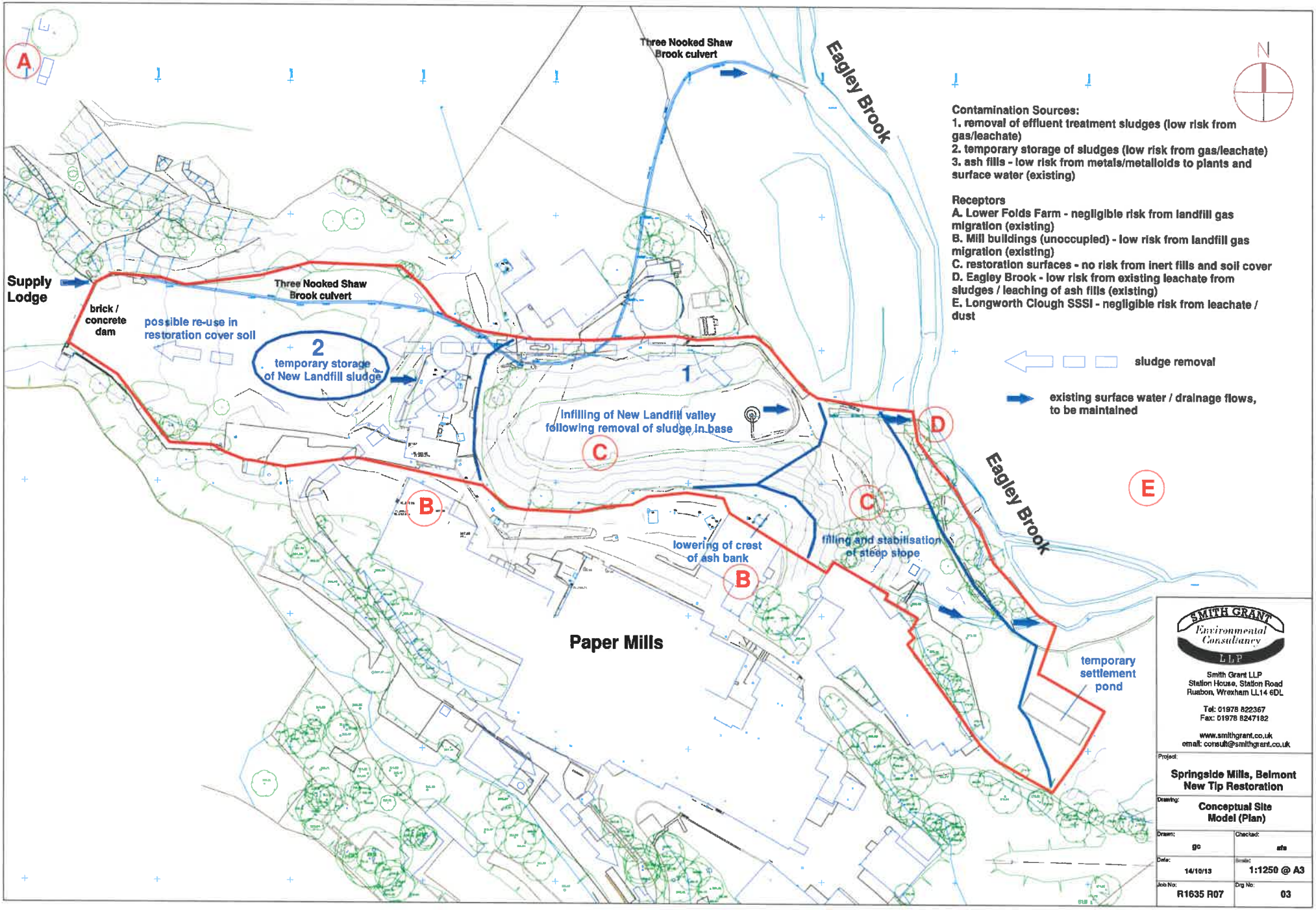


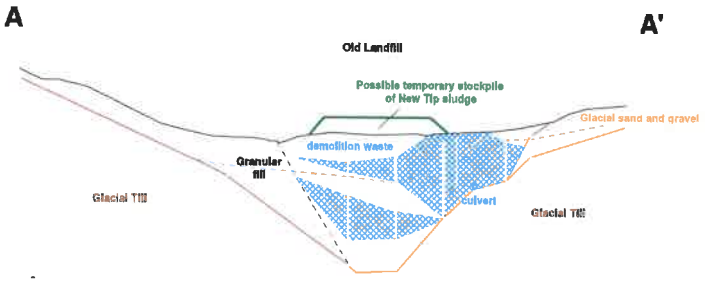
SMITH GRANT Environmental Consultancy LLP
Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL
Tel: 01978 822367
Fax: 01978 8247182
www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project: **Springside Mills, Belmont New Tip Restoration**

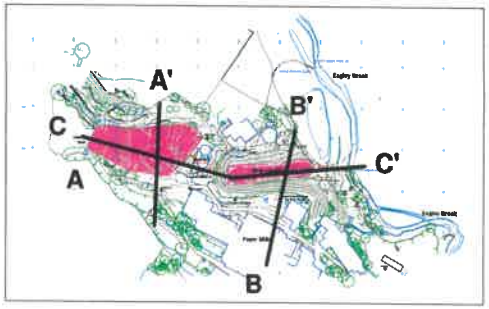
Drawing: **Site Investigation Locations**

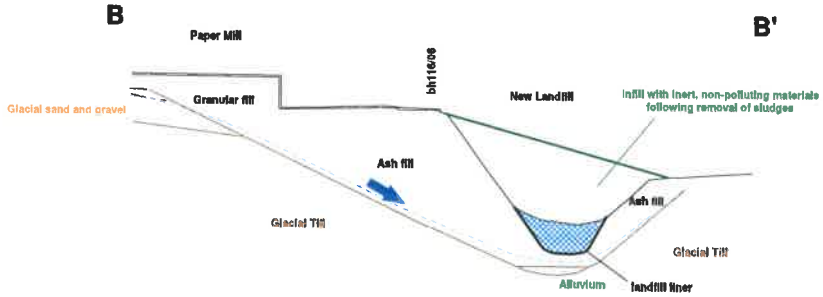
Drawn:	Checked:
gc	afs
Date: 14/10/13	Scale: 1:1250 @ A3
Job No: R1635 R07	Drg No: 02

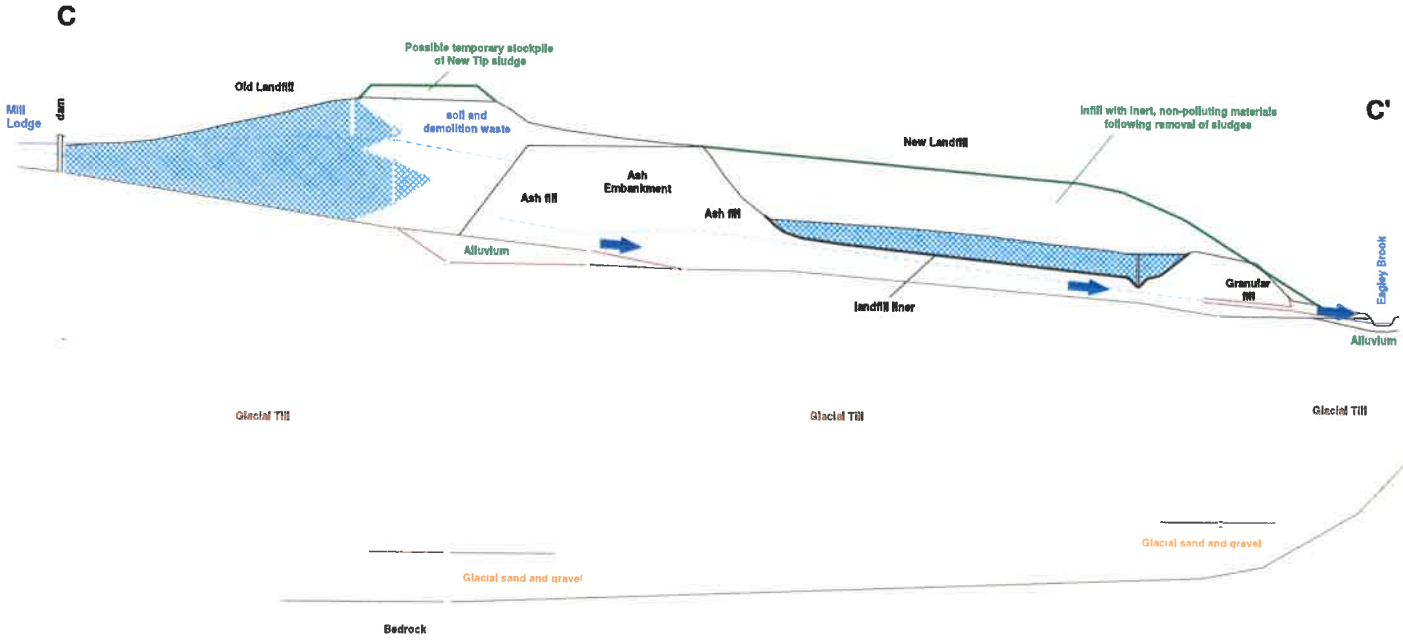

Three Nooked Shaw Brook culvert
Eagley Brook
N
Contamination Sources:
1. removal of effluent treatment sludges (low risk from gas/leachate)
2. temporary storage of sludges (low risk from gas/leachate)
3. ash fills - low risk from metals/metalloids to plants and surface water (existing)
Receptors
A. Lower Folds Farm - negligible risk from landfill gas migration (existing)
B. Mill buildings (unoccupied) - low risk from landfill gas migration (existing)
C. restoration surfaces - no risk from inert fills and soil cover
D. Eagley Brook - low risk from existing leachate from sludges / leaching of ash fills (existing)
E. Longworth Clough SSSI - negligible risk from leachate / dust
sludge removal
existing surface water / drainage flows, to be maintained
Supply Lodge
brick / concrete dam
possible re-use in restoration cover soil
Three Nooked Shaw Brook culvert
2
temporary storage of New Landfill sludge
1
Infilling of New Landfill valley following removal of sludge in base
lowering of crest of ash bank
filling and stabilisation of steep slope
Eagley Brook
temporary settlement pond
Paper Mills
A
B
C
D
E
SMITH GRANT Environmental Consultancy LLP
Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL
Tel: 01978 822367
Fax: 01978 8247182
www.smithgrant.co.uk
email: consult@smithgrant.co.uk
Project: Springside Mills, Belmont New Tip Restoration
Drawing: Conceptual Site Model (Plan)
Drawn: gc
Checked: ats
Date: 14/10/13
Scale: 1:1250 @ A3
Job No: R1635 R07
Drg No: 03



existing surface water / drainage flows, to be maintained







Water table

Effluent treatment sludge

Vertical scale X2

SMITH GRANT Environmental Consultancy LLP

Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL

Tel: 01978 822367
Fax: 01978 8247182

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:
Springside Mills, Belmont New Tip Restoration

Drawing:
Conceptual Site Model (Sections)

Drawn:	Checked:
gc	ate
Date: 14/10/13	Scale: 1:1250 @ A3
Job No: R1635 R07	Drg No: 04

Contaminated Land
Air Quality
Environmental Audit

SMITH GRANT
Environmental Consultancy
LLP

Partnership No: OC 300776

urbanspringside

SPRINGSIDE MILLS, BELMONT, LANCASHIRE; LICENSED LANDFILLS Environmental Permit Nos. 53658 and 53997

Closure Plan

For: Urbanspringside Ltd.

November 2017

R1635-R08-v6

Smith Grant LLP, Station House, Station Road, Ruabon, Wrexham, LL14 6DL
tel: 01978 822367 fax: 01978 824718 e-mail: consult@smithgrant.co.uk web: www.smithgrant.co.uk
Members: A F Smith (Chairman), K E Hawkins, B J Thomas

DOCUMENT CONTROL SHEET

Report Title:	Springside Mills, Belmont, Lancashire: Licensed Landfills Environmental Permit Nos. 53658 and 53997 Closure Plan April 2016
Client:	Urbanspringside Limited
Report Reference Number:	R1635-R08
Issue	Final
Version:	V56
Report Date:	November 2017

silc
SPECIALIST IN LAND CONDITION
Anthony Smith Reg. No. 139s

Signed For Smith Grant LLP

	Name	Position	Signature	Date
Author	**A F Smith BSc PhD MCIWM SiLC**	**Member**		**13/11/2017**
Reviewer	**B J Thomas BSc MSc CEnv MCIWEM**	**Member**		**13/11/2017**

Document Revision Record:

Version	Report Status	Date	Details of Revision
v1	draft	19/06/2014	draft for client review
v2	final	26/06/2014	minor edits
v3	final	11/07/2014	response to EA comments re sample locations / test suite and frequency
v4		06/05/2016	additional detail to reflect proposed waste recovery and use in restoration, and Old Tip gas barrier design and specification
v5	final	06/06/2016	minor edits and section drawing
v6	final	13/11/2017	minor edits

CONTENTS

DRAWINGS

APPENDICES

1. Introduction

1.1. Urbanspringside Ltd. has acquired the former Springside Mill industrial site from Kruger Paper for the purposes of remediating the site for residential development, amenity and conservation purposes. The site was previously owned and operated by William Turner & Sons Ltd. before transfer to Kruger. The site contains two closed industrial waste landfills referred to as the "Old Landfill" and "New Landfill" that were operated by Kruger primarily to receive effluent sludges from their paper recycling and paper-making processes.

1.2. The landfills are regulated by the Environment Agency (EA) via Environmental Permits originally issued to Kruger Paper, now transferred to Urbanspringside. Prior to transfer of the Permits, the EA requested that the Permit transfer application be accompanied by a Closure Plan for both landfills. The Closure Plan required contents were set out in a document "Summary of requirements for progressing the sites to closure" provided by the Environment Agency. These requirements came under the following headings:

- Risk-based monitoring plan for both sites;
- Gas management plan for the Old Tip, with 'in-principle' outline of the designed and managed system;
- Amenity Plan outlining environmental management of odour, dust and emissions to surface water and groundwater;
- Restoration Plan with proposed restoration contours and aftercare management of both sites.

1.3. The Closure Plan report was previously produced by Smith Grant LLP (SGP report reference R1635-R08-v3), based on anticipated methods of dealing with New Tip wastes and restoration of the Old Tip at the time. In order to now facilitate the remediation and redevelopment of the wider Springside Mill in accordance with Planning Consent 10/14/0440 granted by Blackburn with Darwen Borough Council, Urbanspringside is seeking the restoration and surrender of the New Tip Environmental Permit, whilst seeking EA agreement to the detailed plans for restoring the Old Tip to a state whereby the Permit for that site can be surrendered at some date in the future.

1.4. Part 1 of Schedule 5 of the Environmental Permitting (England and Wales) Regulations 2010 concerns the surrender of an Environmental Permit. Section 14(1) states that:
"The regulator must accept an application for the surrender of an environmental permit in whole or in part under regulation 25(2) if it is satisfied that the necessary measures have been taken—
(a) to avoid a pollution risk resulting from the operation of the regulated facility; and
(b) to return the site of the regulated facility to a satisfactory state, having regard to the state of the site before the facility was put into operation."

1.5. A monitoring strategy covering groundwater, surface water and ground gas has been in place at the site since 2006, and was agreed between Edge Consultants Ltd. on behalf of Kruger and the Environment Agency. The monitoring strategy has been implemented from 2007 onwards.

1.6. Further to submission of version 3 of this report to the EA, and discussions and feedback received, further work has been carried out regarding the design and specification of a gas barrier and restoration cover to the Old Tip, and treatability testing / impact assessment for wastes recovered from the New Tip. In addition, the EA has requested information to be submitted in accordance with the Technical Requirements for a Landfill Closure Report, as set out in Environmental Permitting Regulations guidance (EPR 5.02); this information is summarised in Appendix A. Version 5 of the Landfill Closure Plan includes the further information requested.

1.7. The agreement of this Closure Plan will enable restoration works to commence, culminating in the preparation of a Closure Report for the New Tip when this has been emptied of the deposited wastes and validation successfully completed. A Closure Report for the Old Tip may only be prepared when the site is fully restored and there is sufficient monitoring data available regarding gas and leachate monitoring to demonstrate that migration is being managed and achieves environmental assessment limits (EALS).

2. Background Information

2.1. Technical Reports

2.1.1. The following technical reports describing conceptual models for both sites together with reviews of all available monitoring data are listed below:

Table 2.1: Smith Grant LLP Reports

Title	Content and purpose	Reference and date
Springside Mills, Belmont, Lancashire; Licensed Landfills Environmental Permit Nos. 53658 and 53997 Hydrogeological Risk Assessment Report	For Environment Agency Permitting Purposes - review of previously reported data, risk assessment and review of tip leachate management options	R1635-R01-v3, March 2014
Springside Mills, Belmont, Lancashire; Licensed Landfills Environmental Permit Nos. 53658 and 53997 Landfill Gas Risk Assessment Report	For Environment Agency Permitting Purposes - review of previously reported data, description of preliminary flux box testing on Old Tip, and review of landfill gas management options	R1635-R02-v2, December 2013
Springside Mills, Belmont, Lancashire; Licensed Landfills Environmental Permit Nos. 53658 and 53997 Stability Risk Assessment Report	For Environment Agency Permitting Purposes - review of slope stability around and within landfills, and settlement data on Old Tip, with review of Old Tip restoration options.	R1635-R03-v1, March 2014
Restoration of the New Tip at the former Springside Mills Site, Belmont; Environmental Review and Mitigation Proposals	Review of site environmental setting and waste contents, with risk assessment and remedial options review	R1635-R04-v3, November 2012
Former Springside Mills, Belmont, Lancashire, Contamination Desk Study and Preliminary Risk Assessment	Desk Study review to support planning application for main works site reclamation	R1635-R05-v2, September 2013
Former Springside Mill, Belmont, Remediation and Restoration of New Tip; Planning Consent 10/12/1110; Condition 2, Contamination Desk Study, Site Investigations and Remedial Strategy	Contamination desk study, summarising all intrusive investigation results for Local planning Authority in pursuit of Planning Condition Discharge	R1635-R07-v1, March 2014

2.1.2. The Environment Agency is satisfied that the above reports adequately describe the sites and potential environmental risks. Specific comments concern the fitness for purpose of certain landfill

gas monitoring installations, and these are reviewed in section 3 below, the integrity of the Supply Lodge dam (which has been the subject of a recent engineering inspection, details of which are provided in Appendix F), and the suggested absence of evidence for reduction in pollutant concentrations within the Old Tip (further comment provided in Section 3 below).

2.1.3. In conclusion, the Environment Agency agrees that water draining from west-facing surface slope of the Old Tip is likely to enter Three Nooked Shaws Brook (TNSB) via the Supply Lodge, and that the underlying bedrock aquifer is not at risk from leachate pollution. TNSB is diverted via a culvert away from its original course and now flows into Eagley Brook upstream of the site. The primary risk is agreed to be shallow migration of leachate via the TNSB valley below both landfills, apparently converging upon the "Ochre Culvert" discharging to Eagley Brook. Eagley Brook is the primary receptor for any waterborne pollutant emissions from both landfills, as well as any leaching from the main works and ash tips.

