





















Appendix 8 Methodology for Exposure Assessment and Ground Gas Risk Assessment



METHODOLOGY FOR EXPOSURE ASSESSMENT

The following is a general statement of JPB's methodology for investigating and assessing potentially contaminated sites for the purposes of identifying constraints posed by contamination issues. There is a large body of authoritative technical guidance in this field and it would not be either appropriate or worthwhile for this methodology to repeat verbatim that guidance, and the methodology does not seek to do so. Each site will be different, with different constraints and challenges and site specific investigation and assessment details for individual sites are given within the text of each report. The following text provides an informative summary of the methodology JPB generally apply to such sites.

Regulatory Framework

The assessment of potentially contaminated sites and the associated risk to the proposed development is dependent on a number of factors namely; the intended site end use, distribution and level of contamination, characteristics of the soil (i.e. pH, permeability) the groundwater regime and the sensitivity of the surrounding area. An analysis of the interaction between these various factors allows a decision to be made with regard to the extent of any remedial measures required for the development.

The contaminated land provision of the Environment Protection Act 1990, inserted by Section 57 of the Environment Act 1995, came into force in July 2000. In May 2006 the Scottish Executive issued a revised Statutory Guidance Edition 2 (SE/2000/43). Within this "Contaminated Land" is defined as

"any landin such a condition by reason of substances in, on or under the land, that

- a) significant harm is being caused or there is a significant possibility of such harm being caused; or
- b) pollution of the water environment is being, or is likely to be caused;"

In addition *"the questions*

- a) what harm or pollutant of the water environment is likely to be regarded as significant
- b) whether the possibility of the significant harm or significant pollution of all the water environment being considered significant"

In addition, PAN 33 is affected by this and embodies a "suitable for use approach" for land for development, which requires remediation only where there are unacceptable risks to health and the environment depends on the current and proposed end use.

In addition, the guidance requires a significant pollutant linkage to be present which includes;

- A source (pollutant)
- A pathway
- A receptor

JPB have therefore developed a risk assessment approach based on this philosophy, the methodology used is represented diagrammatically in the attached flow chart.

Stage 1 - Preliminary risk assessment-

Desk Study

The methodology utilised for desk studies follows the specifications outlined in CLR2 "Guidance on Preliminary Site Inspection of Contaminated Land", CLR6 "Prioritisation and Categorisation Procedure for Sites which May be Contaminated", CLR11 Model Procedures for the Management of Land Contamination, DEFRA/EA 2004, Contaminated Land Risk Assessment, CIRIA C552 and BS 10175 "Investigation of Potentially Contaminated Sites – Code of Practice", BSI.



During the study, documentary research will include an examination of the Ordnance Survey maps for details regarding previous site and adjacent land uses. Similarly, the available geological maps will be examined to determine the geological/hydrogeological conditions beneath and adjacent to the site. In addition, regional memoirs will be consulted together with mine abandonment plan data and any available borehole records, in order to assess the mining conditions. The assessment also takes cognisance of the information contained in the guidance documents "Risk Based Approach to Development Management – Resources for Developers" published by the Coal Authority and CIRIA SP32 "Construction over Abandoned Mineworkings".

A walkover survey will be carried out to determine the existing site conditions and operations. In addition, a photographic record of the site is taken during the walkover survey.

Information will also be obtained from the SEPA, BGS and Coal Authority websites and other authoritative online resources and from a review of in-house information. A report of environmental database information may also be obtained.

Conceptual Site Model

A Conceptual Site Model (CSM), which describes how potential chemical sources at the site could contribute to increased levels of risk to potentially sensitive receptors, is developed at an early stage and constantly reassessed in light of investigative findings. CSMs are generated in accordance with Guide to Good Practice for the Development of Conceptual Models and the Selection and Application of Mathematical Models of Contaminant Transport Processes in the Subsurface - National Groundwater & Contaminated Land Centre report NC/99/38/2 – Environment Agency 2001.

The first step in developing such a model is to identify whether there are potential hazards which may pose a risk on the site through desk top research and professional judgement. In addition, information regarding the site-specific environmental setting including geology, hydrogeology, hydrology etc, is gathered in order to assess the potential exposure pathways which are likely to exist and the location of humans and environmental resources which could be impacted by the site.

Following this desk-based study and the development of an initial CSM (ICSM), a site investigation is designed in order to determine whether any potentially significant pollutant linkages actually exist on the site. The information gathered during the investigation is then used to revise the ICSM and as the basis of the risk assessment process. While any investigation strategy will be specific to each site the following general comments can be made.

Design of Site Investigations

JPB design and implement site investigations cognisant of the guidance given in BS10175. Care is taken to target investigations at potentially contaminated locations identified in the ICSM from researches and from site visits or other available information. In addition, during the performance of investigations locations are refocused in the light of known site conditions. Further investigations are also undertaken at randomly selected locations resulting in a mixture of random and targeted investigation locations.

The requirement for adequate site coverage is a key consideration at the design stage and the number and type of investigation locations is determined by the available information, the brief and the requirements of the guidance given in CLR4 and R & D Publication Report P5-066/TR Secondary Model Procedure for the development of Appropriate Soil Sampling Strategies for Land Contamination. BS10175 indicates that in order to provide adequate site coverage a sampling grid of between 10m and 25m should normally be applied for a main investigation, for example where a residential development is considered. Where the ICSM indicates there to be no potential source of contamination on the site, or other land uses are envisaged, JPB consider that a wider grid, for example 50m spacing, may be adopted.



Site Zoning

Some sites may need to be divided into geographical sectors where, for example, historical land uses differ or the type of development varies across the site in accordance with R & D Technical Report P5-066/TR. Good practice guidance describes averaging areas as "areas of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions". Where made ground material is contaminated at variable concentrations, but within a single geological unit, JPB consider that this unit can be adopted as an averaging area for the purposes of making an assessment of human health risks. However, where measured contamination concentrations include statistical outliers of high concentration, where different historical land uses have resulted in different patterns of contamination or where there is a clear distribution of higher contaminant concentrations in one sector of the site, averaging areas are chosen to reflect this contaminant distribution. Single high contaminant concentrations may indicate the presence of "hotspots" which may merit closer scrutiny or additional investigation.

Site Coverage

Investigation locations such as trial pits and boreholes are positioned to provide adequate site coverage, where access is available and avoiding existing services. Boreholes are situated at a mixture of targeted and random locations at the site where access is possible.

During the investigation the sampling strategy in CLR 4 "Sampling strategies for contaminated land" together with the guidance given in R & D Publication Report P5-066/TR is followed. The rationale behind the sampling strategy given in the R & D publication is:

Depth of sample	Rationale
0-0.5	To assess
	 Human/animal intake arising from ingestion and dermal contact. Potential for wind entrainment leading to inhalation (of contaminated soils and dusts) or deposition onto neighbouring land. Surface water run-off (e.g. due to flash flooding). Uptake by shallow rooting plants (e.g. crops, ornamental and wild species). Surface leaching to groundwater.
0.5m in made or natural	To assess
ground	 Intake via ingestion/inhalation/dermal contact from "abnormal" (or unpredicted) excavation (e.g. children digging dens) or for other purposes such as swimming pools, ponds house extensions). Uptake by deep rooting shrubs and trees. Intake by, or arising from, the activities of burrowing animals. Intake arsing from construction / maintenance of buildings and services for example. Foundations (usually within 2m of formation level). Water supply pipes, telecommunications, gas & power (0.5-1m of final formation level). Sewers (from 0.5 > 1m of final formation level). To locate perched water or groundwater. To confirm depth of made ground. To locate possible lateral pathways for gas or vapour migration in made ground. To establish extent of any leaching of soluble constituents from superficial soils. To detect "deep" contaminants (e.g. gas generating materials, leachable materials, dense solvents
	located on top of an impermeable stratum). To obtain information of "background" soil properties. To locate "natural" lateral migration pathways.

Samples are generally taken at shallow depth, then at where relevant changes are noted in materials with depth. Where any made ground is thick and relatively uniform samples are taken at least every 0.5m to 1.0m. Where organic contamination is observed within made ground, a sample of natural soil is generally taken from beneath each made ground horizon where the base is proven. Samples are recovered from each trial pit. Samples are recovered at these regular intervals with additional samples of any atypical horizons also taken. It should be noted that there will always be the possibility of additional unrecorded conditions outwith the sampling points. Samples obtained are stored within appropriate containers and dispatched for analysis within 24 hours of sampling.



Attempts are made to recover water samples from all of the boreholes at which standpipes are installed. Each borehole is extensively purged to a volume in excess of three times the well volume, where feasible, using a submersible mini-whale pump or bailer. Purging before sampling allows a more representative water sample of groundwater to be obtained and ensures that any water initially present in the boreholes is removed as this may have been chemically altered due to reaction with air or with installation materials. Water samples are transferred to appropriate containers before being transported to the testing laboratory in cooled conditions.

Testing parameters scheduled on soil and water samples are based on historical and current operations information and their importance in relation to health risks, phytotoxicity, impact on the water environment, protection of building materials, services and structures from chemical attack and potential impact on the quality of potable water supplies. Where possible chemical testing is targeted at locations at the site where particular contaminants are anticipated, with additional testing scheduled to give horizontal and vertical site coverage. Selection of test parameters is performed on a site specific basis as described in the text of each investigation report.