2.1.4. Urbanspringside has prepared a separate method statement covering the proposed excavation and relocation of deposited effluent treatment sludge wastes from the New Tip to the Old Tip for re-use. The method statement also sets out the arrangements for removing the landfill liner, monitoring and validation to allow the New Tip Closure Report to be prepared. The treatment and re-use proposals for cement-stabilised New Tip effluent treatment sludge has now been refined as a result of additional development and testing work, and additional information is provided in Appendix B; the proposed treatment and recovery of New Tip sludge is the subject of a separate deployment application by the licenced specialist contractor Urban Soil Solutions Ltd.

3. Risk-based Monitoring Plan

3.1. Controlled Waters Background

3.1.1. The sites lie at the lower (east) end of the west to east valley of Three Nooked Shaw Brook (TNSB) adjacent to its junction with the larger northwest to southeast Longworth Clough (occupied by Eagley Brook, also known as Belmont Brook). The Old and New Landfills have been constructed within the base of the TNSB valley to the east of a concrete dam impounding the Supply Lodge. The valley is eroded into a deep deposit of glacial till. The Old Landfill is uncontained. The New Landfill occupies a single lined cell.

3.1.2. The sites are underlain at depth by an aquifer within the Carboniferous gritstone bedrock however this is not at risk from pollutants from the landfills due to the thick layer of glacial till which confines the aquifer. There is no monitoring of the aquifer.

3.1.3. No exceedances of Priority Substances Values, as set down in The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010, have been detected during the monitoring of leachate, groundwater and surfaces waters linked to the two landfills, with the following exceptions:

- cadmium has been detected in BH110/06, BH114/06 and BH5/95(d) in excess of the EQS, reflecting slightly elevated natural background levels in the glacial drift, and at a maximum of 0.29 µg l^{-1} in the Ochre Culvert (monitoring point SWR5);
- mercury was detected in all monitoring locations on one occasion (June 2012) probably signifying a systematic laboratory error, and as exceptional slight exceedances of the standard for the upstream TNSB (SWR1 - 0.06 µg l^{-1}), New Tip leachate (0.06 µg l^{-1}), BH110/06 (0.053 µg l^{-1}), and BH4/95(d) (0.055 µg l^{-1}); also, a relatively high concentration was recorded on one occasion (December 2009) in SWR5 at 12 mg l^{-1} - that result cannot be checked but has not been repeated since, and may be erroneous; the average results are not of significance.

3.1.4. Iron and manganese are naturally elevated in the receiving watercourses, TNSB and Eagley Brook, but with average results that meet the EQS. Results in the key surface water monitoring locations up and down-stream of the sites show an improvement in water quality downstream, with no evidence of impact from landfill leachate:

Table 3.1. Iron and Manganese Monitoring in TNSB and Eagley Brook, 2006-2013

	Iron (mg l^{-1})		Manganese (mg l^{-1})	
	average	maximum	average	maximum
SWR1 (TNSB - Supply Lodge)	0.97	1.9	0.21	0.70
SWR4 (Eagley Brook upstream)	0.59	1.4	0.05	0.25
SWR6 (Eagley Brook downstream)	0.55	2.1	0.06	0.38

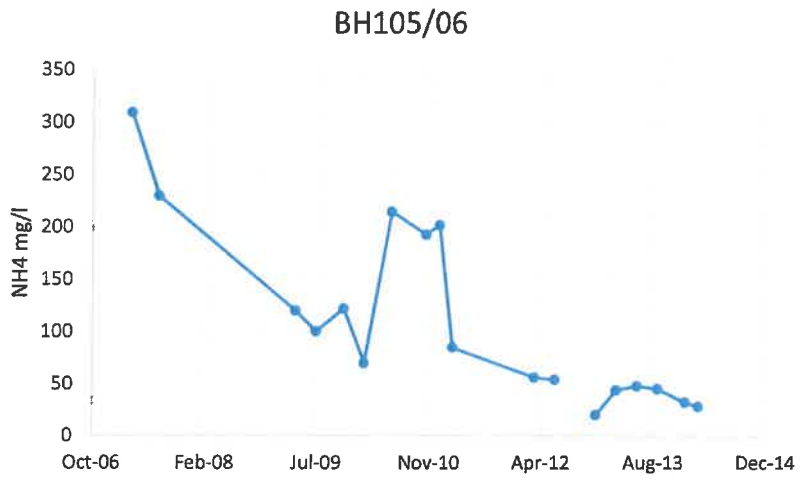
3.1.5. Ammonia concentrations in the receiving watercourses, TNSB and Eagley Brook meet the EQS. Results in the key surface water monitoring locations up and down-stream of the site show an improvement in water quality downstream, with no evidence of impact from landfill leachate:

Table 3.2. Ammonia Monitoring in TNSB and Eagley Brook, 2006-2013

	Ammonia (mg N l^{-1})	
	average	maximum
SWR1 (TNSB - Supply Lodge)	0.15	0.27
SWR4 (Eagley Brook upstream)	0.12	0.29
SWR6 (Eagley Brook downstream)	0.08	0.15

3.2. Leachate Sources

3.2.1. The Old Landfill permitted waste contents include non-polluting sludge from paper manufacture - paper effluent treatment sludges (essentially limestone and clay fillers and cellulose fibre) and demolition wastes. Some hydrocarbons, in particular toluene, have been identified, together with low concentrations of other organic compounds however these have not been shown to be present in significant concentrations in leachate leaving the site. Ammonia within leachate in the central part of the tip has been identified as the pollutant of primary concern with respect to surface waters. The longest run of monitoring data for leachate within the Old Tip is from BH105/06, and shows a declining trend in ammonia concentration within the landfill (see graph below). Leachate concentrations at the down-gradient pump location / adjacent to the Supply Lodge are substantially below the discharge consent limit and similar to the local background.



3.2.2. The New Landfill contents are solely paper effluent treatment sludges of similar composition to those within the Old Tip. The leachate monitoring to date at the pumping well has been found to comply with the discharge consent except for occasional exceedances of the total suspended

solids, probably due to the formation of iron (III) oxyhydroxide flocs on exposure to the atmosphere.

3.2.3. A discharge consent (ref: NPSWQD006635) allows for the pumping of 20m³/d and 10m³/d of leachate from the Old and New Landfills respectively into the 42" culvert. The following quality limits are specified:

- biochemical oxygen demand - 20 mg/l
- ammoniacal nitrogen - 5 mg/l
- pH 5.0 - 9.0
- suspended solids - 20 mg/l
- free from visible oil/grease
- List 1 substances as per Annex 1 to the permit – monitoring is currently carried out for cadmium (consent limit 10.0 µg/l) and mercury (consent limit 2.0 µg/l)
- Annex 2 of the Permit lists other dangerous substances whose discharge should not cause an exceedance of the environmental quality standard (EQS) in the receiving watercourse downstream (this is assumed to be the culverted TNSB).

3.3. New Tip Waste Recovery

3.3.1. In order to assess the potential impact from leachate draining from the New Tip paper wastes during and following their proposed treatment by cement stabilisation and re-use in the restoration of the Old Tip, trials have been carried out (see Appendix B for full details). The initial study involved the bulk sampling of the New Tip waste which was placed in 2 lined metal builders skips of ~4.6m³ maximum capacity. These were equipped with a standpipe to enable sampling of any collected leachate. The sampling locations were from the lower part of the tip near to the leachate chamber ("skip 1") and up-gradient area towards the western end of the landfill ("skip 2"). The wastes were soft and tended to slump but contained no visible water, although water could be squeezed by hand from the material represented by skip 2. The skip 2 material was noticeably softer and weaker than the skip 1 material which appeared to be more consolidated.

3.3.2. The analyses of the solid waste sampled showed high water contents of 53% and 64% (114% and 175% of dry weight), with organic matter contents of 11.2% and 15.5% dry weight. The nitrogen content was low, with carbon:nitrogen ratios of <1:50 suggesting that microbial decomposition of the organic content will be constrained. Volatile organic compounds in the waste included a range of aromatic compounds including toluene and naphthalene in low concentrations.

3.3.3. After filling of the skips, the wastes were sheeted to prevent infiltration and were allowed to settle for a week, after which leachate sampling was carried out. The leachate, which may be assumed to be representative of the drainage from freshly disturbed and lightly re-compacted material, was analysed, and estimates of the volume of free liquid made in order to carry out an assessment of

potential pollutant loads. The leachate was moderately odorous, of milky colour, and contained high levels of chemical oxygen demand (COD), raised phenol and cresol, raised ammonia (in skip 1 only), and slightly elevated concentrations of some metals and aromatic volatile organic compounds (VOCs).

3.3.4. It was previously speculated that degreasing solvents might have entered the effluent stream giving rise to the noted presence of toluene, however the detailed analysis of leachate has also found a range of related aromatic compounds, monohydric phenols and alcohols. The substances found are suggestive of intermediate breakdown products from the natural anaerobic hydrolysis of lignin fibre in the effluent sludge; lignin is a propyl phenol polymer. Although these substances have not been previously identified in pumped leachate or groundwater down-gradient of the landfills, the disturbance of the materials during the proposed restoration of the tips could temporarily give rise to "higher strength" leachate, and the management plan and monitoring therefore takes account of this.

3.3.5. EA-approved method tank tests of cement stabilised New Tip sludge samples are reported in Appendix B, and demonstrate leachability results that comply with surface water EQS values. The treated material also meets physical requirements for handleability and stability in use to form a lower cover layer to the present low-lying, soft and unstable sections of the Old Tip where ground levels need to be raised to create an unsaturated zone. The specialist contractor, Urban Soils Solutions Ltd, holds a "mobile plant licence" for stabilisation and has obtained a deployment notice for treatment of the New Tip sludges to render the treated material physically suitable for use in Old Tip restoration and non-polluting in such use.

3.4. Leachate Pathways

3.4.1. Pathways for leachate egress and estimates of their relative significance in terms of flows are as follows:

Table 3.3. Summary of Leachate Pathways

Old Landfill		Significance
1	runoff and seepage from waste body to west directly into standing water adjacent to and connected with Water Supply Lodge and TNSB upstream culvert	may account for ~60% of Old Tip drainage based on surface area and slopes (6,883m^2); assuming annual effective rainfall of 1,000 mm, the average discharge would be 11.3 m^3 d^{-1} however this does not include natural seepage that enters the landfill from springlines in adjacent rising ground to south and north; given the absence of significant pollution in leachate monitored at the west end of the site compared to boreholes within the waste body it appears that most incident rainfall is likely to flow over the surface of the low permeability paper effluent treatment wastes

2	seepage to east into base of ash embankment, thence down valley across the boulder clay surface, below the basal liner of the New Tip, to discharge via the drain outfall to Eagley Brook	may account for ~40% of Old Tip drainage based on surface area and slopes (6,883m^2); assuming annual effective rainfall of 1,000mm, the average discharge would be 7.5 m^3 d^{-1}
3	managed pumping to TNSB culvert	intermittent pumping - maximum consented discharge rate 20 m^3 d^{-1} - assumed to include a mix of leachate and Supply Lodge surface water seeping through dam
New Landfill		
4	over-topping of basal liner to merge with general valley flow and discharge via drain outfall to Eagley Brook	episodic, during wet weather when pumping ineffective; previously a significant volume >80 m^3 d^{-1} due to entry of TNSB culvert leakage into lined cell
5	seepage through any imperfections in the basal liner into underlying ash drainage layer and alluvium, to merge with pathways 2 & 4	unknown contribution to augment pathway 2 flow from Old Tip plus general area drainage, in particular leakage from TNSB culvert; the Ochre Culvert groundwater discharge is estimated at an average ~100 m^3 d^{-1}
6	managed pumping to TNSB culvert	intermittent pumping - maximum consented discharge rate 10 m^3 d^{-1}

3.4.2. With respect to the Old Landfill, the central leachate monitoring wells, in particular BH3/11 contain leachate with the potential to cause pollution outside the site, in particular with respect to ammonia and toluene. However, the external monitoring wells have recorded no occurrence of toluene above detection limits, and ammonia has only been recorded in slightly elevated concentrations immediately adjacent to the down-gradient (east) end of the landfill within the base of the ash embankment. Given the common presence of ammonia in excess of the surface water EQS concentration in groundwater due to a variety of sources in the catchment (including natural deposition, agriculture, forestry, domestic sanitation, and industry), the concentrations recorded adjacent to the landfills over recent years, in the order of 2-3 mg l^{-1} are not considered to indicate significant risk.

3.4.3. Ammonia concentrations are reduced downstream and monitoring of the Ochre culvert discharge (SW5), which is considered to represent a significant pathway to Eagley Brook, has shown generally low levels of potential pollutants with the exception of iron. The Old Landfill is uncapped and unlined, with waste deposition ceasing over 15 years ago, and is considered to be in a state of equilibrium whereby future increased releases of water-borne pollutants appears to be very unlikely.

3.4.4. The New Tip leachate monitoring and discharges have not been shown to be significantly polluting, except where temporarily disturbed. This is due to the mobilisation of fine cellulose fibre that can generate a high suspended solids / high BOD leachate. Whilst unlikely to cause any impact on groundwater due to natural filtration, the leachate could impact surface waters if directly discharged. It will therefore be important to maintain the containment, and treatment as

necessary, of leachate arising during proposed stabilisation treatment works on the New Tip sludge waste; once treated, the waste is no longer polluting. As it is proposed to treat and remove all of the deposited sludge wastes as part of the landfill closure, any post-closure risks will be nullified. The potential for residual leachate within the landfill basal drainage (ash layer) or natural strata appears to be negligible given the absence of any detectable pollutants in down-gradient monitoring wells, however the liner and any leakage residues of sludge will be removed following treatment and removal of the landfill contents.

3.4.5. The only significant exceedances of environmental standards (WFD Priority Substance EQSs for inland surface waters in leachate leaving the landfills in monitoring since 2009 have been for ammonia, iron and manganese. In addition, there have been recent exceedances of the TNSB Culvert Discharge Consent limit for suspended solids, probably as a result of the formation of iron oxyhydroxide (ochre) flocs. As TNSB already carries peaty water with elevated background iron concentrations the consequences of the discharge exceedances are considered to be negligible.

3.4.6. In conclusion, the leachate leaving the landfills at present is not significantly polluted. There are no groundwater resources at risk from pollutants within leachate from the site. The bedrock aquifer is protected by a substantial thickness of glacial till aquitard or aquiclude and has a hydraulic gradient liable to provide baseflow to Eagley Brook where the drift cover thins. Surface watercourses are linked to the site and leachate migration pathways, either via unmanaged drainage via the base of the former TNSB valley, or via managed discharge to the TNSB culvert. No significant impact of pollutants from the landfills has been recorded within the surface watercourses over the last 7 years of monitoring, and for the ubiquitous non-hazardous substances ammonia, iron and manganese, there is an improvement in water quality downstream of the landfills.

3.5. Controlled Waters Monitoring Proposals

3.5.1. Based upon the above assessment and the historical leachate monitoring programme, the current and future predicted leachate quality is as follows:

Table 3.4. Leachate pollution potential

	Old Landfill		New Landfill	
	current	future predicted	current	future predicted
priority substances	not detected above EQS	no deterioration likely	not detected above EQS	Potential short-term increases in metals during waste disturbance / initial drainage, but less than discharge consent values; mitigated by settlement and aeration in temporary lagoon prior to discharge;

				Long-term – no pollution risk following removal of waste
other pollutants	elevated ammonia and toluene present within landfill body - not found in leachate leaving the site	no deterioration likely	elevated ammonia and toluene present within landfill body - not found in leachate leaving the site	Potential short-term increase in BOD/COD, suspended solids and ammonia in excess of Discharge Consent standards. Some risk of phenol exceedance of EQS in TNSB but not in Eagley Brook; Long-term – no pollution risk following removal of waste

3.5.2. The risk based monitoring plan for surface water and groundwater is set out in Appendix C, and involves an increased frequency of leachate monitoring during the proposed New Tip waste drainage and re-location proposals, reverting to the existing plan following the works, with the exclusion of New Tip up-and down-gradient monitoring wells, and TNSB downstream monitoring point (SWR3), not needed after removal of New Tip.

3.5.3. Groundwater compliance limits have been provided for the key identified potential water pollutants at locations down-gradient of the Old Tip (BH4/95 and BH103/06 deep), and Ochre Culvert (SWR5), down gradient of the both Old and New Tips, as follows:

Table 3.5. Proposed Environmental Assessment Levels

Receptor	Compliance Point	Substance	Baseline Concentration Data	Proposed Limit	Rationale
Ground-water, down-gradient of Old Tip	BH 4/95	cadmium	mean 0.248 max 0.900 s.d. 0.259 (limit of detection 0.02*)	0.756	~95%ile of background; (EQS 0.20 LT)
		mercury	mean <0.087 max 0.280 s.d. 0.072 (limit of detection 0.05*)	0.232	~95%ile of background; (EQS 0.05 LT 0.07 ST)
		ammonia	mean 1.36 max 15.0 s.d. 3.79 (limit of detection 0.05*)	8.95	~95%ile of background; (EQS (type 4) 0.3 LT)
		monohydric phenols	no data	7.7	No data for statistical approach; EQS (LT) adopted

Receptor	Compliance Point	Substance	Baseline Concentration Data	Proposed Limit	Rationale
		toluene	no data	50.0	No data for statistical approach; minimum reporting value (MRV) taken from EA H1 guidance Annex J Appendix A2 (v2.1) (EQS 50 LT 380 ST)
		chemical oxygen demand (COD)	mean 54.6 max 150.0 s.d. 52.1 (limit of detection 1*)	159	~95%ile of background; No EQS
	BH 103/06 (deep)	cadmium	mean 0.077 max 0.500 s.d. 0.149 (limit of detection 0.02*)	0.375	~95%ile of background; (EQS 0.20 LT)
		mercury	mean <0.088 max 0.280 s.d. 0.077 (limit of detection 0.05*)	0.242	~95%ile of background; (EQS 0.05 LT 0.07 ST)
		ammonia	mean 2.64 max 3.70 s.d. 0.73 (limit of detection 0.05*)	4.10	~95%ile of background; (EQS (type 4) 0.3 LT)
		monohydric phenols	no data	7.7	No data for statistical approach; EQS (LT) adopted
		toluene	no data	50.0	No data for statistical approach; minimum reporting value (MRV) taken from EA H1 guidance Annex J Appendix A2 (v2.1) (EQS 50 LT 380 ST)
		chemical oxygen demand (COD)	mean 21.4 max 35.2 s.d. 8.2 (limit of detection 1*)	37.7	~95%ile of background; No EQS

Receptor	Compliance Point	Substance	Baseline Concentration Data	Proposed Limit	Rationale
Eagley Brook feeder	Ochre Culvert discharge (SWR5) (ground-water down-gradient of Old and New Tips)	cadmium	mean <0.064 max 0.290 s.d. 0.084 (limit of detection 0.02*)	0.231	~95%ile of background; (EQS 0.20 LT)
		mercury	mean <0.133 max 0.640 (excluding July 2009 anomalous result) s.d. 0.193 (limit of detection 0.05*)	0.520	~95%ile of background; (EQS 0.05 LT 0.07 ST)
		ammonia	mean 0.404 max 0.730 s.d. 0.162 (limit of detection 0.05*)	0.728	~95%ile of background; (EQS (type 4) 0.3 LT)
		monohydric phenols	no data	7.7	No data for statistical approach; EQS (LT) adopted
		toluene	no data for SWR5 (leachate surface discharge consistently below limit of detection 1.0)	50.0	No data for statistical approach; minimum reporting value (MRV) adopted from H1 Annex J Appendix A2 (v2.1) guidance (EQS 50 LT 380 ST)
		chemical oxygen demand (COD)	mean 13.9 max 39.0 s.d. 8.5 (limit of detection 1*)	31	~95%ile of background; No EQS

Concentrations in µg l^{-1}; * - for statistical analysis, results below limit of detection are assumed to be at limit of detection; equivalent 95%ile concentrations calculated as mean + 2 std. deviations of the data set; ST – short term - 95%ile, LT – long term – annual average; EQS values from Environment Agency H1 guidance, Annex D.