Stage 2 Generic Quantitative Risk Assessment

The next stage of the site-specific assessment is to perform a Stage 2 risk assessment using the information gathered during the site investigation to determine the actual nature and extent of contamination, evaluating the data using conservative generic criteria to determine whether any recorded levels of contaminants could be potentially of concern.

Stage 2 Criteria

The Stage 2 generic quantitative assessment of risks to human health, property, ecology, surface water and ground water considers the potential for exposure based on comparison of the results to conservative generic criteria.

Human Health Risks

DEFRA and the Environment Agency including; Soil Guideline Values (SGVs) derived using the CLEA model and the methodology described in EA Science Report SC050021/SR3, EA CLEA science reports and the associated TOX and SGV series of reports. In addition, JPB have adopted S4UL values published by LQM/CIEH and GAC values published by EIC/AGS/CL:AIRE as GACs and, where other suitable values are not available, GACs derived by JPB generated using the CLEA model and in accordance with the above guidance.

The Contaminated Land Exposure Assessment (CLEA) model was developed for the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency. The model estimates child and adult exposures to soil contaminants for those potentially living, working and/or playing on contaminated sites over long time periods and has been used to produce the Soil Guideline Values for the UK, first published in 2002. The guidance was updated following the "Way Forward" process, and the revised technical guidance and SGVs above published in 2009.

The CLEA model used to derive generic criteria has undergone a number of updates, the model used for the derivation of current published criteria; SGVs, S4ULs, EIC/AGS/CL:AIRE was Version 1.06. S4ULs were, however, derived using some exposure parameters amended in the light of the C4SL project (see below).

The CLEA model calculates GACs which represent doses "without appreciable health risk" or "minimal human health risk" depending on whether a contaminant is a threshold or non-threshold substance. An update (version 1.071) was released in 2015, and includes the library data sets from the DEFRA research project SP1010 (Development of Category 4 Screening Levels (C4SLs) for assessment of land affected by contamination), allowing the derivation of generic criteria characterised as representing "low" levels of risk.



In addition, CLEA 1.071 continues to allow the derivation of GACs which represent doses "without appreciable health risk" or "minimal human health risk". This procedure has been adopted to calculate JPB derived GACs using CLEA 1.071. JPB derived criteria are based on conservative assumptions including; the development of small terraced houses on the site, a soil organic matter content of 1% and pH value of 7.

C4SLs represent a higher, but still low, level of risk than SGVs, S4ULs, EIC/AGS/CL:AIRE or JPB GACs. Although they represent different levels of risk, JPB consider that both C4SLs and other JPB GACs are appropriately protective generic criteria for assessing contaminated land for the following reasons. S4ULs, EIC/AGS/CL:AIRE and JPB GACs have been derived in accordance with technical guidance and a risk assessment model which are scientifically based and have been published by authoritative bodies. C4SLs have been confirmed to represent levels of risk which are lower than is required to meet the definition of "contaminated land" ("Simplification of the contaminated land regime", Impact Assessment: Defra 1133). Their use is also endorsed by DEFRA in their Policy Companion Document to the SP1010 project which states that C4SLs "are intended to be more pragmatic (whilst still strongly precautionary) compared to existing generic screening levels".

Where available C4SL values have been adopted as JPB GACs. However, to date only a limited number of HCVs for C4SL have been published and consequently a limited number of contaminants have published C4SLs. As selecting an appropriate C4SL HCV requires specialist toxicological competences, JPB have not derived HCV for additional contaminants. Where a published C4SL is not available for a particular contaminant, JPB have adopted a GAC derived using the CLEA model and based on "without appreciable health risk" or "minimal human health risk" risk levels. Where an S4UL or EIC/AGS/CL:AIRE value is available it has been adopted as a GAC, where no C4SL, S4UL or EIC/AGS/CL:AIRE GAC is available, JPB GAC derived in accordance with the above guidance have been adopted.

Annex E of SP1010 indicates that in order to apply the benzo(a)pyrene surrogate approach and C4SL used in the above guidance, the assumptions made in its derivation must be verified, in particular the PAH profile in the site soils must be similar to the test material used in the toxicological study on which the C4SL HCV is based. To assess the PAH profile in the test soil samples, JPB calculate the ratio of seven other genotoxic PAHs (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene and indeno(1,2,3-c,d)pyrene), relative to benzo(a)pyrene, to ensure the site soil PAH profile is similar to the test material used in the study. The ratios relative to benzo(a)pyrene must fit within the upper and lower limits detailed in Table 2.5 and Figure 2.1 of Annex E.

These ratios are calculated for soils at each site and the result appended to the report. It should be noted that PAH ratios are calculated for samples with appreciable PAH contents, as the above ratio test does not work correctly where some genotoxic PAH concentrations are near or below laboratory reporting limits as ratios become skewed by zero or "less than reporting limit" values.