3.5.4. No standards are proposed for iron and manganese due to the elevated natural background concentrations of these substances, and their absence as significant sources within the paper wastes. No standard is proposed for suspended solids due to the occasional natural elevation of these in the receptors due to storm runoff and iron flocs from natural ferruginous seeps within Longworth Clough, however all discharges will be required to be free from discoloration and odour, and free from visible oil films in accordance with the current discharge consent.

3.5.5. Exceedance of groundwater compliance limits will trigger investigation into the causes, including repeat sampling and analysis, risk assessment and proposals for remedial action as necessary. Remedial actions might involve the interception of groundwater and treatment, and/or leachate volume reduction by reducing water inflows.

3.6. Landfill Gas

3.6.1. Details of the Environment Agency specified gas monitoring locations and other monitored installations are provided below:

Table 3.6. Gas Monitoring Wells

Location	Borehole well	EA specified (2007)	Response zone (m bgl)	Response stratum over typical water table (m)	monitored to January 2012 by Edge Consultants / Coffey Geotechnics	monitored since January 2012 by Smith Grant
within Old Landfill body	BH101/06	x	1.0 - 8.0	waste onto clay till, saturated to near ground level	up to Nov 2007	lost
	BH105/06	x	4.0 - 6.0	sand and gravel over clay till, saturated to near ground level	x	x
	BH1/11		1.0 - 14.0	waste, water table at ~4.5	x	x
	BH2/11		1.0 - 12.0	waste, water table at ~5.0	x	flooded, lost December 2012
	BH3/11		1.0 - 9.0	waste, water table at ~3.0	x	x
north of Old Landfill	BH106/06	x	1.0 - 4.0	sand and gravel, water table in 1.0 - 1.5m range	x	x
	BH117/07		0.8 - 4.0	clayey sand on water table at ~2.2m	x	
	BH118/07		2.0 - 5.0	sand, gravel and silt on water table at ~3.0	x	
	BH119/07		2.0 - 6.0	sand on water table at 5.0	x	
	BH120/07		1.5 - 5.5	sand and gravel on water table at ~2.5	x	
south of Old Landfill	BH1/95		17.7 - 24.7	clay till below water table	x	not found
	BH102/06	x	18.0 - 20.0	clay till below water table	x	x
	BH109/06	x	0.5 - 6.0	clay till, water table in surface - 0.5 range	damaged	not found
	BH110/06	x	1.0 - 3.5	clay till, water table in surface - 0.3 range	x	x
in ash bank between Old and	BH4/95	x	14.5 - 25.0	clay till, saturated	x	x
	BH6/95		1.3 - 13.0	granular fill, water table at ~12.0	x	
	BH103/06 (s)	x	2.0 - 16.0	granular fill over clay till at base, water table at ~12.0	x	x

Location	Borehole well	EA specified (2007)	Response zone (m bgl)	Response stratum over typical water table (m)	monitored to January 2012 by Edge Consultants / Coffey Geotechnics	monitored since January 2012 by Smith Grant
New Landfills	BH107/06	x	1.0 - 4.8	granular fill to 1.4 over predominantly clay till with clayey sandy gravel layers, water table ~2.5	x	x
	BH108/06	x	1.0 - 6.0	predominantly granular fill with water table in 3.0 - 3.5 range	x	x
	BH114/06		2.0 - 16.0	predominantly granular fill with some more cohesive bands, water table in 10.0 - 11.5 range	x	x
	WS8/05	x	0.9 - 4.0	granular made ground, unsaturated	x	x
north of New Landfill	BH112/06		1.0 - 4.3	predominantly cohesive till to 1.6 over clay till, water table in 1.0 - 1.6 range	x	x
	BH113/06		1.0 - 5.0	cohesive till to 1.8 over 0.7 peat band and clay till, water table in 2.5-2.7 range	x	x
south of New Landfill	BH115/06(s)		2.0 - 6.0	granular fill onto clay till at base, water table in 4.0-5.0 range	x	x
	BH115/06(d)		10 - 20	clay till, water table in 10.0 - 12.0 range	x	
	BH116/06(s)		2.0 - 14.0	granular fill, water table in 12.0 >14.0 range	x	x
	BH116/06(d)		16.0 - 20.0	clay till, saturated	x	x
east of New Landfill	BH5/95(s)		5.8 - 7.0	base of granular fill onto alluvial clay, saturated	x	x
	BH104/06 (s)		2.0 - 10.0	granular fill with clay till at base, water table in 5.0 - 5.5 range	x	x

3.6.2. Results from boreholes in cells shaded orange in Table 4.1 are considered unrepresentative of soil gas due to the saturation zone lying above the well response zone. They can however provide information on headspace equilibrium above the water table where dissolved methane may be present. Boreholes within saturated degradable waste may accumulate gas from bubbles rising directly into the borehole headspace (BH101/06 and 105/06).

3.6.3. The Environment Agency has questioned the performance of some monitoring wells where atmospheric conditions have been recorded, suggesting leakage into the well from surface. In permeable ground, as represented by the ash embankment, leakage of air into a well via the soil surrounds is inevitable and natural, and does not invalidate the monitoring. Leakage of this type is to be expected and is the cause of methane oxidation taking place in the shallow soils within

the ash embankment, as demonstrated by the relative preponderance of carbon dioxide over methane with the presence of oxygen, in marked contrast to monitoring data from wells within the paper waste. All wells have been inspected by SGP and examined for potential leakage past the well head, depth of the response zone, water table and flow failures. Two wells have been identified as having potential problems due to settlement of the well surrounds; these are BH102/06 and WS4/03. All other wells have been found to be in good order.

3.6.4. The proposed forwards gas monitoring plan is set out in Appendix C and will continue the current format, but with increased frequency of monitoring to monthly for the period of movement and storage of New Tip waste on the Old Landfill and restoration works when lateral gas migration could potentially increase.

3.6.5. The monitoring arrangements will be reviewed following restoration of the Old Tip, but are expected to include twice yearly walkover FID surveys of the landfill cover to check for localised emissions. Further monitoring wells are likely to be needed following completion of the New Tip restoration and installation of gas venting one the development side of the Old Tip.

3.6.6. Environmental Assessment Levels for landfill gas will be 1% above background for methane and 3% above background for carbon dioxide at such time as new sensitive receptors arise at the site (i.e. during and following possible residential or other built development).

4. Landfill Gas Management Plan

4.1. Site Overview

4.1.1. Both landfills contain effluent treatment sludges that include minor proportions of degradable organic matter in the form of cellulose, hemi-cellulose and lignin within a matrix of fine particulate inert minerals. The sludges are largely water-saturated and in some respects, resemble natural organic-rich wetland soils. Anaerobic decomposition is occurring at slow rates that appear to be mediated by nutrient availability, with the primary degradation products being methane, carbon dioxide and water, although toluene, phenols and other VOC intermediate degradation products have been detected in freshly disturbed New Tip waste leachate. No VOCs have been detected in landfill gas monitoring.

4.1.2. The volume of potentially gas-generating sludge fill is estimated to be 19,500 m^3 in the Old Tip and around 3,000 m^3 in the New Tip. As previously noted, the Old Tip is unlined and is contained by a variety of largely impermeable natural soils and permeable man-made fills (boiler ash and demolition rubble / hardcore). The New Tip has a basal liner that appears to have good integrity and retains leachate.

4.1.3. The New Tip effluent sludge wastes are proposed to be treated by stabilisation methods and removed in their entirety from the lined cell, and the liner removed. Any degradable waste, as defined by having an organic content >6% or visible paper waste, will similarly be removed from the New Tip site. No significant sources of landfill gas will remain within the New Tip, and landfill gas management will not be required for this site. The remainder of this section therefore addresses landfill gas risks and management for the Old Tip only.

4.1.4. The organic matter content of waste samples from the Old Tip had an average content of 9.7%, with a maximum of 48.6%. The above-average organic matter levels were associated with the paper wastes. Using the GasSim decay equation, a preliminary estimate of the potential current gas generation from the landfill has been made:

- mass of waste – 19,500 t (assuming bulk density of 1 t m^{-3})
- carbon content - 200 kg t^{-1} waste
- medium decay rate constant 0.1
- 13 years since deposition (conservative assumption - actual median age of waste >33 y)
- gas generation rate = 11.7 m^3 hr^{-1} (1.1 l m^{-2} hr^{-1} assuming 60% methane content)

4.1.5. Surface flux box testing by SGP has indicated a best estimate of about 2.5 m^3 hr^{-1} emission rate for landfill gas from the Old Tip.

4.1.6. The glacial till which forms the dominant natural strata surrounding both landfills are cohesive and generally has low permeability to gas and water. Minor discontinuous lenses of sands and gravels have been encountered in some boreholes below the water table, however these are considered unlikely to provide potential gas migration pathways due to their saturated condition and discontinuous nature.

4.1.7. The valley sides to both landfills have been modified to varying extents by the deposition of coal ash from the paper mill boilers prior to the deposition of paper effluent sludge wastes. These deposits are most extensive in the area of an embankment separating the Old and New Tips, and in the ground to the south of the New Tip where they extend to up to 14.5 m in depth (BH 116/06). The ash is loose-tipped, granular and free-draining, and is consequently permeable to migrating landfill gas. The Old Tip wastes are retained by the western slope of the ash embankment crossing the TNSB valley. To the south of the Old Tip, made ground is also present and comprises a mix of dense ash and brick demolition materials beneath the existing hard-standings.

4.2. Landform Requirements

4.2.1. The fundamental requirements for the capping with respect to future gas management on the Old Tip are that:

- it must remain above the local water table, as defined by standing water adjacent to the Supply Lodge dam at about 193 m aod;
- it must have adequate slopes to promote moderate surface runoff and to counter future settlements that might produce closed hollows and ponding.

4.2.2. Currently the Old Tip has an unsatisfactory profile with no capping, saturated / flooded areas and over-steep slopes of up to 1 in 5 that do not facilitate satisfactory restoration or gas management. It is therefore proposed to re-grade the Old Tip surface to the final (cover surface) contours as shown on the Appendix E drawing. This will involve a minor cut into the upper part of the landfill which comprises soil and inert waste, and filling of the lower areas, in particular towards the dam. The net requirement is for 6,000m^3 of cover/capping materials, incorporating the landfill cover system and a woven geotextile; this averages out to 1m cover thickness over the waste area, although on-going consolidation of the softer wastes in the west of the tip is expected, and will be increased as a result of the capping surcharge, needing additional cover thickness in these areas to achieve the objectives in 4.2.1. Further details regarding the proposed re-grading and restoration are provided in section 6 below.

4.3. Landfill Gas Management

4.3.1. The SGP Landfill Gas Risk Assessment report (R1635-R02, December 2013) set out the options for landfill gas management taking into account the slow rate of gas production at the site. It has been concluded that the objectives of gas management are to:

- control sub-surface lateral gas migration to the east and southeast, particularly with regard to the proposed future residential development of the land adjacent;
- reduce methane emissions from the site by means of bio-oxidation within the landfill cover soil; and
- prevent landfill gas accumulation in the cover soils to levels that could cause vegetation damage or death.

4.3.2. Typical rates of methane oxidation in landfill caps are assumed by default to be around 10%, however an extensive literature review (Chanton et al, Journal of Environmental Quality, 2009) has documented higher rates in various soils, at up to 53% in sandy soils. At low methane generation rates, oxidation rates of up to 96-100% have been found. The DEFRA report, "Methane emissions from landfill sites in the UK", January 2003, found that oxidising potential of landfill cover in laboratory and field trials is capable of treating ~80 - 140 m^3 ha^{-1} hr^{-1} of methane with a conversion efficiency of 75%; this level of flow is substantially greater than that estimated for the Old Landfill, and a reasonable target for methane oxidation for the site could be set at 75% conversion efficiency. On the basis of the average measured flux box rate of 0.04 mg m^2 s^{-1}, a 75% reduction would be 0.01 mg m^2 s^{-1}, which is 10% of the Environment Agency standard for methane flux from temporary or interim capped landfills.

4.3.3. The requirements for bio-oxidation are a suitable depth of unsaturated gas-permeable soil (i.e. open-textured soils), with small potential for the development of preferential pathways via fissures to surface. The suitable minimum depth of soil cover is considered to be 1m comprising a very permeable unsaturated base layer that allows lateral dispersion and diffusion of gas to spread concentrations and flows, and a relatively moist upper soil layer to provide a plant root zone and oxidation zone. Methane bio-oxidation occurs via the action of microbes in aerobic soil; the physical conditions are best achieved within moist, organic-rich soils that are not subject to excessive shrink-swell behaviour (i.e. low content of expansive clays). Compost-enriched sandy loams are likely to be best-suited to enhance bio-oxidation.

4.3.4. The proposed cover specification to be constructed on the re-graded tip surface will utilise locally-sourced materials as far as possible and will be as follows:

Table 4.1. Old Tip Capping Outline Specification

depth	material	function
0-150mm	topsoil	Grass / shrub support / bio-oxidation
150 – 700mm	sandy subsoil / compost	Bio-oxidation layer / plant root support
-	woven geotextile	Filter/separation layer to prevent fines migration down into drainage layer / root barrier
700 – 1,000mm	coarse-textured drainage layer (300mm minimum thick layer, fine/medium gravel size, low fines content)	Layer to provide high porosity for lateral dispersion of gases, and water drainage

depth	material	function
0 – 2,500mm variable	free-draining cement-stabilised effluent treatment sludge recovered from New Tip, typical 500 – 1,500mm thick layer placed over soft uncapped sludges, with allowance for settlement	provides mechanical strength over areas of soft, deformable wastes; thickness will need to be increased over softest / low-lying areas of waste to create necessary unsaturated zone and support to upper cover soils, to meet approved finished levels and allow for future settlement of underlying waste

4.3.5. Previous research on bio-oxidation covers has demonstrated the efficacy of such systems, however there will be an inspection and maintenance requirement to counter the development of local settlement and development of preferential flow pathways via weak points. No enclosed structures or impermeable paved areas will be permissible on the landfill surface until such time as gas production has reached negligible levels.

4.3.6. Proposals for preventing lateral gas migration out of the Old Tip utilise a proprietary venting system along the southeast and east margins of the Old Tip, outside the extent of any paper wastes, but at a minimum 25m distance from future proposed houses. Gas migration outside the tip has been driven by atmospheric pressure variations and diffusion, with no significant pressures or flows detected in wells outside the tip. The proposed barrier alignment is shown on Drawing R08-05. Use of a full depth impermeable cut-off wall keyed into the underlying boulder clay is not feasible given the valley topography and need to avoid groundwater damming within the infilled valley. There is also evidence from existing split-level boreholes in the ash embankment that most gas migration has occurred at depths of less than 5m below ground level, which is probably related to the relatively shallow water levels within the landfill itself.

4.3.7. It is therefore proposed to use a proprietary vent system "Virtual Curtain Gas Migration Barrier", designed and installed by the specialist contractor SEL Environmental Ltd. This features a series of geosynthetic vents installed by vibro-flotation methods, producing a high intrinsic permeability 'k' in excess of 1.75×10^{-5} m² (approximately 150X greater than 20mm single sized gravel). Each vent node creates a low-pressure zone and pressure gradient or preferential pathway for gas. The extent of the zone of influence around each node will be dependent on the local ground conditions, but is expected to be well-suited to the deep boiler ash deposits generally present along the alignment. The vertical vent nodes connect to an upper horizontal gas collection and dilution duct which then connects to proprietary vent bollards above ground level.

4.3.8. The gas barrier specification will be subject to detailed design with supporting gas flow modelling to provide assurance regarding performance characteristics. This will have the objective of limiting gas concentrations outside the barrier to below 1% methane / 5% carbon dioxide. The barrier initial design and specification is as follows, with an extended section shown on drawing R08-05:

- length 150m (terminating where cohesive glacial till rises to <1m below surface)
- average 8.5m depth (to maximum 10m depending upon depth to glacial till / long-term water table in base of valley, and ease of installation)
- vent node spacing 3-5m, subject to flow modelling
- surface venting via bollards at 15m centres

4.3.9. Over a distance of approximately 30m within the central section of the former TSNB valley the ash embankment is >10m deep, however the unsaturated depth of ash below the barrier down to the water table will be an average of around 2.3m (maximum 3.0m). It is considered that the radius of influence of the nodes will prevent any significant migration below the base of the barrier in this area, whilst not interfering with normal groundwater movement.

4.3.10. As noted above, the monitored off-site migration appears to be essentially by diffusion, with some evidence of atmospheric pressure variations causing convective flows, but significant gas pressures or flows have never been recorded in the off-site boreholes. At present there is clear evidence of bio-oxidation of methane having occurred within the ash embankment, and it is expected that this process will continue on the landfill side of the barrier. Therefore, methane emissions via the venting system are expected to be minimal. However, in the event that significant flows are detected during monitoring of the barrier performance, then additional measures could be incorporated to pass the collected emissions through an additional bio-filter to reduce methane concentrations through bio-oxidation. Flows and concentrations will be insufficient for any form of thermal treatment.

5. Amenity Management

5.1. Leachate

5.1.1. Short-term management of leachate during the removal and temporary storage of New Tip wastes will be required to ensure that pollution of Eagley Brook does not occur. The discharge permit currently allows for the pumping of up to 5 m^3d^{-1} of leachate within specified concentration limits into the TNSB culvert. The skip trials (see Appendix A) indicate that the maximum potential leachate volume arising from pore-water drainage off the disturbed wastes could be a maximum of around 2.32 m^3d^{-1}, and the dilution factor for this volume entering TNSB and estimated worst case low flow conditions of 2 ls^{-1} would be 1:74.4. The dilution factor to Eagley Brook would be considerably greater given the much larger size of this watercourse.

5.1.2. Leachate arising from freshly disturbed waste will be treated prior to discharge; this will involve settlement and aeration processes to achieve the discharge consent limits. In the event that discharge consent limits are not met then leachate will be recirculated within the lined system to allow for further filtration and settlement of organic fibres and enhanced biodegradation.

5.1.3. The proposals for treatment and reuse of New Tip wastes will require controlled dewatering within the New Tip; further details are provided in the Urbanspringside Method Statement.

5.1.4. In the long-term, no new measures are proposed or likely to be required for leachate at the Old Tip, although monitoring will be continued in accordance with proposals in section 4. The removal of all permit waste and associated residues from the New Tip means that there will be no future leachate source at this site, and no requirement for long-term management.

5.2. Surface Water Drainage

5.2.1. The New Tip is a contained system and at present surface water mixes with leachate and is either pumped to the discharge point on the TNSB culvert, or, given the absence of significant pollution, is allowed to overtop the liner and flow via the Ochre culvert to Eagley Brook.

5.2.2. During the proposed works to remove treated, recovered waste from the New Tip, no surface water drainage will be allowed to leave the lined New Tip except via a pumped or gravity drain to a settlement tank to enable monitoring prior to discharge. All discharges will take place via the consented discharge point on the TNSB culvert unless otherwise agreed. Any exceedance of agreed limits will result in either additional treatment or removal of the drainage by tanker for disposal to a treatment works.

5.2.3. Surface drainage not entering the licensed waste deposits or impacted by leachate will continue to drain to Eagley Brook, although inspections of all discharges will be carried out routinely to

ensure that silt pollution is not present. In the event that silty runoff is observed then drainage will be temporarily impounded to allow settlement before any discharge of the clarified water.

5.2.4. The removal of the sludges and lined cell is proposed, with re-engineering of the adjacent ash slopes and infilling of the lower TNSB valley with inert soil and rock to create a stable landform to support planned development. The geotechnical engineering design of this has been carried out, with key considerations being the reduction of slope angles to increase the factor of safety, and the provision of groundwater drainage in the base of the valley to avoid any disturbance to the existing hydrogeological regime.

5.3. Dust

5.3.1. The sites occupy sheltered locations within a valley and with tree surrounds. There are no sensitive receptors with respect to windblown fugitive dust within 100m of potential sources.

5.3.2. The paper wastes are damp and do not give rise to dust emissions when handled. Haul roads are largely hard-surfaced and track-out and dust raising by haulage is considered unlikely. In the event that mud, or dust accumulates on haul road surfaces than these will be cleaned and damped down by bowser as necessary.

5.4. Odour

5.4.1. Disturbance of the paper waste can release airborne odour, however during recent movement of the New Tip contents to promote drainage within the lined cell, odours were not noticeable at distances of >50m from the source. Odours tend to be released from the recently exposed waste surfaces but rapidly diminish within several minutes as volatile substances are dispersed.

5.4.2. The nearest potentially sensitive receptors to odour outside the site are users on the footpath close to the New Tip, where any exposure to odour would be transient at worst, and residences at over 150m to the northwest and southwest, up-wind in the prevailing wind directions.

5.4.3. It is considered that odour nuisance outside the site is highly unlikely to occur. However, Urbanspringside will establish monitoring procedures and working rules to minimise odours in the event that these might cause nuisance or complaint outside the site. Mitigation measures may include:

- stopping works and covering over odour sources until conditions abate / wind directions change;
- limiting waste movements to reduce source areas;
- deployment of odour suppressing mist sprays / chemicals

5.4.4. Further details are provided in the Urbanspringside method statement.

5.5. Litter / Vermin

5.5.1. The wastes do not contain litter or foodstuffs. There are no requirements for litter or pest control.

5.6. Accidents / Fire

5.6.1. The closure operations will be covered by an Urbanspringside Health and Safety Plan and Risk Assessment.

5.6.2. Key risks are considered to be physical hazards arising from the use of earth-moving machinery on soft unstable surfaces and slopes. Due regard will be paid to ground stability and safe working practices.

5.6.3. Wastes and other soil-forming materials to be handled during the works are likely to be in a damp condition and not form a fire risk. Vegetable matter generated as a result of clearance works, or used to form part of the Old Tip cover will be temporarily placed in small heaps that are not subject to excessive heating and fire risk. No burning will be permitted on site.

5.6.4. The polymer landfill liner from the New Tip will be removed and stored in a location that is remote from possible ignition sources or other flammable materials pending, shredding and or disposal off-site.

6. Restoration Plan

6.1. New Tip

6.1.1. Proposed restoration contours for the New Tip are shown in the drawing in Appendix E associated with the site redevelopment planning consent. These require the infilling of the lower TNSB valley, including the New Tip footprint with a combination of re-graded suitable fill materials from the adjacent slopes and imported inert wastes.

6.1.2. The restoration of the east-facing slope is subject to detailed landscaping proposals prepared by Appleton Associates and ERAP as part of the planning consent for restoration of the New Tip. The slope angles are designed to merge with the natural valley sides of Longworth Clough, and surface runoff / gullying will be mitigated by use of horizontal terraces across the slopes, with land drains directed to the southern side via a catchpit before discharge to the existing millrace.

6.1.3. The upper surface of the infilled valley will have a shallow slope to promote drainage and restoration to amenity grassland, although the long-term proposal is for residential development.

6.1.4. Given the proposed after-uses of the restored site, it is unlikely that topsoil will be used due to the preference for use of lower fertility subsoils in keeping with the setting. The upper surface of the fills will therefore use selected materials to include stony clay subsoils free from extraneous materials such as brick and concrete. The finished slope will be progressively restored to vegetation with an initial stabilising grass cover using hydroseeding techniques.

6.2. Old Tip

6.2.1. The Old Tip is currently uncapped, with partial natural vegetation colonisation, and areas of bare waste, standing water and dead trees. Initial works have partly cleared the existing scrub vegetation to allow for reshaping and later placement of a landfill cover across the site. Stripping and re-grading works will be carried out by suitable equipment possibly needing "Bogmaster" type excavators to form stable working areas across the softer deposits.

6.2.2. An impermeable cap would not maintain or improve the quality of water surrounding the site, which is demonstrably in satisfactory condition and unlikely to deteriorate in the future. An impermeable cap would be undesirable with respect to landfill gas control as this would increase risks of lateral migration, and would probably have a limited life due to anticipated future settlements of the soft paper waste fills. An impermeable cap would necessitate the construction of a gas drainage blanket, and would concentrate flows of landfill gas to a number of vents which would nevertheless have insufficient flow to sustain flaring or power generation, but would make treatment of the gas by methane oxidation more difficult.

6.2.3. The restoration design therefore centres upon the construction of a permeable cover system that enhances natural methane oxidation within an aerobic soil layer.

6.2.4. Proposed restoration contours for the Old Landfill are shown in the drawing in Appendix E. These involve some limited cutting of materials on the highest part of the site, and re-grading and lifting of levels to a minimum of 194m aod, considered necessary to maintain the cover system above the local water table near to the Lodge dam.

6.2.5. The landform to be created forms a saddle with slopes of around 1 in 12 to the east and west. Following placement of the landfill cover / bio-oxidation system, as described in section 4, the site will be restored to a combination of amenity grassland and native tree / shrub planting.

6.2.6. The earthworks model produced by Daineswell Ltd and MCK Associates Ltd. on behalf of Urbanspringside of the cut and fill operation to achieve the design will require a minimum net fill of approximately 6,000m^3 of various cover materials; the tip area enclosing paper wastes and needing restoration is about 6,255m^2. The approximate volumes of cover materials required are estimated to be:

- 940 m^3 topsoil or suitable soil-forming material;
- 3,440 m^3 organic-rich permeable soil as bio-oxidation layer;
- 1,880 m^3 coarse granular gas drainage layer (screened low fines hardcore / clinker of median 5mm particle size – fine/medium gravel)
- ~ 3,000 m^3 cement-stabilised effluent treatment sludge to provide working surface / raise levels above water table.

6.2.7. Long-term settlement of the restored Old Tip is to be expected, principally within the area of softer paper wastes in the west of the site; short term stability during the works will be improved by a woven, fully permeable geotextile matting over the formation. Over-filling of cover materials will therefore be desirable to avoid potential future water-logging of the lower area in the west, and consequent reduction in air entry to the cover and reduced methane oxidation potential. Sludges below the central part of the Old Tip are denser and have been subject to consolidation and surcharge by the placing of inert construction and demolition wastes; this part of the site was latterly used for parking and storage, and settlement monitoring has demonstrated minimal ground movement over the last few years.

6.3. Treatment of New Tip Wastes

6.3.1. New Tip wastes have over the last 12 months been subject to works to enhance self-drainage within their lined cell, by relocating the sludges in the lowest, eastern part of the cell to the higher part of the cell in the west. This has facilitated gravity drainage of leachate, and has resulted in a reduction in water content and consequential shrinkage of the waste volume and mass.

However, the sludge remains in a soft condition that constrains handling and reuse without additional treatment.

6.3.2. It is therefore proposed to treat the New Tip sludge wastes by means of cement stabilisation techniques by a specialist contractor, Urban Soils Solutions Ltd., to reduce water contents, improve physical stability, and reduce the leachate potential. This operation will be carried out in situ within the New Tip lined cell area, and will involve batch mixing waste with the reactive agents, and curing before the treated material can be removed and transported to the Old Tip for use in restoration. The stabilised treated waste is non-polluting, more permeable and has a higher bearing capacity than the untreated sludge, making it well suited to the purpose of providing a base layer to the cover system for the Old Tip.

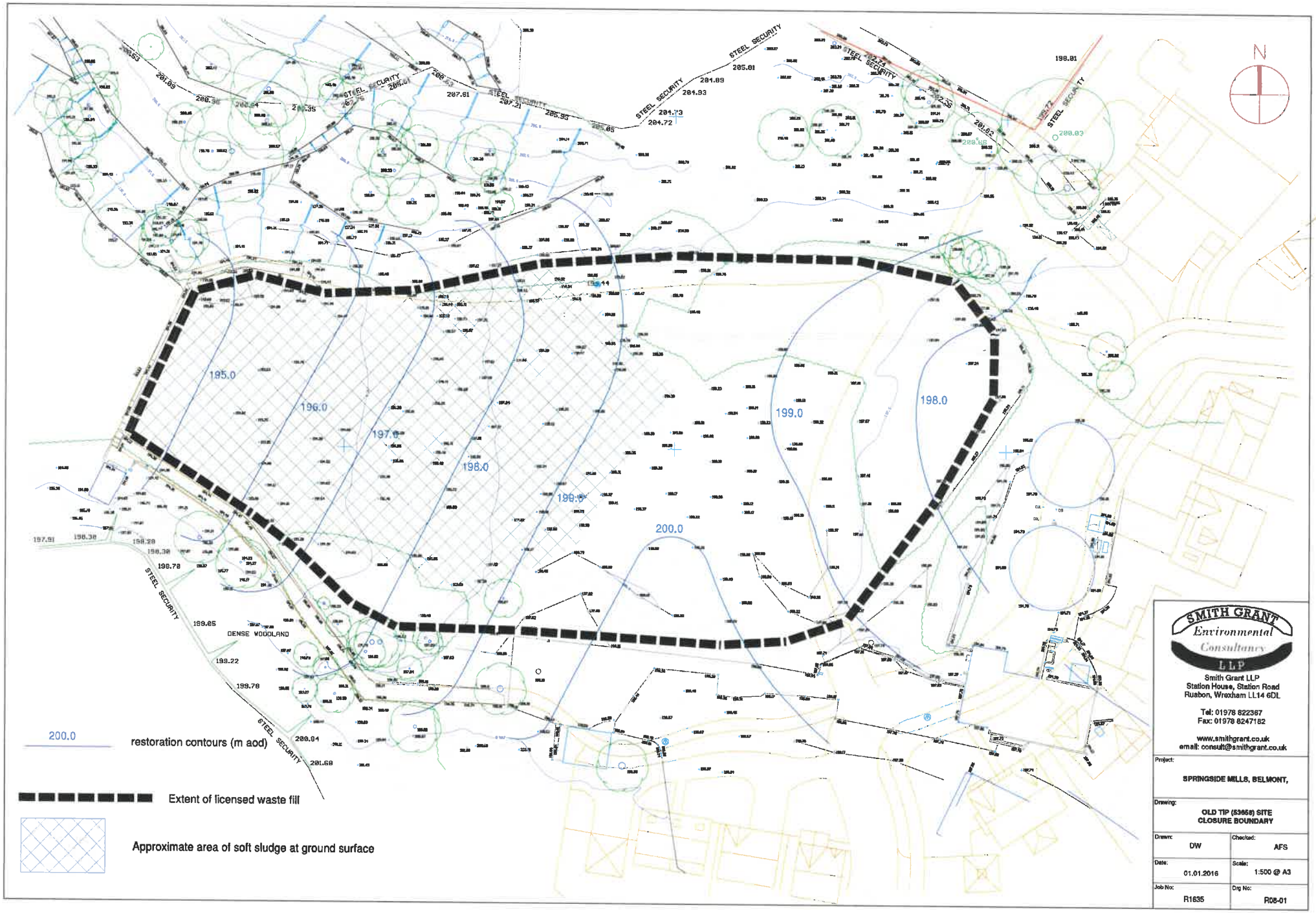
6.3.3. Within the Old Tip, the placing of recovered stabilised New Tip sludge as the lower part of the restoration cover is considered unlikely to cause any significant change in the underlying 5-10m thickness of existing waste, however the monitoring plan is designed to record any change so that mitigation measures can be taken if necessary. The treated stabilised sludge will be relatively permeable to gases compared to the underlying material, and therefore no increase in lateral gas migration as a result of the cover placement is considered likely.

6.4. Supply Lodge Wall

6.4.1. The Supply Lodge wall has received an Engineers inspection by Reid Jones Partnership on behalf of Urbanspringside; their report is included as Appendix F. The upper brick section of the wall (above standing water levels) is reported to be permeable to water and will be removed in its entirety leaving the top of the structure some 200mm higher than normal dry weather levels in the supply lodge.

6.4.2. The restoration of the Old Tip will lend support to the Supply Lodge wall. It is proposed to buttress the east face of the dam by the placing of granular fill in this area, to displace the saturated and very weak paper waste currently lying against the wall. The ground level to be formed adjacent to the wall will be about 700mm higher than the existing ground level and will be flat for a distance of 2m before rising east as the general landfill cover. On the Lodge side of the dam, it is proposed to create a 1v:2h slope down by means of placing coarse rock fill; this will provide additional protection, improve public safety and amenity value.

DRAWINGS



SMITH GRANT Environmental Consultancy LLP
Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL
Tel: 01978 822367
Fax: 01978 824782
www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:	SPRINGSIDE MILLS, BELMONT,
Drawing:	OLD TIP (53658) SITE CLOSURE BOUNDARY
Drawn: DW	Checked: AFS
Date: 01.01.2016	Scale: 1:500 @ A3
Job No: R1635	Drg No: R08-01

Extent of licensed waste fill

195.0

Proposed restoration and development contour (m aod)

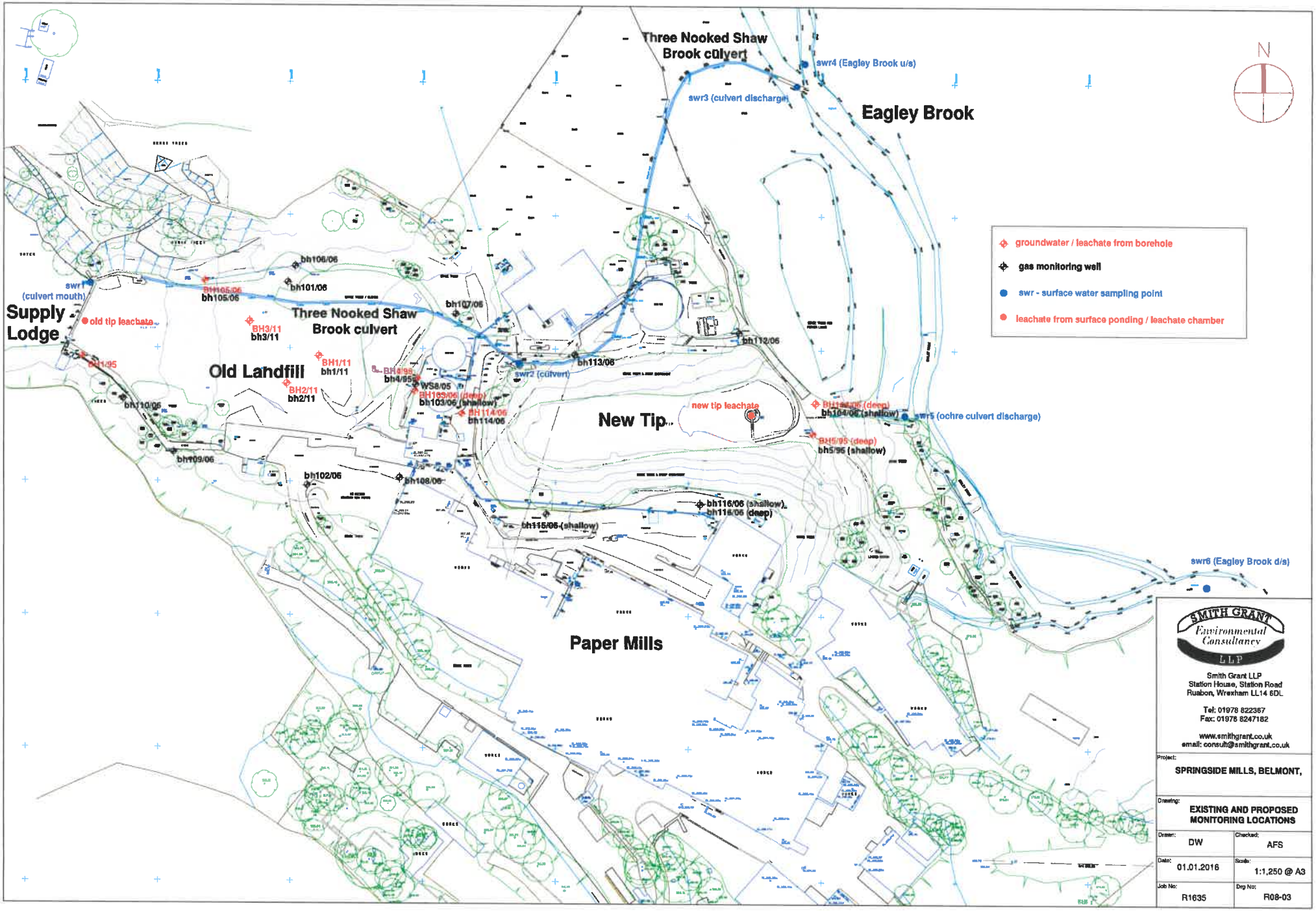
SMITH GRANT Environmental Consultancy LLP

Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL

Tel: 01978 822367
Fax: 01978 8247162

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:	**Springside Mills, Belmont**
Drawing:	**New Tip (53997) Site Closure Boundary**
Drawn: **go**	Checked: **ats**
Date: **03/01/2016**	Scale: **1:1,000 @ A3**
Job No: **R1635-R08**	Drg No: **R08-02**



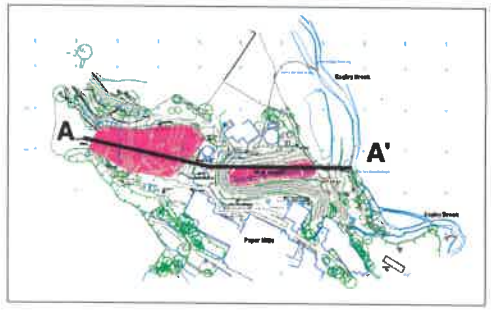
SMITH GRANT Environmental Consultancy LLP