Phytotoxic Risks

To assess the site's potential for phytotoxicity JPB refer to the MAFF/DoE document "Review of the Rules for Sewage Sludge Application to Agricultural Land – Soil Fertility Aspects of Potentially Toxic Elements" in the absence of other definitive phytotoxic screening levels. This document is authoritative and scientifically based, it sets out total concentrations of various metallic elements which shouldn't be exceeded in order to maintain soil fertility and avoid toxicity. Therefore, it is considered that these limits can be applied to contaminated land and other situations, e.g. they have been adopted by DEFRA in its "Soil Code" and by the Forestry Commission. It should be noted that plant growth can also be significantly affected by many other factors including: pH, nutrient availability, soil texture and structure, temperature, moisture content and aeration. In addition, reference has been made to "Soil Code" (MAFF 1998), and CLR2, "Guidance on Preliminary Site Inspection of Contaminated Land".



Structures and Services

Where structures or services are considered to be viable receptors, risks are assessed using contemporary best practice guidance given in documents published by the Building Research Establishment (BRE), CIRIA, Water Research Council (WRc), UKWIR, the HSE and other relevant organisations.

Risks posed to buildings and services due to aggressive soil sulphate, chloride and pH conditions are assessed using the guidance given in BRE Special Digest 1 (2005), Concrete in aggressive ground.

Water Supply Pipes

Risks posed by soil and groundwater contaminant concentrations to water supply pipes are assessed in accordance with the UK Water Industry Research (UKWIR) document, "Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites", UKWIR report reference 10/WM/03/21, 2010. This guidance identifies the chemicals present in soils which can either permeate pipes or impact on their integrity by causing swelling, cracking and degradation or corrosion. The main focus is, therefore, on organic contaminants and on the soil's conductivity, pH and redox potential. Due cognisance is also taken of the requirements and guidance issued by utility companies.

UKWIR guidance states that where a site has been greenfield and no chemicals have been historically or currently stored or used on it (or part of the site meets these criteria), no restriction is made on the type of water pipes which can be used on the site (or part of the site as appropriate). Direct communication between JPB and Scottish Water (SW) indicates that SW will not require intrusive investigations on sites which have been greenfield throughout their history, providing supporting documentary evidence is supplied.

Where investigations are required, samples are obtained from locations on site as identified in the site ICSM. Where the route of water supply pipes is known, sample locations during investigations would include locations on or within 15m either side of the route, otherwise investigation coverage for the whole site is as described previously in this methodology, as recommended in section 2.5.5 of the UKWIR report and in SW guidance.

Selected soil samples are tested for the parameters recommended in the UKWIR guidance; VOCs (including TIC), SVOCs (including TIC), amines, petroleum hydrocarbons (including "mineral oils"), conductivity, pH value and redox potential. Results of analyses are collated and compound group concentrations summed as described in section 2.7.9 of the UKWIR guidance, these sums are adopted as Representative Contaminant Concentrations (RCCs). The maximum concentration recorded at the site (or if appropriate within a particular site zone) for each substance is used for summing and tabulation, this is a conservative assumption.

The RCCs are compared with the UKWIR threshold values for polyethylene (PE) and polyvinylchloride (PVC pipes) detailed in Table 3.1 of the UKWIR, which have been adopted as JPB GACs. Exceedence of a single GAC indicates PE or PVC pipework is not appropriate and other pipe materials should be selected. Consideration of the corrosive properties of soils is also required where PE, PVC or barrier pipes are not selected as appropriate. The comparison of RCCs with GACs and the other criteria in Table 3.1 of the UKWIR guidance results in a list of pipe materials which would be suitable in terms of chemical properties, a preferred selection can then be made on the basis of cost, appropriateness etc. or the choice of specific materials to be used made by the engineer/developer. Further recommendations on standards and specifications for water supply pipes and fittings for various pipe materials are given in Part 4 of the UKWIR guidance.



Combustibility

Where potentially combustible materials are encountered the following assessment methodology is adopted. Despite the potential for combustion in many sites characterised by carbonaceous materials, the number of recorded instances of actual combustion are very few and there has been no definitive study of the phenomena. Consequently, there are no commonly accepted criteria for comprehensively assessing and dealing with the risk of spontaneous combustion. The ICRCL Guidance Note 61/84 "notes on fire hazards of contaminated land" suggests that there is an unacceptable risk of combustion if the material has a Calorific Value in excess of 10 MJ/kg or perhaps only 7 MJ/kg.

However, a paper presented at the Fourth Mineral Waste Utilisation Symposium related to the Utilisation of Coal Refuse for Highway Base or Sub-base Material. In this paper it states that "low permeability values are desirable in order to reduce air circulation and the potential for spontaneous combustion". It then goes on to suggest that "proper compaction of coal refuse reduces air voids to less than 10% and the potential for spontaneous combustion is substantially reduced".