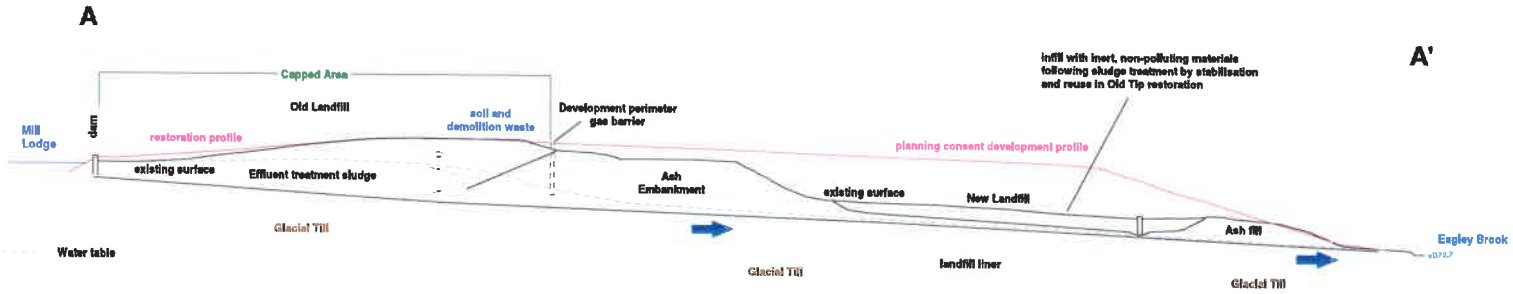
Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL

Tel: 01978 822367
Fax: 01978 8247182

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

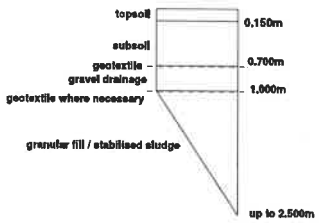
Project:	SPRINGSIDE MILLS, BELMONT,
Drawing:	EXISTING AND PROPOSED MONITORING LOCATIONS
Drawn: DW	Checked: AFS
Date: 01.01.2016	Scale: 1:1,250 @ A3
Job No: R1635	Drg No: R08-03





existing drainage flows to be maintained

Old Tip Capping Detail



SMITH GRANT Environmental Consultancy LLP

Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL

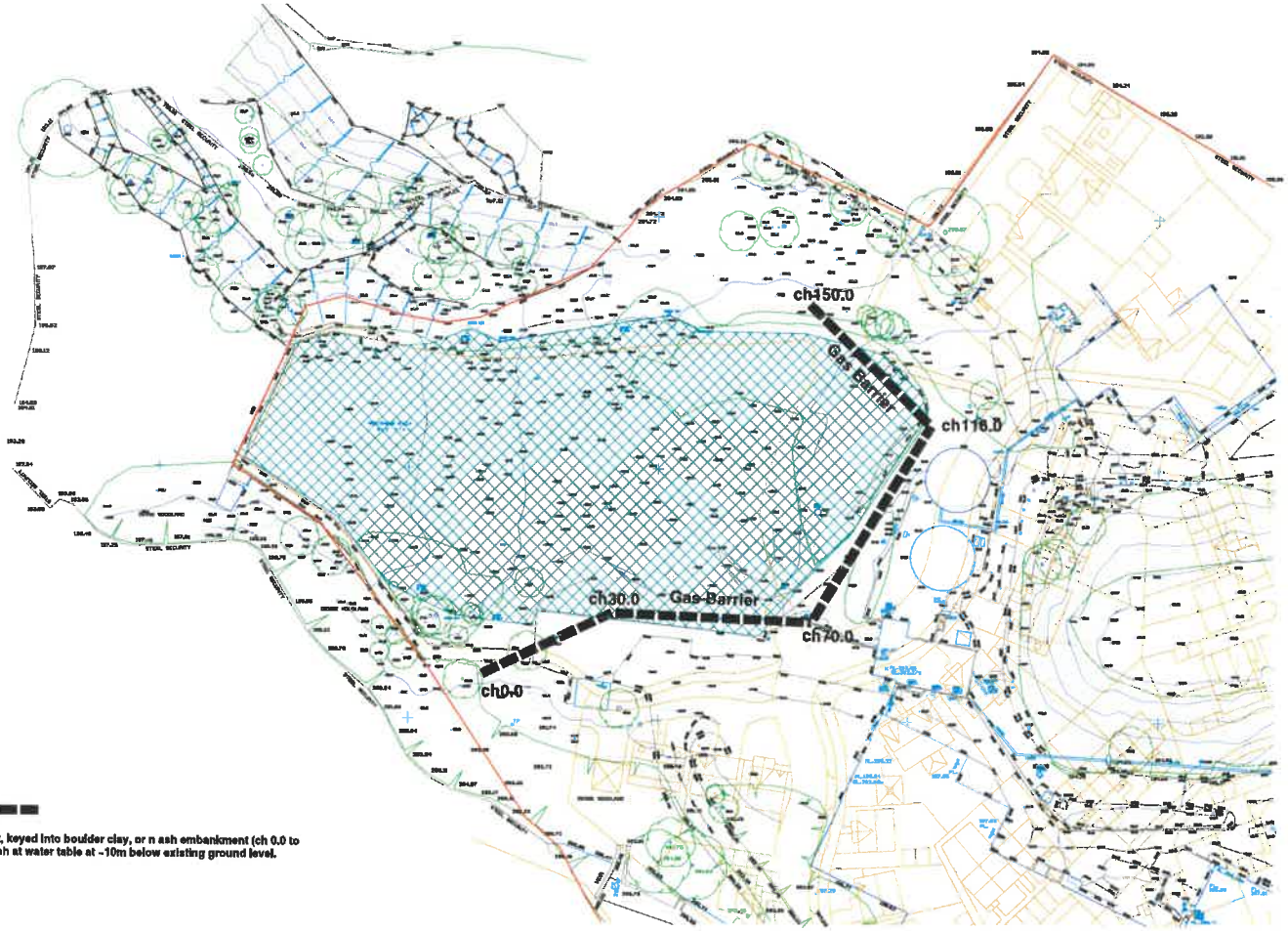
Tel: 01978 822387
Fax: 01978 8247182

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:
Springside Mills, Belmont

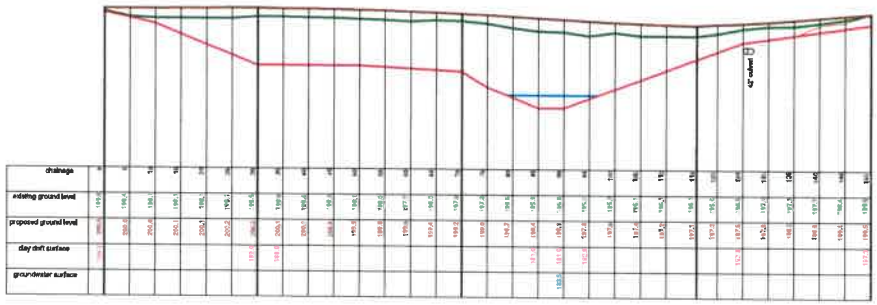
Drawing:
Restoration Section and Old Tip Cover Detail

Drawn:	Checked:
gc	afs
Date: 06/06/16	Scale: 1:1250 @ A3
Job No: R1635 R08	Drg No: R08-04



barrier alignment, keyed into boulder clay, or n ash embankment (ch 0.0 to ch 100.00) into ash at water table at -10m below existing ground level.

Gas Barrier - Extended Section



SMITH GRANT Environmental Consultancy LLP

Smith Grant LLP
Station House, Station Road
Ruabon, Wrexham LL14 6DL

Tel: 01978 822367
Fax: 01978 8247182

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:	Springside Mills, Belmont
Drawing:	Old Tip Landfill Gas Management Plan
Drawn: gc	Checked: sfs
Date: 03/01/2016	Scale: 1:1,000 @ A3
Job No: R1635-R08	Drg No: R08-05

APPENDIX A

Summary of Closure Plan Technical Requirements

Springside Mill, Belmont (former Kruger Paper)
Landfill Closure Report - Technical Requirements (EPR 5.02)

Landfill closure report template		**Old Tip (53658)**	**New Tip (53997)**
	Submission	Details of evidence submitted	Details of evidence submitted
Area of site progressing to definite closure - site plans	a) proposed closure area	closure area is entire permit site; **Site Plan, drawing ref: R08-01,** 1:500 scale, 19/01/2016; uncompleted landfill: no site plan is attached to Permit; boundary of paper sludge waste determined by investigation	closure area is entire permit site; **Site Plan, drawing ref: R08-02,** 1:1000 scale, 19/01/2016; uncompleted landfill; no site plan attached to Permit; boundary of paper sludge waste defined by limit of cell liner
	b) gas control system	refer to landfill gas risk assessment **report R1635-R02** and **drawing ref: R08-04, 19/01/2016**; showing alignment of proposed perimeter gas vent, and sections of vent system and landfill cover / methane oxidation layer; note no gas extraction system installed to date or required under current permit; future gas management will be via passive venting and biological oxidation	**Not Applicable** no gas extraction system installed or required under current permit; no future requirement for gas control due to total removal of degradable waste
	c) leachate extraction system	no permanent leachate collection system or leachate wells in operation - leachate was intermittently pumped from surface water pond, as shown on **dwg R08-01**, to surface water discharge point (consent ref: NPSWQD006635)	leachate pumped from central collection chamber via pipeline to surface water discharge point (consent ref: NPSWQD006635) - **see drawing R08-02.** Leachate extraction system to be removed in association with removal of all leachate sources
	d) surface water management system	refer to hydrogeological risk assessment **report R1634-R01;** no system currently in place - rainfall either infiltrates or runs off to west (Mill Lodge) or east (ash embankment); groundwater discharges on north and south sides of landfill flow across landfill west to Mill Lodge; in future, surface runoff from restored tip and peripheral spring discharges to be directed to tip perimeter drains, as per **drawing R08-01.**	refer to hydrogeological risk assessment **report R1634-R01;** rainfall on tip surface passes to leachate collection; future drainage arrangements during restoration of New Tip described in URL report and **drawing R08-02.**
	e) location of extraction and monitoring wells	extraction well locations - see b) and c) responses; monitoring wells - existing and proposed shown on **drawing R08-03**	extraction well locations - see b) and c) responses - existing and proposed shown on **drawing R08-03**
Waste Stability		final (existing) level survey drawing; refer to stability assessment **report R1635-R04**; settlement rate data indicates low settlement; cover placement may induce short-term increased settlement under loading	final (existing) level survey drawing; refer to stability assessment **report R1635-R04**; existing wastes to be physically treated (cement solidification/ stabilisation) prior to removal; inert backfills to be placed under geotechnical specification for purpose of supporting development

Landfill closure report template		Old Tip (53658)	New Tip (53997)
Site infrastructure	leachate infrastructure	portable pump and pipework to be removed during restoration works	sump and pump to be retained and operated during waste treatment and removal; following removal of all waste contents and liner, the site will be infilled, commencing at the eastern side, to form a central low area to collect surface runoff; a pump will be temporarily operated as filling proceeds and when necessary to remove accumulated rainfall; drainage water will be pumped to a settlement tank to south prior to discharge to the existing mill race; all infrastructure will be removed on completion of the site restoration
	leachate infrastructure maintenance	not required following restoration	not required following restoration
	landfill gas infrastructure	surface (passive) venting of gas barrier via bollards; bio-oxidation in landfill cover	not required following restoration
	landfill gas infrastructure maintenance	restored Old Tip cover and gas venting to be subject to routine inspection and maintenance by landscape management company	not applicable
	groundwater infrastructure	none present – not applicable	existing under-cell drainage / Ochre culvert to remain unchanged
	groundwater infrastructure maintenance	see under New Tip for down-gradient drainage	Ochre culvert discharge for groundwater to be maintained by landscape maintenance company
	surface water infrastructure	perimeter drains and Lodge Dam – see drg R08-01	none present; development drainage will subject to separate engineering by developer, with adopted sewers
	surface water infrastructure maintenance	subject to routine inspection and maintenance by landscape management company	surface runoff drains subject to routine inspection and maintenance by landscape management company;
	cap maintenance	aftercare maintenance procedures, including repairs to cap soils and vegetation, and treatment of localised subsidence / instabilities	not applicable – waste to be removed and no residual permit waste to cap
Monitoring	leachate monitoring	refer to section 3.0 RBMP	refer to section 3.0 RBMP
	landfill gas monitoring	refer to section 3.0 RBMP	refer to section 3.0 RBMP
	groundwater monitoring	refer to section 3.0 RBMP	refer to section 3.0 RBMP
	surface water monitoring	refer to section 3.0 RBMP	refer to section 3.0 RBMP
	restored surface monitoring	refer to section 3.0 RBMP	not applicable following closure survey and report
Reporting	significant environmental effects	procedure for assessing and reporting significant groundwater, surface water, gas or stability impacts	not applicable following closure survey and report

Landfill closure report template		Old Tip (53658)	New Tip (53997)
Habitats	Habitats Directive site review	ecological monitoring to ensure no impact on Habitats Directive sites (Longworth Clough SSSI) in accordance with planning condition; impacts unlikely assuming that no discernible pollution to Eagley Brook, and no pathway for pollutants to Longworth Clough	not applicable following closure survey and report

APPENDIX B

New Tip Treatability Testing

Springside Mills, Belmont; New Tip Paper Waste

Skip Trial Notes

June 2014

Introduction

Proposals to drain and re-locate the paper mill effluent treatment sludges ("paper waste") from the New Tip raise questions over the possible quality, quantity and management requirements for any water emissions from the waste. There has been in situ leachate monitoring within the body of the New Tip landfill given its shallow depth (typically around 3m), and all leachate monitoring has been from a central collection sump where dilution by surface runoff and oxidation through atmospheric exposure has occurred. All monitoring to date has shown that the leachate has met consent limits for discharge to Three Nooked Shaws Brook, with the occasional exception of suspended solids, apparently arising from the formation of iron oxyhydroxide (ochre) flocs.

The paper waste is wet and unsuitable for re-location or recovery unless the moisture is reduced. This is partly due to the low permeability of the material and its containment which inhibits drainage under gravity. The paper waste has a spongy and cohesive consistency, and drainage of excess porewater is expected to be at a slow rate.

A trial was therefore devised to assess the potential worst case quality and quantity of leachate that might be drained from the waste in the initial stages of its' proposed re-location.

Methodology

Two bulk samples were collected on 19th May 2014 from locations within the central axis of the New Tip at locations near to standing water in the lower part of the site, near to the leachate sump ("skip 1") and about 30m to the west in the upper part of the site. Both locations were covered by vegetation mats which were stripped away using a long-boom 360° excavator located outside the lined cell. Paper sludge was collected from depths of between 1 and 2.5m using a smooth bucket, taking care not to intercept the basal liner. The waste samples were placed in a dumper for immediate transport and unloading to steel builders skips located on car parking near to the Old Tip.

Sub-samples of the skip 1 and skip 2 wastes were collected for laboratory analysis, and were placed in appropriate containers, and transported to the laboratory (Jones Environmental) in a chilled cool-box within 6 hours. Analysis was carried out for pH, ammonia, sulphate, sulphide, organic matter and volatile organic compounds (VOCs).

The skips were lined with PE membrane to be water tight, and were of nominal 6 cubic yard size. Washed rounded gravel was placed in the base of the skips to provide a drainage layer, and was sloped to a collection point in one corner, equipped with a 50mm HDPE slotted standpipe to permit leachate sampling. Skip 1 was filled with approximately 3.7m^3 of waste and skip 2 with approximately 3.3m^3 of waste; both skips contained 900mm depth of settled paper waste. The waste was lightly compacted by excavator bucket to eliminate air pockets, and the plastic sheet was extended over the top of the skips to prevent evaporation and rainfall entry.

Leachate samples were collected by peristaltic pump from the standpipes of each skip on 28th May 2014, 9 days after filling. Field measurements of pH, temperature, dissolved oxygen, electrical conductivity and oxidation-reduction potential were made, and samples were placed in containers supplied by the laboratory. The samples were stored in a chilled cool-box and delivered to the laboratory (SAL) within 3 hours of collection.

Laboratory analysis was carried out for pH, a range of metals, ammonia and oxidised nitrogen, chemical oxygen demand (COD), chloride, sulphide, sulphate, VOCs and semi-volatile organic compounds (SVOCs).

The skips were covered over again after sampling. A second round of pumped removal of leachate was carried out on 12th June 2014, 17 days after filling of the skips, on this occasion the volume of leachate removed from each skip to drain down the standpipe contents and any water sitting on the waste surface was recorded.

The skip trial will continue until the extractable leachate volume alters significantly, at which point the waste contents will be removed back to the landfill.

Skip 2 leachate sampling, 28/05/14

Skip 1 leachate, 28/05/14

Skip 1 leachate, 12/06/14

Skip 2 leachate, 12/06/14

Observations

The waste was notably softer and wetter in the skip 2 sampling position than at skip 1 position; this may be due to the down-hill waste being older and more consolidated, despite the water table being effectively at surface. Skip 1 material when squeezed by hand would leave a damp surface, whereas some drops of leachate could be squeezed from the skip 2 material. Neither test pit showed water/ leachate entry, although skip 2 pit quickly slumped. A moderate organic odour was noted, although the wastes remained a uniform light grey colour, and the odour was undetectable more than 10m from the excavations. The sides of the skip1 pit were relatively stable, with minor slumping at about 2m depth over a period of half an hour.

During leachate sampling on 28th May, a small volume of water/leachate was noted in the corner of the skip on the waste surface. This was identical to the leachate removed from the standpipe and was a light milky grey colour and with a moderate organic odour. The field measurements were as follows:

	Skip 1	Skip 2
temperature °C	13.1	13.0
pH	6.59	6.32
dissolved oxygen mg l^{-1}	5.16	7.52
redox ORP mV	-21.3	-10.1
electrical conductivity µs cm^{-1}	10010	10400

The volumes of leachate present and removed were as follows:

day	date	Skip 1	Skip 2
0	19th May 2014	0	0
9	28th May 2014	15 removed during sampling	15 removed during sampling
24	12th June 2014	28 removed over 15 mins to "dry"	42 removed over 15 mins to "dry"

Volumes in litres

The volume of free liquid leachate generated within the skips averages 0.78 l/m^3 waste/day (based on leachate removed between 28th May and 12th June). Scaled up to the full landfill contents, this would be 2.34 m^3/d, although drainage would not occur simultaneously from all of the waste, and the rate of drainage will quickly reduce as excess pore water is released. However using the above figure, which is 23% of the discharge consent limit, the calculated dilution rate during low dry weather flow within TNSB, estimated at 2 l/s, is 1:74. This calculation does not include storm runoff, which would add to volumes but would reduce concentrations, both within the leachate, and within the receiving water due to increased baseflow.

Test Results

Solid waste

Solid waste analyses are presented on Jones Environmental certificate reference 14/5930. Moisture content was recorded as 114% and 175% for skips 1 and 2 respectively, relative to dry weight, i.e. 53% and 64% respectively of fresh weight. For comparison, the typical water content for similar paper wastes being spread to farmland is around 40% fresh weight.

pH was slightly alkaline in both samples, reflecting the lime content. Organic matter was 11.2% and 15.5% of the dry weight, forming a relatively small fraction of the waste, the remainder being mineral matter. Sulphide concentrations were below the limit of detection. Ammoniacal nitrogen concentrations were 0.04 and 0.09% for skips 1 and 2 respectively, indicating a probable carbon:nitrogen ratio in the waste of >>50, although total nitrogen was not analysed; the low ammoniacal nitrogen content would suggest a significant constraint on bio-degradation of the organic content of the waste.

VOC analysis revealed a range of non-chlorinated mainly aromatic hydrocarbons together with some alkanes. These are likely to be natural constituents or breakdown intermediates from wood pulping residues including lignin and resins. Substances detected in excess of 1 mg/kg are summarised below:

substance	skip 1	skip 2	substance	skip 1	skip 2
toluene	<1.0	18.8	2,6-dimethyloctane*	1.1	1.7
ethylbenzene	<1.0	1.0	decane*	<1.0	12.5
p/m-xylene	2.9	6.1	1-ethyl-2-dimethylbenzene*	<1.0	5.0
o-xylene	1.3	2.7	1,2,3-trimethylbenzene*	1.4	<1.0
isopropylbenzene	<1.0	1.1	1-methyl-3-propylbenzene*	<1.0	1.7
propylbenzene	2.3	2.5	undecane*	<1.0	5.5
1,3,5-trimethylbenzene	1.8	6.3	o-cymene*	1.4	<1.0
sec-butylbenzene	1.2	1.3	4-ethyl-1,2-dimethylbenzene*	<1.0	2.0
4-isopropyltoluene	<1.0	1.7	1-ethyl-2,3-dimethylbenzene*	1.1	<1.0
n-butylbenzene	3.9	4.5	1,3-diethyl-5-methylbenzene*	1.9	1.4
naphthalene	9.7	17.2	dodecane*	3.6	7.2
ethyl-cyclohexane*	1.7	2.5	2,6-dimethylundecane*	1.5	3.1

* tentatively identified compound

The results indicate generally higher concentrations in the skip 2 compared to skip 1 wastes, probably related to the relative age of the deposits.

In total, the identified aromatic compounds amount to 40 mg/kg in skip 1, and 93 mg/kg in skip 2. Identified aliphatic compounds amount to 7 and 31 mg/kg respectively. The concentrations found are not acutely hazardous to human health, and would not exceed the long-term generic assessment criteria (LQM/CIEH edition 2, 2009; 6% soil organic matter) for the protection of human health if permanently present at shallow depth within residential land (aliphatic hydrocarbons C6 – C16 fractions, and aromatic hydrocarbons C7 – C16 fractions) with the exception of naphthalene. Naphthalene concentrations in both samples exceed the residential GAC (8.7 mg/kg at 6% organic matter) but are considerably below the commercial / industrial generic assessment criteria.

The above compounds are generally likely to be semi-volatile and strongly absorbed to clays and organic matter within the waste. All are expected to be non-persistent and readily bio-degradable by a range of bacteria and fungi. The principle modes of attenuation are likely to be via volatilisation and microbial assimilation which will be determined largely by drainage and aeration and the availability of macro-nutrients.

Leachate

Sample test results are presented on SAL certificate reference 398245-1. The test results are considered to be representative of pore water released during settlement of the freshly disturbed waste, and may therefore represent "worst case" concentrations of substances likely to be released during and immediately following re-location of the New Tip contents. The results are based on total analysis rather

than only dissolved substances and metal concentrations will be unrepresentative of the potential concentrations in a settled discharge.

The chemical oxygen demand (COD) was high, at 19,000 and 24,000 mg/l for skips 1 and 2 respectively, compared to a typical guideline of 30 mg/kg in discharge consents; the high COD probably reflects the presence of fine organic matter (cellulose fibre) suspended in the pore water, as the concentrations of other chemical substances and the mineral content are unlikely to contribute significantly.

Ammoniacal nitrogen concentrations were above the existing leachate discharge consent limit of 5 mg/l in skip 1, at 16 mg/l, but was low in skip 2 at 0.9 mg/l; the difference between the results is not readily explained, however the overall results are considered to be low compared to a typical non-hazardous waste landfill, and there is little doubt that the consent standard would be achieved following aeration and settlement of the leachate.

Metals concentrations were elevated with respect to EQS values, however the discharge consent standards for cadmium (10 µg/l) and mercury (2 µg/l) were achieved, and, where dilution in the receiving waters (TNSB or Eagley Brook) is accounted for (worst case 1:115), then no EQS is likely to be exceeded with the exception of phenol. The short term (95%ile) EQS for phenol of 46 µg/l would not be exceeded in TNSB, although the long term (annual average) of 7.7 µg/l could be theoretically exceeded, although of course the elevated concentrations are expected to be of short duration, and treatment of the leachate would reduce phenol concentrations alongside the more significant issue relating to suspended solids / COD.

The range of VOCs / SVOCs detected largely reflects the solid analysis, being dominated by methylphenol (cresol) and phenol, toluene, xylenes and trimethylbenzene. No naphthalene was detected, confirming the strong absorption of this substance. One chlorinated compound, chlorotoluene, was detected at a low level of 5 µg/l in both samples.

The key test results together with comparisons against water quality standards are summarised below:

TNSB dw flow	2	l/s	172.8	m3/d	dilution factor TNSB DW flow / max leachate flow	73.85

substance	skip 1	skip 2	Discharge Consent	EQS	other	max predicted conc in TNSB
cadmium	2	2.3	10			0.031
mercury	0.29	0.55	2			0.007
phenol	110	1300		7.7LT 46ST		17.604
methylphenol (cresol)	9400	16000			330 ST (10% of salmon LC50)	216.667
1,2,4 trimethylbenzene	39	43				0.582
1,3,5 trimethylbenzene	12	13				0.176
2-chlorotoluene	5	5			15 (chloro-benzene)	0.068
ethylbenzene	9	5		10LT (benzene)		0.122
isopropylbenzene	4	3				0.054
n-propylbenzene	14	7				0.190
m/p-xylene	30	18		30LT		0.406
o-xylene	22	15		30LT		0.298

substance	skip 1	skip 2	Discharge Consent	EQS	other	max predicted conc in TNSB
p-isopropylbenzene	2	2				0.027
s-butylbenzene	3	3				0.041
toluene	61	190		50LT 380ST		2.573

Concentrations in µg/l; predicted concentrations in TNSB assume negligible background concentrations.

Conclusions

Leachate from the New Tip has consistently met the discharge consent requirements apart from an occasional exceedance of suspended solids levels, attributed to the formation of iron flocs, although leachate is visibly clear during discharge. However there is concern that the satisfactory leachate quality could be changed as a result of disturbance of the wastes during the clearing of the New Tip contents.

The skip trial has provided useful information concerning the potential volume and quality of leachate (pore water) that could be released during, and in the short term following, disturbance and re-location of New Tip wastes. The leachate flows, in the absence of inputs from rainfall, draining under gravity or as a result of increased pore pressure from compaction, are likely to be small and readily contained without risk of uncontrolled release to the nearby surface watercourses.

The principal concerns relate to the high chemical oxygen demand and suspended solids content of the undiluted leachate, together with initial concentrations of phenol and cresol in particular. The testing is believed to represent a worst case scenario, and the quality of actual leachate escaping from the waste is unlikely to sustain the same high levels of COD over time. Nevertheless, the test results confirm a requirement for collection and treatment of fresh leachate before discharge. This process should continue until flows and concentrations are sufficiently diminished and the waste is physically stable enough to allow removal from the liner.

The Contractors method statement provides for internal drainage of leachate towards the eastern lower end of the New Tip within the lined cell, pending pumping to the reinstated filter bed. This will facilitate aeration of the leachate and settlement to reduce suspended solids and consequent oxygen demand to acceptable limits. Whilst COD is not specified within the current discharge consent, the limit for biological oxygen demand (BOD) of 20 mg/l should be readily achievable by these means (typically, a COD value of 30-40 will correlate with a BOD of 20).

In the medium term, temporary storage of the drained waste on the Old Tip would not generate significant additional loadings of pollution into the Old Tip waste body that could cause a reduction in existing Old Tip leachate quality given the relative sizes of the waste masses. However, the prevention of surface runoff to the Supply Lodge would be important until the waste is stabilised.

A further round of leachate analysis and volume measurement is being carried out before ending the trial, at which time the skip contents will be returned to landfill and the equipment cleaned and decommissioned.

Jones Environmental Laboratory

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

Smith Grant LLP
Station House
Station Road
Ruabon
Wrexham
LL14 6DL

Attention :	Tony Smith
Date :	30th May, 2014
Your reference :	R1635
Our reference :	Test Report 14/5930 Batch 1
Location :	
Date samples received :	19th May, 2014
Status :	Final report
Issue :	1

Two samples were received for analysis on 19th May, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Phil Sommerton BSc
Project Manager

Bob Millward BSc FRSC
Principal Chemist

Jones Environmental Laboratory

Client Name: Smith Grant LLP
Reference: R1635
Location:
Contact: Tony Smith
JE Job No.: 14/5930

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	1-2	3-4									LOD/LOR	Units	Method No.
Sample ID	NTW1	NTW2											
Depth													
COC No / misc													
Containers	T V	T V											
Sample Date	19/05/2014	19/05/2014											
Sample Type	Soil	Soil											
Batch Number	1	1											
Date of Receipt	19/05/2014	19/05/2014											
Total Sulphate [#M]	678	601									<50	mg/kg	TM50/PM15
VOC TICs	See Attached	See Attached										None	TM15/PM10
Natural Moisture Content	113.8	174.7									<0.1	%	PM4/PM0
Ammoniacal Nitrogen as N	372.2	864.5									<0.6	mg/kg	TM38/PM20
Organic Matter	11.2	15.5									<0.2	%	TM21/PM24
Sulphide	<10	<10									<10	mg/kg	TM106/PM45
pH [#M]	7.95	7.55									<0.01	pH units	TM73/PM11

Please see attached notes for all abbreviations and acronyms

Client Name: Smith Grant LLP
Reference: R1635
Location:
Contact: Tony Smith
JE Job No.: 14/5930

VOC Report : **Solid**

J E Sample No.	1-2	3-4											
Sample ID	NTW1	NTW2											
Depth													
COC No / misc													
Containers	TV	TV											
Sample Date	19/05/2014	19/05/2014											
Sample Type	Soil	Soil											
Batch Number	1	1											
Date of Receipt	19/05/2014	19/05/2014											

Please see attached notes for all abbreviations and acronyms

												LOD/LOR	Units	Method No.
VOC MS														
Dichlorodifluoromethane	<2	<2										<2	ug/kg	TM15/PM10
Methyl Tertiary Butyl Ether #	<2	<2										<2	ug/kg	TM15/PM10
Chloromethane #	<3	<3										<3	ug/kg	TM15/PM10
Vinyl Chloride	<2	<2										<2	ug/kg	TM15/PM10
Bromomethane	<1	<1										<1	ug/kg	TM15/PM10
Chloroethane #	<2	<2										<2	ug/kg	TM15/PM10
Trichlorofluoromethane #	<2	<2										<2	ug/kg	TM15/PM10
1,1-Dichloroethene (1,1 DCE) #	<6	<6										<6	ug/kg	TM15/PM10
Dichloromethane (DCM) #	<7	<7										<7	ug/kg	TM15/PM10
trans-1-2-Dichloroethene #	<3	<3										<3	ug/kg	TM15/PM10
1,1-Dichloroethane #	<3	<3										<3	ug/kg	TM15/PM10
cis-1-2-Dichloroethene #	<3	<3										<3	ug/kg	TM15/PM10
2,2-Dichloropropane	<4	<4										<4	ug/kg	TM15/PM10
Bromochloromethane #	<3	<3										<3	ug/kg	TM15/PM10
Chloroform #	<3	<3										<3	ug/kg	TM15/PM10
1,1,1-Trichloroethane #	<3	<3										<3	ug/kg	TM15/PM10
1,1-Dichloropropene #	<3	<3										<3	ug/kg	TM15/PM10
Carbon tetrachloride #	<4	<4										<4	ug/kg	TM15/PM10
1,2-Dichloroethane #	<4	<4										<4	ug/kg	TM15/PM10
Benzene #	<3	<3										<3	ug/kg	TM15/PM10
Trichloroethene (TCE) #	<3	<3										<3	ug/kg	TM15/PM10
1,2-Dichloropropane #	<6	<6										<6	ug/kg	TM15/PM10
Dibromomethane #	<3	<3										<3	ug/kg	TM15/PM10
Bromodichloromethane #	<3	<3										<3	ug/kg	TM15/PM10
cis-1-3-Dichloropropene	<4	<4										<4	ug/kg	TM15/PM10
Toluene #	626	18776 ++										<3	ug/kg	TM15/PM10
trans-1-3-Dichloropropene	<3	<3										<3	ug/kg	TM15/PM10
1,1,2-Trichloroethane #	<3	<3										<3	ug/kg	TM15/PM10
Tetrachloroethene (PCE) #	<3	<3										<3	ug/kg	TM15/PM10
1,3-Dichloropropane #	<3	<3										<3	ug/kg	TM15/PM10
Dibromochloromethane #	<3	<3										<3	ug/kg	TM15/PM10
1,2-Dibromoethane #	<3	<3										<3	ug/kg	TM15/PM10
Chlorobenzene #	<3	<3										<3	ug/kg	TM15/PM10
1,1,1,2-Tetrachloroethane	<3	<3										<3	ug/kg	TM15/PM10
Ethylbenzene #	635	1036										<3	ug/kg	TM15/PM10
p/m-Xylene #	2893	6118 ++										<6	ug/kg	TM15/PM10
o-Xylene #	1321	2733 ++										<3	ug/kg	TM15/PM10
Styrene	<3	<3										<3	ug/kg	TM15/PM10
Bromoform	<3	<3										<3	ug/kg	TM15/PM10
Isopropylbenzene #	827	1099										<3	ug/kg	TM15/PM10
1,1,2,2-Tetrachloroethane #	<3	<3										<3	ug/kg	TM15/PM10
Bromobenzene	<2	<2										<2	ug/kg	TM15/PM10
1,2,3-Trichloropropane #	<4	<4										<4	ug/kg	TM15/PM10
Propylbenzene #	2277 ++	2541 ++										<4	ug/kg	TM15/PM10
2-Chlorotoluene	<3	<3										<3	ug/kg	TM15/PM10
1,3,5-Trimethylbenzene #	1832	6335 ++										<3	ug/kg	TM15/PM10
4-Chlorotoluene	<3	<3										<3	ug/kg	TM15/PM10
tert-Butylbenzene #	<5	<5										<5	ug/kg	TM15/PM10
1,2,4-Trimethylbenzene #	4336 ++	15196 ++										<6	ug/kg	TM15/PM10
sec-Butylbenzene #	1195	1319										<4	ug/kg	TM15/PM10
4-Isopropyltoluene #	883	1736										<4	ug/kg	TM15/PM10
1,3-Dichlorobenzene #	<4	<4										<4	ug/kg	TM15/PM10
1,4-Dichlorobenzene #	<4	<4										<4	ug/kg	TM15/PM10
n-Butylbenzene #	3895 ++	4456 ++										<4	ug/kg	TM15/PM10
1,2-Dichlorobenzene #	<4	<4										<4	ug/kg	TM15/PM10
1,2-Dibromo-3-chloropropane #	<4	<4										<4	ug/kg	TM15/PM10
1,2,4-Trichlorobenzene #	<7	<7										<7	ug/kg	TM15/PM10
Hexachlorobutadiene	<4	<4										<4	ug/kg	TM15/PM10
Naphthalene	9730 ++	17193 ++										<27	ug/kg	TM15/PM10
1,2,3-Trichlorobenzene #	<7	<7										<7	ug/kg	TM15/PM10
Surrogate Recovery Toluene D8	75	78										<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	82	87										<0	%	TM15/PM10

Job number: 14/5930 **Method:** VOC
Sample number: 2 **Matrix:** Solid
Sample identity: NTW1
Sample depth:
Sample Type: Soil
Units: ug/kg

Note: Only samples with TICs (if requested) are reported. If TICs were requested but no compounds found they are not reported.

CAS No.	Tentative Compound Identification	Retention Time (minutes)	% Match	Concentration
1072-05-5	Heptane, 2,6-dimethyl-	5.004	90	284
1678-91-7	Cyclohexane, ethyl-	5.136	95	1657
2216-30-0	Heptane, 2,5-dimethyl-	5.316	81	874
1000309-22-4	Sulfurous acid, cyclohexylmethyl hexadecyl ester	5.664	80	502
2051-30-1	Octane, 2,6-dimethyl-	5.735	95	1060
611-14-3	Benzene, 1-ethyl-2-methyl-	6.251	92	821
526-73-8	Benzene, 1,2,3-trimethyl-	6.550	94	1420
1074-43-7	Benzene, 1-methyl-3-propyl-	6.648	93	983
527-84-4	o-Cymene	6.835	90	1417
933-98-2	Benzene, 1-ethyl-2,3-dimethyl-	6.870	94	1118
2050-24-0	Benzene, 1,3-diethyl-5-methyl-	6.941 - 7.512	83,83	1884
112-40-3	Dodecane	7.277	96	3609
17301-23-4	Undecane, 2,6-dimethyl-	7.352	91	1533

All solid results are expressed on a dry weight basis unless stated otherwise.

Job number: 14/5930 **Method:** VOC
Sample number: 4 **Matrix:** Solid
Sample identity: NTW2
Sample depth:
Sample Type: Soil
Units: ug/kg

Note: Only samples with TICs (if requested) are reported. If TICs were requested but no compounds found they are not reported.