There is an imprecise relationship between Loss on Ignition and Calorific Value but previous comparisons by JPB have indicated 10 MJ/kg to be roughly equivalent to 30% Loss on Ignition and 7 MJ/kg to be roughly equivalent to 23% Loss on Ignition.

JPB adopts the following guidelines:

- i) combustion may be induced and supported only if the Loss on Ignition value exceeds about 20% and the Calorific Value exceeds 7 MJ/kg.
- ii) carbonaceous material needs to be of some bulk ie thicker than 1 metre and greater than 10 m³ in volume.
- iii) spontaneous combustion should not occur in thoroughly compacted material to which air is excluded.

Water Environment

Current SEPA guidance described in document WAT-PS-10-01: Assigning Groundwater Assessment Criteria for Pollutant Inputs (Live Document) notes that for land contamination four receptors were to be assessed, if identified as being present, namely; surface water; groundwater abstraction, groundwater resource, and groundwater dependant terrestrial ecosystem (GWDTE or wetland). Routine leachability testing is carried out for water soluble contaminants in order to determine if there is a threat from soil borne contaminants to ground and surface waters.

For the protection of surface waters and groundwater resources the concentration of each contaminant in soil leachates, groundwaters and surface waters are compared against relevant assessment limits. The assessment limits may be a UK Drinking Water Standard (UKDWS), Resource Protection Value (RPV) or EQS depending on the nature of the receptor which is being considered to potentially be at risk. In addition, reference is made to SEPA guidance document WAT-SG-53: Supporting Guidance, Environmental Standards for Discharges to Surface Waters, The Scotland River Basin District (Standards) Directions 2014, UKTAG's m-BAT tool and SEPA's River Basin Management Plans.

Where no assessment limit has been provided by SEPA, other limits may be adopted such as WHO Drinking Water Guidelines, US EPA National Primary Drinking Water Regulations or the laboratory's minimum reporting limit (MRL).



Stage 2 Risk Evaluation

Stage 2 risk-based guidance levels such as GACs are conservative generic values against which measured contaminant concentrations can be compared. Where measured concentrations are found to be below these screening criteria then the contamination identified is not considered to pose a significant risk. The guidance used to evaluate investigation data is chosen to be relevant for the particular risk and receptor being assessed as well as being applicable to the legislative issues of concern. Where measured concentrations of contaminants exceed generic criteria, the risks posed by the contaminants of concern are considered more fully in a Stage 3 risk assessment. Where no generic criteria are available or a substance, an automatic Stage 3 assessment is carried out if the contaminant is present above laboratory reporting limits.

Stage 2 criteria adopted by JPB for risk assessments are included in reports. If any of the appropriate criteria contained in these documents are exceeded, the conclusion is that significant risk could exist and that a further assessment (Stage 3) is warranted in order to calculate the potential levels of risk. This process, therefore, focuses on the contaminants of concern and can, if necessary, inform any further investigations which may be required for more detailed examination.

Derivation of JPB Human Health Criteria

Assessment of risks to human health

Each contaminant exceeding Stage 2 criteria is examined for its potential to cause harm. Consideration is then given to the significant pollutant linkages which are plausible for the identified hazards, i.e. whether a contaminant can conceivably come into contact with a specified receptor group. It is possible that a contaminant may be deemed a hazard due to its presence above screening criteria but ultimately not constitute a risk as no viable pathway exists between the source and the receptor. The relative sensitivity of all potential receptors identified is quantitatively assessed using the data obtained during the desk study and site investigation phases.

The risk to human health is determined using an exposure assessment, an estimate of potential doses of the chemicals in exposed individuals via the pathways identified in the ICSM. This focuses on a hypothetical individual within each exposed population and involves the use of models which incorporate assumptions regarding human behaviour and physiological attributes. The assumptions are made in a "worst case" or "reasonable worst case" manner to provide estimates of dose which are unlikely to be exceeded by receptors at or in the vicinity of the site. The main focus of the exposure assessment is the estimation of long-term (chronic) dose levels from repeated exposure to chemicals in the soil and groundwater. In some cases, for example cyanides, acute exposure is also considered. Exposure to each chemical is estimated for each viable pathway and for any potential sensitive receptors.

The purpose of the human health assessment is to identify the levels of exposure to contaminants which, if not exceeded, do not cause unacceptable adverse health effects. The subject of human health assessments is covered in depth in the DEFRA/EA Science reports to which the reader is referred for further background information, however, a short review is given below.