CAS No.	Tentative Compound Identification	Retention Time (minutes)	% Match	Concentration
108-87-2	Cyclohexane, methyl-	4.302	94	332
6876-23-9	Cyclohexane, 1,2-dimethyl-, trans-	4.884	91	346
1678-91-7	Cyclohexane, ethyl-	5.136	95	2538
2216-30-0	Heptane, 2,5-dimethyl-	5.316	81	1253
2051-30-1	Octane, 2,6-dimethyl-	5.735	93	1728
124-18-5	Decane	6.131	93	12532
611-14-3	Benzene, 1-ethyl-2-methyl-	6.251	93	5013
526-73-8	Benzene, 1,2,3-trimethyl-	6.550	94	931
1074-43-7	Benzene, 1-methyl-3-propyl-	6.648	90	1676
1120-21-4	Undecane	6.728	95	5456
934-80-5	Benzene, 4-ethyl-1,2-dimethyl-	6.870	96	2044
2050-24-0	Benzene, 1,3-diethyl-5-methyl-	6.941	86	1428
112-40-3	Dodecane	7.277	96	7222
17301-23-4	Undecane, 2,6-dimethyl-	7.352	94	3085

All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Notification of Deviating Samples

Client Name: Smith Grant LLP
Reference: R1635
Location:
Contact: Tony Smith

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
No deviating sample report results for job 14/5930						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/5930

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a **storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.**

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at **35°C ±5°C** unless **otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.**

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
OC	Outside Calibration Range

JE Job No: 14/5930

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.				
TM15	In-House method based on USEPA 8260. Determination of Volatile Organic compounds (VOCs) by Headspace GC-MS. Accredited to ISO 17025 for soils and waters and MCERTS for Soils. All accreditation is matrix specific. Quantification by Internal Standard method.	PM10	In-house method based on USEPA 5021. Preparation of solid and liquid samples for headspace analysis. Samples are spiked with surrogates to facilitate quantification. ISO 17025 accredited extraction method. All accreditation is matrix specific			AR	Yes
TM15	In-House method based on USEPA 8260. Determination of Volatile Organic compounds (VOCs) by Headspace GC-MS. Accredited to ISO 17025 for soils and waters and MCERTS for Soils. All accreditation is matrix specific. Quantification by Internal Standard method.	PM10	In-house method based on USEPA 5021. Preparation of solid and liquid samples for headspace analysis. Samples are spiked with surrogates to facilitate quantification. ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes		AR	Yes
TM21	TOC and TC by Combustion	PM24	Eltra preparation			AD	Yes
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM20	in-house method based on USEPA 1311 (TCLP). Solid samples are extracted with two parts de-ionised water to one part solid material for analysis of the extract for various parameters.			AR	Yes
TM50	Total Sulphate by ICP-OES	PM15	In-house method based on USEPA 3010A. Acid digestion of dried and crushed solid samples using Aqua Regia reflux.	Yes	Yes	AD	Yes
TM73	pH in by Metrohm	PM11	1:2.5 soil/water extraction	Yes	Yes	AR	No
TM106	Sulphide by CFA	PM45	Cyanide & Thiocyanate prep for soils			AR	Yes

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Combrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 398245-1

Date of Report: 03-Jun-2014

Customer: Smith Grant LLP
Station House
Station Road
Ruabon
Wrexham
LL14 6DL

Customer Contact: Mr Tony Smith

Customer Job Reference: R1635
Date Job Received at SAL: 28-May-2014
Date Analysis Started: 29-May-2014
Date Analysis Completed: 03-Jun-2014

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING
1549

Report checked and authorised by :
Mr Ross Walker
Customer Services Manager (Land)

Issued by :
Mr Ross Walker
Customer Services Manager (Land)

SAL Reference: 398245
Customer Reference: R1635

Water Analysed as Water
Metals

				SAL Reference	398245 001	398245 002
				Customer Sample Reference	Skip 1	Skip 2
				Date Sampled	28-MAY-2014	28-MAY-2014
Determinand	Method	Test Sample	LOD	Units		
Aluminium	T6	AR	20	µg/l	910	1000
As (Total)	T301	AR	0.2	µg/l	85	120
Cd (Total)	T301	AR	0.02	µg/l	2.0	2.3
Calcium	T6	AR	100	µg/l	920000	1300000
Cu (Total)	T301	AR	0.5	µg/l	120	67
Iron	T6	AR	10	µg/l	12000	70000
Pb (Total)	T301	AR	0.3	µg/l	17	15
Magnesium	T6	AR	100	µg/l	75000	86000
Mn (Total)	T301	AR	1	µg/l	1	2
Hg (Total)	T301	AR	0.05	µg/l	0.29	0.55
Ni (Total)	T301	AR	1	µg/l	280	350
Potassium	T6	AR	100	µg/l	120000	160000
Zn (Total)	T301	AR	2	µg/l	390	860
Sodium	T6	AR	100	µg/l	38000	47000

SAL Reference: 398245
Customer Reference: R1635

Water Analysed as Water
Miscellaneous

				SAL Reference	398245 001	398245 002
				Customer Sample Reference	Skip 1	Skip 2
				Date Sampled	28-MAY-2014	28-MAY-2014
Determinand	Method	Test Sample	LOD	Units		
Ammoniacal nitrogen	T686	AR	0.05	mg/l	16	0.90
Chemical Oxygen Demand	T4	AR	5	mg/l	19000	24000
Chloride	T686	AR	1	mg/l	100	95
Sulphate	T686	AR	0.5	mg/l	<0.5	2.7
Sulphide	T4	AR	0.05	mg/l	0.37	0.16
Total Oxidised Nitrogen	T686	AR	0.1	mg/l	<0.1	<0.1
pH	T7	AR			6.5	6.7

SAL Reference: 398245
Customer Reference: R1635

Water Analysed as Water
Semi-Volatile Organic Compounds (USEPA 625)

					SAL Reference	398245 001	398245 002
					Customer Sample Reference	Skip 1	Skip 2
					Date Sampled	28-MAY-2014	28-MAY-2014
Determinand	Method	Test Sample	LOD	Units			
1,2,4-Trichlorobenzene	T16	AR	10	µg/l		<10	<10
1,2-Dichlorobenzene	T16	AR	10	µg/l		<10	<10
1,3-Dichlorobenzene	T16	AR	10	µg/l		<10	<10
1,4-Dichlorobenzene	T16	AR	10	µg/l		<10	<10
2,4,5-Trichlorophenol	T16	AR	10	µg/l		<10	<10
2,4,6-Trichlorophenol	T16	AR	10	µg/l		<10	<10
2,4-Dichlorophenol	T16	AR	10	µg/l		<10	<10
2,4-Dimethylphenol	T16	AR	10	µg/l		<10	<10
2,4-Dinitrophenol	T16	AR	10	µg/l		(36) <50	(36) <50
2,4-Dinitrotoluene	T16	AR	10	µg/l		<10	<10
2,6-Dinitrotoluene	T16	AR	10	µg/l		<10	<10
2-Chloronaphthalene	T16	AR	10	µg/l		<10	<10
2-Chlorophenol	T16	AR	10	µg/l		<10	<10
2-methyl phenol	T16	AR	10	µg/l		<10	<10
2-Methylnaphthalene	T16	AR	10	µg/l		<10	<10
2-Nitroaniline	T16	AR	10	µg/l		<10	<10
2-Nitrophenol	T16	AR	10	µg/l		<10	<10
3-Nitroaniline	T16	AR	10	µg/l		<10	<10
3/4-Methylphenol	T16	AR	10	µg/l		**9400**	**16000**
4-Bromophenyl phenylether	T16	AR	10	µg/l		<10	<10
4-Chloro-3-methylphenol	T16	AR	10	µg/l		<10	<10
4-Chloroaniline	T16	AR	10	µg/l		<10	<10
4-Chlorophenyl phenylether	T16	AR	10	µg/l		<10	<10
4-Nitroaniline	T16	AR	10	µg/l		<10	<10
4-Nitrophenol	T16	AR	10	µg/l		(36) <50	(36) <50
Acenaphthene	T16	AR	10	µg/l		<10	<10
Acenaphthylene	T16	AR	10	µg/l		<10	<10
Anthracene	T16	AR	10	µg/l		<10	<10
Azobenzene	T16	AR	10	µg/l		<10	<10
Benzo(a)Anthracene	T16	AR	10	µg/l		<10	<10
Benzo(a)Pyrene	T16	AR	10	µg/l		<10	<10
Benzo(b/k)Fluoranthene	T16	AR	10	µg/l		<10	<10
Benzo(ghi)Perylene	T16	AR	10	µg/l		<10	<10
Bis (2-chloroethoxy) methane	T16	AR	10	µg/l		<10	<10
Bis (2-chloroethyl) ether	T16	AR	10	µg/l		<10	<10
Bis (2-chloroisopropyl) ether	T16	AR	10	µg/l		<10	<10
Bis (2-ethylhexyl)phthalate	T16	AR	10	µg/l		<10	<10
Butyl benzylphthalate	T16	AR	10	µg/l		<10	<10
Carbazole	T16	AR	10	µg/l		<10	<10
Chrysene	T16	AR	10	µg/l		<10	<10
Di-n-butylphthalate	T16	AR	10	µg/l		<10	<10
Di-n-octylphthalate	T16	AR	10	µg/l		<10	<10
Dibenzo(ah)Anthracene	T16	AR	10	µg/l		<10	<10
Dibenzofuran	T16	AR	10	µg/l		<10	<10
Diethyl phthalate	T16	AR	10	µg/l		<10	<10
Dimethyl phthalate	T16	AR	10	µg/l		<10	<10
Fluoranthene	T16	AR	10	µg/l		<10	<10
Fluorene	T16	AR	10	µg/l		<10	<10
Hexachlorobenzene	T16	AR	10	µg/l		<10	<10
Hexachlorobutadiene	T16	AR	10	µg/l		<10	<10
Hexachlorocyclopentadiene	T16	AR	10	µg/l		(36) <50	(36) <50
Hexachloroethane	T16	AR	10	µg/l		<10	<10
Indeno(123-cd)Pyrene	T16	AR	10	µg/l		<10	<10
Isophorone	T16	AR	10	µg/l		<10	<10
Naphthalene	T16	AR	10	µg/l		<10	<10
Nitrobenzene	T16	AR	10	µg/l		<10	<10
Pentachlorophenol	T16	AR	10	µg/l		(36) <50	(36) <50
Phenanthrene	T16	AR	10	µg/l		<10	<10
Phenol	T16	AR	10	µg/l		**110**	**1300**
Pyrene	T16	AR	10	µg/l		<10	<10
SVOC screen	T16	AR	10	µg/l		<10	<10

SAL Reference: 398245
Customer Reference: R1635

Water Analysed as Water
Volatile Organic Compounds (USEPA 624)

					SAL Reference	398245 001	398245 002
					Customer Sample Reference	Skip 1	Skip 2
					Date Sampled	28-MAY-2014	28-MAY-2014
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
1,1,1,2-Tetrachloroethane	T54	AR	1	µg/l		<1	<1
1,1,1-Trichloroethane	T54	AR	1	µg/l		<1	<1
1,1,2,2-Tetrachloroethane	T54	AR	1	µg/l		<1	<1
1,1,2-Trichloroethane	T54	AR	1	µg/l		<1	<1
1,1,2-Trichloroethylene	T54	AR	1	µg/l		<1	<1
1,1-Dichloroethane	T54	AR	1	µg/l		<1	<1
1,1-Dichloroethylene	T54	AR	1	µg/l		<1	<1
1,1-Dichloropropene	T54	AR	1	µg/l		<1	<1
1,2,3-Trichloropropane	T54	AR	1	µg/l		<1	<1
1,2,4-Trimethylbenzene	T54	AR	1	µg/l		39	43
1,2-dibromoethane	T54	AR	1	µg/l		<1	<1
1,2-Dichlorobenzene	T54	AR	1	µg/l		<1	<1
1,2-Dichloroethane	T54	AR	1	µg/l		<1	<1
1,2-Dichloropropane	T54	AR	1	µg/l		<1	<1
1,3,5-Trimethylbenzene	T54	AR	1	µg/l		12	13
1,3-Dichlorobenzene	T54	AR	1	µg/l		<1	<1
1,3-Dichloropropane	T54	AR	1	µg/l		<1	<1
1,4-Dichlorobenzene	T54	AR	1	µg/l		<1	<1
2,2-Dichloropropane	T54	AR	1	µg/l		<1	<1
2-Chlorotoluene	T54	AR	1	µg/l		5	5
4-Chlorotoluene	T54	AR	1	µg/l		<1	<1
Benzene	T54	AR	1	µg/l		(13) <1	(13) <1
Bromobenzene	T54	AR	1	µg/l		<1	<1
Bromochloromethane	T54	AR	1	µg/l		<1	<1
Bromodichloromethane	T54	AR	1	µg/l		<1	<1
Bromoform	T54	AR	1	µg/l		<1	<1
Bromomethane	T54	AR	1	µg/l		<1	<1
Carbon tetrachloride	T54	AR	1	µg/l		<1	<1
Chlorobenzene	T54	AR	1	µg/l		<1	<1
Chlorodibromomethane	T54	AR	1	µg/l		<1	<1
Chloroethane	T54	AR	1	µg/l		<1	<1
Chloroform	T54	AR	1	µg/l		<1	<1
Chloromethane	T54	AR	1	µg/l		<1	<1
Cis-1,2-Dichloroethylene	T54	AR	1	µg/l		<1	<1
Cis-1,3-Dichloropropene	T54	AR	1	µg/l		<1	<1
Dibromomethane	T54	AR	1	µg/l		<1	<1
Dichlorodifluoromethane	T54	AR	1	µg/l		<1	<1
Dichloromethane	T54	AR	50	µg/l		<50	<50
EthylBenzene	T54	AR	1	µg/l		9	5
Isopropyl benzene	T54	AR	1	µg/l		4	3
M/P Xylene	T54	AR	1	µg/l		30	18
n-Propylbenzene	T54	AR	1	µg/l		14	7
O Xylene	T54	AR	1	µg/l		22	15
p-Isopropyltoluene	T54	AR	1	µg/l		2	2
S-Butylbenzene	T54	AR	1	µg/l		3	3
Styrene	T54	AR	1	µg/l		<1	<1
T-Butylbenzene	T54	AR	1	µg/l		<1	<1
Tetrachloroethene	T54	AR	1	µg/l		<1	<1
Toluene	T54	AR	1	µg/l		61	190
Trans-1,2-Dichloroethene	T54	AR	1	µg/l		<1	<1
Trans-1,3-Dichloropropene	T54	AR	1	µg/l		<1	<1
Trichlorofluoromethane	T54	AR	1	µg/l		<1	<1
Vinyl chloride	T54	AR	1	µg/l		<1	<1

SAL Reference: 398245
Customer Reference: R1635

Water Analysed as Water
Volatile Organic Compounds (USEPA 624)

SAL Reference	**398245 001**	**398245 002**
Customer Sample Reference	**Skip 1**	**Skip 2**
Date Sampled	**28-MAY-2014**	**28-MAY-2014**

Determinand	Method	Test Sample	LOD	Units		
VOC Screen (Extra Peaks)	T54	AR	10	µg/l	Trimethylsilanol **50**	Trimethylsilanol **63**
					2 Butanol **93**	2 Butanol **110**
					Dimethyl sulphide **99**	n-butanol **37**
					Unidentified Aliphatic Hydrocarbon containing O circa C6 **22**	Isopentyl Alcohol **77**
					2-Hexanol **13**	Pentanol **49**
					Methyl phenol **14**	Hexanol **58**
					No other compounds detected above **10**	1-Hexanol, 2-ethyl **21**
						Undecane **27**
						Methyl phenol **23**
						No other compounds detected above **10**

Index to symbols used in 398245-1

Value	Description
AR	As Received
36	LOD Raised due to low Matrix spike recovery
13	Results have been blank corrected.
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T7	Probe
T6	ICP/OES
T54	GC/MS (Headspace)
T301	ICP/MS (Total)
T4	Colorimetry
T686	Discrete Analyser
T16	GC/MS

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Aluminium	T6	AR	20	µg/l	U	001-002
As (Total)	T301	AR	0.2	µg/l	U	001-002
Cd (Total)	T301	AR	0.02	µg/l	U	001-002
Calcium	T6	AR	100	µg/l	N	001-002
Cu (Total)	T301	AR	0.5	µg/l	U	001-002
Iron	T6	AR	10	µg/l	N	001-002
Pb (Total)	T301	AR	0.3	µg/l	U	001-002
Magnesium	T6	AR	100	µg/l	N	001-002
Mn (Total)	T301	AR	1	µg/l	U	001-002
Hg (Total)	T301	AR	0.05	µg/l	U	001-002
Ni (Total)	T301	AR	1	µg/l	U	001-002
Potassium	T6	AR	100	µg/l	N	001-002
Zn (Total)	T301	AR	2	µg/l	U	001-002

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Sodium	T6	AR	100	µg/l	N	001-002
Ammoniacal nitrogen	T686	AR	0.05	mg/l	U	001-002
Chemical Oxygen Demand	T4	AR	5	mg/l	N	001-002
Chloride	T686	AR	1	mg/l	N	001-002
Sulphate	T686	AR	0.5	mg/l	N	001-002
Sulphide	T4	AR	0.05	mg/l	N	001-002
Total Oxidised Nitrogen	T686	AR	0.1	mg/l	N	001-002
pH	T7	AR			U	001-002
1,2,4-Trichlorobenzene	T16	AR	10	µg/l	U	001-002
1,2-Dichlorobenzene	T16	AR	10	µg/l	U	001-002
1,3-Dichlorobenzene	T16	AR	10	µg/l	U	001-002
1,4-Dichlorobenzene	T16	AR	10	µg/l	U	001-002
2,4,5-Trichlorophenol	T16	AR	10	µg/l	U	001-002
2,4,6-Trichlorophenol	T16	AR	10	µg/l	U	001-002
2,4-Dichlorophenol	T16	AR	10	µg/l	U	001-002
2,4-Dimethylphenol	T16	AR	10	µg/l	U	001-002
2,4-Dinitrophenol	T16	AR	10	µg/l	U	001-002
2,4-Dinitrotoluene	T16	AR	10	µg/l	U	001-002
2,6-Dinitrotoluene	T16	AR	10	µg/l	U	001-002
2-Chloronaphthalene	T16	AR	10	µg/l	U	001-002
2-Chlorophenol	T16	AR	10	µg/l	U	001-002
2-methyl phenol	T16	AR	10	µg/l	U	001-002
2-Methylnaphthalene	T16	AR	10	µg/l	U	001-002
2-Nitroaniline	T16	AR	10	µg/l	U	001-002
2-Nitrophenol	T16	AR	10	µg/l	U	001-002
3-Nitroaniline	T16	AR	10	µg/l	U	001-002
3/4-Methylphenol	T16	AR	10	µg/l	U	001-002
4-Bromophenyl phenylether	T16	AR	10	µg/l	U	001-002
4-Chloro-3-methylphenol	T16	AR	10	µg/l	U	001-002
4-Chloroaniline	T16	AR	10	µg/l	U	001-002
4-Chlorophenyl phenylether	T16	AR	10	µg/l	U	001-002
4-Nitroaniline	T16	AR	10	µg/l	U	001-002
4-Nitrophenol	T16	AR	10	µg/l	U	001-002
Acenaphthene	T16	AR	10	µg/l	U	001-002
Acenaphthylene	T16	AR	10	µg/l	U	001-002
Anthracene	T16	AR	10	µg/l	U	001-002
Azobenzene	T16	AR	10	µg/l	U	001-002
Benzo(a)Anthracene	T16	AR	10	µg/l	U	001-002
Benzo(a)Pyrene	T16	AR	10	µg/l	U	001-002
Benzo(b/k)Fluoranthene	T16	AR	10	µg/l	U	001-002
Benzo(ghi)Perylene	T16	AR	10	µg/l	U	001-002
Bis (2-chloroethoxy) methane	T16	AR	10	µg/l	U	001-002
Bis (2-chloroethyl) ether	T16	AR	10	µg/l	U	001-002
Bis (2-chloroisopropyl) ether	T16	AR	10	µg/l	U	001-002
Bis (2-ethylhexyl)phthalate	T16	AR	10	µg/l	U	001-002
Butyl benzylphthalate	T16	AR	10	µg/l	U	001-002
Carbazole	T16	AR	10	µg/l	U	001-002
Chrysene	T16	AR	10	µg/l	U	001-002
Di-n-butylphthalate	T16	AR	10	µg/l	U	001-002
Di-n-octylphthalate	T16	AR	10	µg/l	U	001-002
Dibenzo(ah)Anthracene	T16	AR	10	µg/l	U	001-002
Dibenzofuran	T16	AR	10	µg/l	U	001-002
Diethyl phthalate	T16	AR	10	µg/l	U	001-002
Dimethyl phthalate	T16	AR	10	µg/l	U	001-002
Fluoranthene	T16	AR	10	µg/l	U	001-002
Fluorene	T16	AR	10	µg/l	U	001-002
Hexachlorobenzene	T16	AR	10	µg/l	U	001-002
Hexachlorobutadiene	T16	AR	10	µg/l	U	001-002
Hexachlorocyclopentadiene	T16	AR	10	µg/l	U	001-002
Hexachloroethane	T16	AR	10	µg/l	U	001-002
Indeno(123-cd)Pyrene	T16	AR	10	µg/l	U	001-002
Isophorone	T16	AR	10	µg/l	U	001-002
Naphthalene	T16	AR	10	µg/l	U	001-002
Nitrobenzene	T16	AR	10	µg/l	U	001-002
Pentachlorophenol	T16	AR	10	µg/l	U	001-002
Phenanthrene	T16	AR	10	µg/l	U	001-002
Phenol	T16	AR	10	µg/l	U	001-002
Pyrene	T16	AR	10	µg/l	U	001-002
SVOC screen	T16	AR	10	µg/l	N	001-002
1,1,1,2-Tetrachloroethane	T54	AR	1	µg/l	U	001-002