Health Criteria Values

Human health assessment criteria are derived by comparing the estimated exposure of critical receptors to the contaminants with Health Criteria Values (HCVs). HCV represent a tolerable or minimal risk to health from chronic exposure to these contaminants or, in the case of C4SLs, a "low" risk level. Acute health risks must be assessed separately. Health Criteria Values are derived through the collation and review of toxicological data and its subsequent use in the derivation of soil contaminant intakes that are considered to be protective of human health. These intakes are guidelines to a risk assessor on the level of long-term human exposure to individual chemicals in soil that are tolerable or pose a minimal risk, or in the case of C4SLs pose a low but acceptable risk. HCVs are established from a review of the evidence from occupational and environmental epidemiological studies, animal studies and from scientific understanding of the mechanisms of absorption, transport, metabolism and toxicity of chemicals within the human body.



The derivation of HCVs for tolerable or minimal risks is described in detail within EA Science report-SC050021/SR2. The derivation of HCVs representing low risks used to derive C4SLs is described in DEFRA report SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination.

Contaminants generally exhibit two possible types of toxicity, threshold toxicity and non-threshold toxicity. For contaminants which exhibit threshold toxicity there is some, non-zero, measurable amount of exposure (dose) that is required before a biological threshold is breached and an adverse health effect is produced. However, in some cases the toxicological mechanism responsible for producing the adverse effect is such that there is no basis to assume a threshold exists. This is most notably the case for genotoxic carcinogens. The biological mechanisms by which these types of chemicals cause damage to DNA and genetic material means that any exposure to these chemicals, no matter how small, will carry some level of risk. The theoretical basis for this is that one 'hit' on DNA can produce a mutation that may eventually lead to a tumour. It is, therefore, not possible to identify the threshold with any confidence. Hence, the prudent assumption is made that such compounds do not have a threshold. It should be noted that not all carcinogens are genotoxic, some may exhibit a threshold, and whether a contaminant is a threshold or non-threshold substance should be determined by a review of the available toxicological evidence.

HCVs for Tolerable or Minimal Risk

HCVs for tolerable risk levels for threshold substances are referred to in the UK as Tolerable Daily Intakes (TDIs), some other authorities or organisations derive similar criteria such as Reference Doses (RfDs) or Provisional Tolerable Weekly Intakes (PTWIs). These values are in principle similar and can be thought of as "safe" levels of exposure at which adverse effects are not likely to occur, although some conversion or further consideration may be required before adoption of values from other jurisdictions in the UK context. These health criteria are typically derived by applying "safety" or "uncertainty" factors to intake levels observed to have little or no effects in humans or animals.

Exposure to receptors will occur not just from soil-borne contamination but also from intakes of food, water and air. Where a contaminant is a threshold substance these background intakes of a contaminant must, therefore, be calculated and subtracted from the TDI, to calculate the intake of the contaminant which could be tolerated from exposure to soil contamination alone (this quantity is the TDSI – Tolerable Daily Soil Intake), in addition to normal background exposure. This background intake is the Mean Daily Intake (MDI). Where information is not available on intake levels of contaminants or where the MDI exceeds the TDI, the Science report-SC050021/SR3 states that the TDSI should be set in the model to be 50% of the TDI.

DEFRA/EA have adopted the Index Dose (ID) as the HCV for minimal risk levels for non-threshold substances, which can be considered to present a minimal human health risk from exposure to soil contaminants. For non-threshold contaminants background intake is not considered as there is no "safe level". In addition, application of the ALARP (As Low As Reasonably Practicable) principle for these substances means that intake should be reduced to as low a level as practicable, that this principle is being adopted by the competent authorities for intakes from food, water and air and that actions are being taken to reduce these other intakes.

There are a number of sources of toxicity criteria and background exposure levels which include Department of the Environment, Food and Rural Affairs (DEFRA); World Health Organisation (WHO); the US Environmental Protection Agency (US EPA) IRIS (Integrated Risk Information System) and other published scientific literature. Where available the definitive UK toxicological and background exposure levels published in the DEFRA/EA/SEPA CLEA TOX reports, under the advice of the Department of Health and The Food Standards Agency, are used as the primary source. However, as authoritative UK based information is available for only a limited number of substances, health criteria and other model input data has been sourced from non-UK published information. The methodology outlined in Science report-SC050021/SR2 has been used to derive HCVs where an authoritative UK HCV has not been published.



HCVs for Low Risk

HCVs for low levels of risk are known as LLTC, LLTC used in deriving C4SLs adopted by JPB have been derived as described in DEFRA report SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. The assumptions and decisions used to derive LLTC are discussed in the above document. The overall LLTC derivation methodology described contains several elements which are similar to or, conversely, differ from, those used to derive "minimal risk" HCVs. Key aspects of the similarities and differences between the approaches are summarised in Table 2.4 of the above document.

General Approach to Risk Estimation

Stage 2 generic criteria have been selected from published values or derived by JPB as described above. JPB derived GACs using the CLEA 1.071 model where sufficiently reliable UK authoritative or peer-reviewed input data (including HCVs) is available. In the first instance the model input values published by DEFRA/EA, derived by Land Quality Management (LQM) in association with the Chartered Institute of Environmental Health (CIEH) and data published in Environment Industry Commission (EIC)/CL:AIRE Report: Soil Generic Assessment Criteria for Human Health Risk Assessment have been used for JPB derived GAC if available. Both the CLEA model and C4SL methodology derive GACs for use when considering the risk to human health from chronic exposure to toxic metals, metalloids and organic substances in soil. The assessment criteria represent contaminant concentrations in soils, which if exceeded on site may be indicative of unacceptable risks to human health. It is envisaged that these methodologies can also be used as a tool during either the detailed quantitative risk assessment or the risk management process.

These methodologies adopt the risk-based source-pathway-receptor pollutant linkage framework and a deterministic methodology. The exposure pathways considered are direct ingestion of soil and dust, direct dermal contact with contaminated soil, consumption of home grown or allotment vegetables, ingestion of soil attached to such vegetables, inhalation of soil vapours outdoors and inhalation of soil vapours indoors. The CLEA model used in both methodologies is intended to reflect and be compliant with the guidance in DEFRA/EA Science Reports.

Where input data from the above sources is not available, data published by other organisations has been used. It should be noted that the toxicological data available for particular substances in many cases is very limited and incomplete. In order to adopt a relatively consistent approach, where authoritative or peer reviewed UK data is not available, data has been obtained primarily from USEPA and Dutch RIVM report sources as these sources offer a wide range of expert reviewed parameter values such as health criteria values, physical and chemical property data for commonly encountered soil contaminants.

Risks posed by Polychlorinated biphenyls (PCBs) in soil

For risk assessment purposes PCB congeners are divided into two groups; (1) dioxin-like PCBs and (2) non-dioxin like PCBs. Dioxin-like PCBs have similar structures and toxic mechanisms to dioxins and furans and so are assessed together with dioxin and furans. Non-dioxin like PCBs have a different toxic end point to dioxin-like PCBs and must, therefore, be assessed separately.

If the criteria set out in the SGV report are fulfilled, the PCB test results can be directly compared with the SGV given in the report. However, SGVs relate to background PCB levels where a site source is absent, and this limits the applicability of the SGV.

Where the assumptions required for the use of the SGV are not met, dioxin-like PCBs are assessed using the SGV worksheets for the standard land uses. Where site specific dioxin and furan data is not available, the median urban or rural dioxin and furan values given in the SGV report are used to account for "background" concentrations of these substances. A hazard index (HI) is calculated using the worksheet and if the HI is >1, then dioxin-like PCBs may pose a risk to human health receptors in the scenario being considered.



A specific methodology to assess risks posed by non-dioxin like PCBs has not yet been published by EA/DEFRA, however, JPB have adopted the current UK methodology used to assess other organic compounds. This involves selecting a list of target compounds, a TDI and other input data and using the CLEA model to derive GACs. PCBs are typically present as mixtures. The most persistent and toxic non-dioxin-like PCBs are present at their highest concentrations in PCB mixture aroclor 1254. The 7 ICES list indicator PCBs make up about 50% of aroclor 1254. JPB, therefore, compare the sum of these indicator PCBs with the assessment criteria. The criteria are derived using a TDI for aroclor 1254 and other input data using the CLEA model. The TDI is adjusted to account for the percentage of the 7 ICES compounds present in aroclor 1254. If the sum of the soil concentrations of the 7 ICES exceeds the GAC, then non-dioxin-like PCBs may pose a risk to human health receptors in the scenario being considered.

Therefore, if either the dioxin-like PCB or non-dioxin-like PCB assessment indicates the presence of a risk, remediation may be required or a further assessment may be proposed.

Risks posed by Cyanides in soil

Cyanide compounds exhibit both acute and chronic toxicity, although it should be recognised that complex cyanides are much less toxic than free cyanides. There is currently no UK SGV available to assess chronic cyanide toxicity, although a review of the toxicology of cyanide has been published (DEFRA CLR TOX 5 report).

Criteria derived to be protective of chronic cyanide exposure exceed those derived to be protective of acute exposure to both types of cyanide. Therefore, the criteria derived for acute exposure to free and complex cyanides have been conservatively adopted to be protective of receptors.

The Environment Agency has not published guidance on the assessment of risks due to acute exposure to cyanide compounds. However, HPA publications indicate that hydrogen cyanide and its solutions may be fatal following acute exposure via all intake routes (ingestion, inhalation and dermal). The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) published a nominal acute reference dose (ARfD) based on the lowest reported acute lethal dose. JPB have derived assessment criteria for free and complex cyanides in soils based on the above ARfD, exceedence of which is considered to pose a risk to sensitive site receptors.