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
1,1,1-Trichloroethane	T54	AR	1	µg/l	U	001-002
1,1,2,2-Tetrachloroethane	T54	AR	1	µg/l	U	001-002
1,1,2-Trichloroethane	T54	AR	1	µg/l	U	001-002
1,1,2-Trichloroethylene	T54	AR	1	µg/l	U	001-002
1,1-Dichloroethane	T54	AR	1	µg/l	U	001-002
1,1-Dichloroethylene	T54	AR	1	µg/l	U	001-002
1,1-Dichloropropene	T54	AR	1	µg/l	U	001-002
1,2,3-Trichloropropane	T54	AR	1	µg/l	U	001-002
1,2,4-Trimethylbenzene	T54	AR	1	µg/l	U	001-002
1,2-dibromoethane	T54	AR	1	µg/l	U	001-002
1,2-Dichlorobenzene	T54	AR	1	µg/l	U	001-002
1,2-Dichloroethane	T54	AR	1	µg/l	U	001-002
1,2-Dichloropropane	T54	AR	1	µg/l	U	001-002
1,3,5-Trimethylbenzene	T54	AR	1	µg/l	U	001-002
1,3-Dichlorobenzene	T54	AR	1	µg/l	U	001-002
1,3-Dichloropropane	T54	AR	1	µg/l	U	001-002
1,4-Dichlorobenzene	T54	AR	1	µg/l	U	001-002
2,2-Dichloropropane	T54	AR	1	µg/l	U	001-002
2-Chlorotoluene	T54	AR	1	µg/l	U	001-002
4-Chlorotoluene	T54	AR	1	µg/l	U	001-002
Benzene	T54	AR	1	µg/l	U	001-002
Bromobenzene	T54	AR	1	µg/l	U	001-002
Bromochloromethane	T54	AR	1	µg/l	U	001-002
Bromodichloromethane	T54	AR	1	µg/l	U	001-002
Bromoform	T54	AR	1	µg/l	U	001-002
Bromomethane	T54	AR	1	µg/l	U	001-002
Carbon tetrachloride	T54	AR	1	µg/l	U	001-002
Chlorobenzene	T54	AR	1	µg/l	U	001-002
Chlorodibromomethane	T54	AR	1	µg/l	U	001-002
Chloroethane	T54	AR	1	µg/l	U	001-002
Chloroform	T54	AR	1	µg/l	U	001-002
Chloromethane	T54	AR	1	µg/l	U	001-002
Cis-1,2-Dichloroethylene	T54	AR	1	µg/l	U	001-002
Cis-1,3-Dichloropropene	T54	AR	1	µg/l	U	001-002
Dibromomethane	T54	AR	1	µg/l	U	001-002
Dichlorodifluoromethane	T54	AR	1	µg/l	U	001-002
Dichloromethane	T54	AR	50	µg/l	N	001-002
EthylBenzene	T54	AR	1	µg/l	U	001-002
Isopropyl benzene	T54	AR	1	µg/l	U	001-002
M/P Xylene	T54	AR	1	µg/l	U	001-002
n-Propylbenzene	T54	AR	1	µg/l	U	001-002
O Xylene	T54	AR	1	µg/l	U	001-002
p-Isopropyltoluene	T54	AR	1	µg/l	U	001-002
S-Butylbenzene	T54	AR	1	µg/l	U	001-002
Styrene	T54	AR	1	µg/l	U	001-002
T-Butylbenzene	T54	AR	1	µg/l	U	001-002
Tetrachloroethene	T54	AR	1	µg/l	U	001-002
Toluene	T54	AR	1	µg/l	U	001-002
Trans-1,2-Dichloroethene	T54	AR	1	µg/l	U	001-002
Trans-1,3-Dichloropropene	T54	AR	1	µg/l	U	001-002
Trichlorofluoromethane	T54	AR	1	µg/l	U	001-002
Vinyl chloride	T54	AR	1	µg/l	U	001-002
VOC Screen (Extra Peaks)	T54	AR	10	µg/l	N	001-002

APPENDIX C

Risk-based Monitoring Plan

Controlled Waters

In summary, monitoring of pumped landfill leachate from both Tips has been in compliance with the discharge consent limits, specified as follows:

Table B1.

parameter	limit	parameter	limit
pH	5.0 – 9.0	cadmium	10.0 µg/l
BOD	20 mg/l	mercury	2.0 µg/l
suspended solids	20 mg/l	ammonia	5 mg/l
oils - no visible floating film		Other List 1 substances – not normally tested for	
other substances to not exceed EQS values in receiving watercourse (TNSB)			

The current monitoring regime uses upstream and downstream boreholes for both landfills, boreholes within the Old Tip, leachate surface discharges, and adjacent surface watercourses, as follows:

Table B2.

	Old Landfill	New Landfill
upstream wells	BH110/06	BH114/06
downstream wells	BH4/95 BH103/06(d)	BH104/06(d) BH5/95(d)
in waste wells	BH105/06 BH1/11 BH2/11 BH3/11	none
leachate	discharge point adjacent to Supply Lodge	leachate sump
surface waters	SWR1 (TNSB culvert entry at Supply Lodge) SWR2 (TNSB culvert at ash embankment) SWR3 (TNSB culvert above Eagley Brook confluence	SWR4 (Eagley Brook upstream of TNSB) SWR5 (Ochre Culvert) SWR6 (Eagley Brook downstream of Mill)

The agreed potential migration routes for leachate are:

- from the Old Landfill west towards the Supply Lodge, east into and below the ash embankment towards the Ochre Culvert and Eagley Brook;
- from the New Landfill, east into the Ochre Culvert and Eagley Brook

It is proposed to continue monitoring at the following locations:

Table B3.

	Old Landfill	**New Landfill**
upstream wells	BH110/06	BH114/06
downstream wells	BH4/95 BH103/06(d)	none
in waste wells	BH105/06 BH1/11 BH2/11 BH3/11	none
leachate	discharge point adjacent to Supply Lodge	leachate sump
surface waters	SWR1 (TNSB culvert entry at Supply Lodge) SWR2 (TNSB culvert at ash embankment) SWR5 (Ochre Culvert)	SWR4 (Eagely Brook upstream of TNSB) SWR5 (Ochre Culvert) SWR6 (Eagley Brook downstream of Mill)

Down-gradient wells for the New Tip have been removed as not lying within the leachate flow path and serving no useful purpose. Similarly, there is no potential entry for leachate between the SWR2 and SWR3 monitoring positions on the TNSB culvert, therefore the SWR3 monitoring point serves no useful purpose and is excluded.

The monitoring suite is as follows:

field recording:

Table B4.

borehole purge volume (l)	dissolved oxygen (mg/l)
groundwater depth (m)	electrical conductivity (uS/cm)
base of borehole depth (m)	pH (units)
temperature (°C)	oxygen reduction (redox) potential - ORP mV

laboratory measurement:

Table B5.

metals	**inorganics**	**organics**
arsenic	pH	chemical oxygen demand
cadmium	chloride	total oxidisable nitrogen
calcium	sulphate	ammoniacal nitrogen
copper	sulphide	benzene*
iron		toluene*
lead		ethylbenzene*
manganese		xylenes*
mercury		monohydric phenols*

metals	inorganics	organics
nickel		
potassium		
zinc		

*SWR5, boreholes and tip leachate only

Monitoring frequency will be:

Table B6.

period	location	frequency
during New Tip remediation & waste storage on Old Tip	Old Tip / New Tip leachate; BH4/95, BH103/06(d) SWR5 Ochre Culvert	monthly
	all other sites	quarterly
restoration of Old Tip	Old Tip leachate; BH4/95, BH103/06(d) SWR5 Ochre Culvert	monthly
post-restoration	Old Tip leachate, SWR5 Ochre Culvert	quarterly

Field records and laboratory monitoring data will be compiled into a factual report following each sampling round, and will be distributed to the stakeholders and Environment Agency.

Inspection, maintenance and replacement of monitoring wells will take place as necessary to maintain continuity of data collection until and unless otherwise agree with the Environment Agency. A written record of the condition of monitoring wells will be noted on each sampling round.

Landfill Gas

The Old Landfill remains a source of landfill gas, with evidence for migration of methane / carbon dioxide into the permeable made ground to the south and east of the tip. The New Tip is not a significant source of landfill gas, and the degradable waste contents are to be removed. Monitoring will be continued on the current quarterly frequency at the following wells:

Table B7.

WS8/05	BH108/06	BH115/06(S)	BH3/11
BH103/06(S)	BH110/06	BH116/06(S)	BH1/13
BH105/06	BH112/06	BH116/06(D)	BH2/13
BH106/06	BH113/06	BH1/11	BH3/13
BH107/06	BH114/06	BH2/11	

The following wells which have been monitored at some time in the past are no longer proposed for monitoring for the reasons stated:

BH4/95 - damaged condition and adjacent to wells WS8/05 and BH103/06

BH101/06 - lost for many years, and not in a sensitive area

BH102/06 - limited utility given deep response zone in boulder clay, effectively superseded by BH1/13 and BH2/13
BH109/06 - lost for several years and in non-sensitive area with negligible migration risk (boudler clay and shallow water table / in springline
BH104/06 - remote from Old Tip, with no evidence of gas presence in past

Monitoring comprises field measurement of borehole pressure and flow, concentration of methane, carbon dioxide, oxygen, hydrogen sulphide, and borehole water level.

Borehole inspection, maintenance and data reporting will be as set down for water monitoring arrangements.

The monitoring regime on and around the Old Tip will be revised in agreement with the Local Planning Authority and Contaminated Land Officers and Environment Agency when works to restore the landfill and install gas management measures are carried out.

APPENDIX D

Gas Monitoring Well Review

R1635 Kruger, Springside Mills

Gas Monitoring Well Condition Survey, March 2014

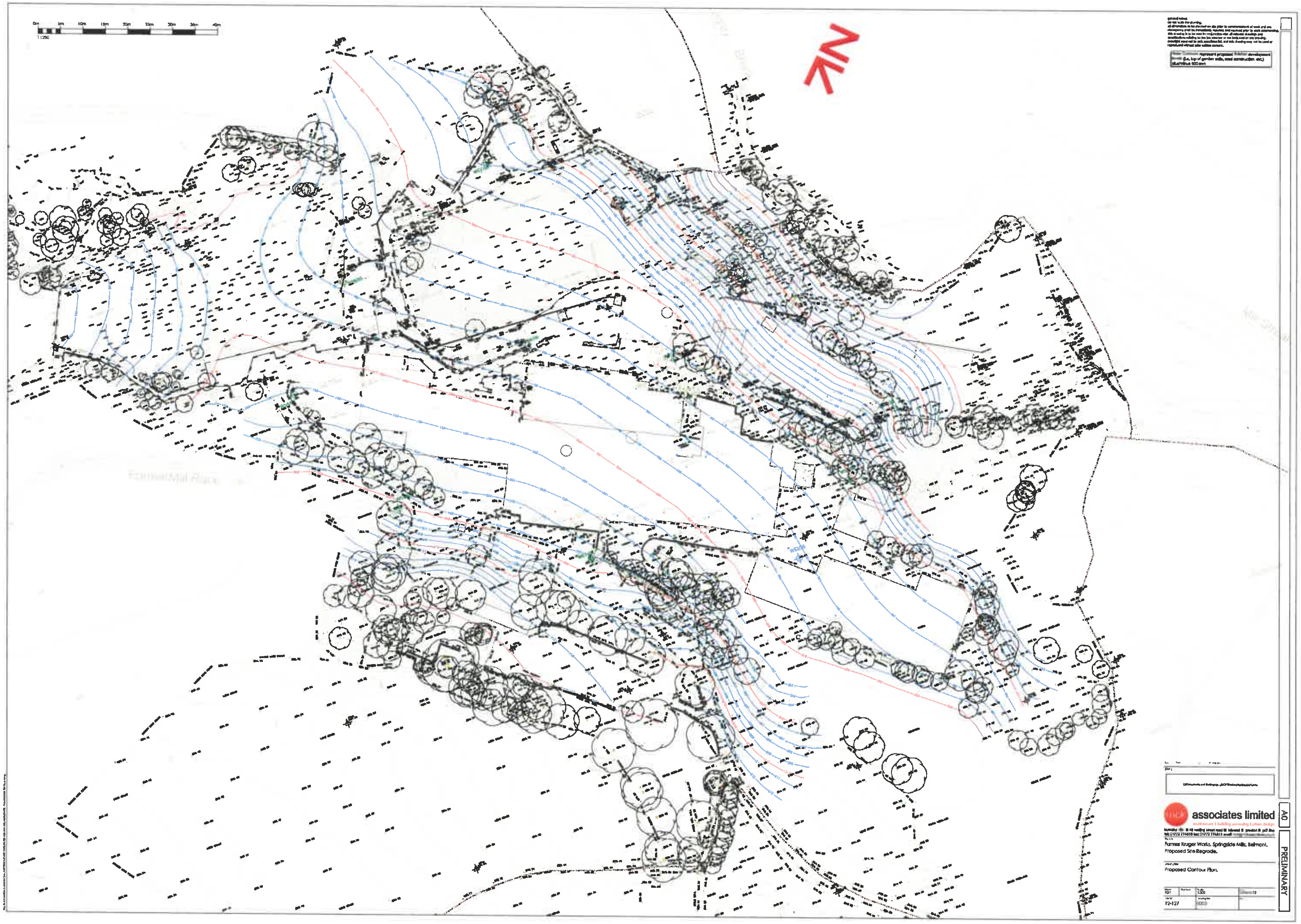
surveyors: AFS/DW/GC

borehole	date of installation	location	condition	notes
BH4/95	1995	ash embankment	poor	top of standpipe broken, and bung pushed down although airtight
BH5/95	1995	east of New Tip	buried	may be recoverable, previously in good condition
WS8/05	2005	ash embankment, adj to BH4/95	good	no issues
BH101/06	2006	north part of Old Tip	lost	destroyed
BH102/06	2006	south of Old Tip	poor	ground caved in around standpipe, although depth of respnse zone means that performance unlikely to be impaired
BH103/06 (S)	2006	ash embankment, adj to WS8/05	good	no issues
BH104/06	2006	east of New Tip	lost	possibly destroyed during fencing works
BH105/06	2006	north part of Old Tip	good	no issues
BH106/06	2006	north margin of Old Tip	good	dense vegetation needs clearing
BH107/06	2006	north side of ash embankment	good	no issues
BH108/06	2006	south side of ash embankment	good	no issues
BH109/06	2006	south of Old Tip	lost	no traces found
BH110/06	2006	south of Old Tip	good	no issues
BH112/06	2006	north of New Tip	good	no issues
BH113/06	2006	north of New Tip	good	no issues
BH114/06	2006	ash embankment	good	no issues
BH115/06 (S)	2006	south of New Tip	good	no issues
BH116/06 (S)	2006	south of New Tip	good	no issues
BH116/06 (D)	2006	south of New Tip	good	no issues
BH1/11	2011	within Old Tip	good	occasional flooding
BH2/11	2011	within Old Tip	good	occasional flooding
BH3/11	2011	within Old Tip	poor	bung cannot be removed, frequently flooded
BH1/13	2013	south of Old Tip	good	no issues
BH2/13	2013	south of Old Tip	good	no issues
BH3/13	2013	south of ash embankment	good	no issues

good condition: bung and gas tap airtight, evidence of bentonite seal, water level usually below top of response zone, not subject to flow failure or or oxygen rise during pumping signifying leakage from surface

APPENDIX E

Restoration Contour Plan


associates limited
architecture | building surveying | urban design
Former Kruger Works, Springside Mills, Belmont,
Proposed Site Regrade.
Proposed Contour Plan.
1:500
12-127
A0
PRELIMINARY

APPENDIX F

Lodge Dam Inspection Report

Reid Jones partnership

Consulting Civil &
Structural Engineers

Ref. 4144/ej/l01
Date. 10 June 2014

Urban Regen Ltd
23 Springvale
Edgworth
Bolton
BL7 0FS

For the attention of Mr J Bamforth

Dear John,

VISUAL INSPECTION – POND DAM, FORMER KRUGER WORKS, BELMONT

You requested we visit the above site to inspect the dam construction and its current condition in order to assess its integrity and long-term stability.

We visited the site on Wednesday 7th May and again on Thursday 5th June 2014.

The dam appears to be constructed of concrete to a level approximately 300mm above current water level within the pond with brickwork above and a concrete capping forming the walkway across the dam. The dam is 850mm wide overall and 1450mm above current pond water level. The pond water level is controlled via an outlet at the northern end of the dam and therefore remains relatively constant.

Along the top and off the side of the dam there are several steel platforms and support frames used for water sampling and monitoring. The steel is rusty and cables trail along the handrail and across the walkway.

During our first visit the water level on the front of the dam was 400mm higher than the pond and on the second visit, after heavy rainfall, was 750mm above the pond. There is a degree of water seepage through the brickwork, which over time, and subject to rainfall, will allow the hydrostatic pressure to reduce or equalise.

There is some vegetation growth in various areas along the dam predominantly from the brickwork mortar joints.

The dam generally is in good overall condition and is plumb and level along its length and there are no indications of distress or signs of movement visible.

We would recommend the platforms and other steel support frames and vegetation be removed to prevent any deterioration of the structural integrity in the long term. The areas of masonry affected should be re-pointed following any removal works.

We consider the dam to be stable currently and have no reason to doubt its long-term structural stability or integrity, particularly if the above-mentioned maintenance/mitigation works are carried out.

Photos of the dam are attached for record purposes.

We trust this brief report is satisfactory, however please do not hesitate to call should you have any questions.

Yours sincerely
For and on behalf of
Reid Jones Partnership Ltd

Edwin Jones
Director

Enc.

PHOTO 1 – VIEW OF DAM FROM SOUTH SIDE

PHOTO 2 – VIEW OF DAM FROM NORTH SIDE

PHOTO 3 – VIE OF SAMPLING PLATFORM AND VARIOUS FRAMES ALONG LENGTH OF DAM

PHOTO 4 – VIEW OF FRONT FACE OF DAM

PHOTO 5 – VIEW OF SURFACE WATER INLET TO POND