Stage 3 Detailed Quantitative Risk Assessment

Representative Contaminant Concentrations and Site Specific Assessment Criteria

To merit a Stage 3 assessment concentrations of contaminants will have exceeded Stage 2 criteria, or there are no available Stage 2 criteria. At this stage the chemical dose to potentially exposed human receptors are calculated, incorporating site specific data together with conservative health assumptions where necessary to derive Site Specific Assessment Criteria (SSACs). Data evaluation and statistical procedures are used to derive representative contaminant concentrations (RCC) for contaminants of concern in the relevant averaging areas of sites. RCCs are compared with SSACs at the risk evaluation stage in order to determine their significance. This process effectively reduces the conservatism of the Stage 2 assessment and provides a site specific assessment at Stage 3.

At Stage 2 all soil contaminant concentrations are compared with GACs. At Stage 3 RCCs are calculated and used for comparison with assessment criteria. Depending on the nature of the data the RCC may consist of either the maximum concentration recorded or a 95% Upper Confidence Limit (UCL95). Where small data sets are available, or where point source contamination such as hydrocarbon spillages are present, statistical analysis is not appropriate and the maximum contaminant concentration recorded is adopted as the RCC. Where larger data sets are available statistical analysis may be performed to derive an RCC where appropriate. Where RCCs exceed assessment criteria this indicates that the contaminant poses a human health risk and that remedial actions may be required to prevent actual harm. As an initial assessment, JPB generally alter only



specific pH and %SOM values and the development type to generate SSACs. Should a more detailed DQRA assessment be merited, a more extensive re-examination of data inputs may be undertaken.

Statistical analysis is carried out in accordance with the methodology outlined in guidance given in CL:AIRE/CIEH Publication, "Guidance on Comparing Soil Contamination Data with a Critical Concentration". A number of statistical tools may be used for deriving UCL95 values, JPB principally use ProUCL, a software package developed by the US EPA for this purpose. In general, RCC values are selected as follows;

- Determine if there is sufficient data for statistical analysis, if not the maximum concentration is selected as the RCC;
- If data is sufficient the data set for each contaminant is tested for distribution type (normal distribution, lognormal etc.);
- The data set for each contaminant is tested for the presence of outliers, and these are considered for removal or inclusion in further calculations;
- An appropriate UCL95 is calculated, based on the distribution type and revised data set, and this is used as the RCC.

Consideration of whether outliers represent potential contaminant hotpots is also undertaken.

Lead risks are assessed using a C4SL value derived using a model which uses the geometric mean of blood lead levels as one of its input parameters. For this reason, the log transformation of soil lead concentrations across a site is required prior to deriving the RCC.

Stage 3 JPB Risk Estimation Practice

JPB's Stage 3 assessment practice is to calculate SSACs, incorporating site specific data together with conservative health assumptions where necessary. This effectively reduces the conservatism of the Stage 2 assessment and provides a site specific assessment. Depending on the pollutant linkages identified in the conceptual site model and on the nature of contamination identified during site investigations, particular risk assessment tools are selected which are considered to be appropriate to assess risks to human health under the existing site conditions.

The CLEA model used has been designed to comply with current UK DEFRA guidance on the assessment of contaminants on land and where possible this is JPB's risk assessment tool of choice. Health criteria, toxicological, physical and chemical data are input for each contaminant for the land use envisaged. The model derives a Site-Specific Assessment Criteria (SSAC) for the contaminant which, if exceeded, would represent a human health risk to the sensitive receptor. The basis of the CLEA models are more fully discussed in the CLEA software manual and DEFRA report SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination respectively.

The CLEA model used to derive SGVs, C4SLs, GACs and SSACs includes inhalation of outdoor and indoor dust pathways where appropriate. Inhalation pathways are most important in driving risk assessments where inhalation HCVs are low or where inhalation exposure is high. Where a Stage 3 assessment is required, the inhalation SSACs may be presented in JPB's reports to allow further consideration of these pathways and any remedial actions which may be required.

On completion of contemporary developments, the amount of bare soil exposed is generally limited to localised landscaping. This is considered to be minimal as a proportion of the site area and given that clean topsoil will generally be placed to provide a suitable rooting horizon during development, this pathway will be usually be broken by this cover for most inorganic contaminants and, therefore, JPB do not assess this further. An additional degree of conservatism is build into the assessment here as the overall SSACs still have these pathways included. However, where volatile organic contaminants are present, such as BTEX or naphthalene, these substances may potentially migrate through clean cover and, if present at sufficiently high concentrations, may require the introduction of protective measures such as the installation of membranes in solums of buildings etc. to prevent unacceptable exposure to receptors via vapour migration and inhalation. The generation of dust during site works may also expose site operatives or the occupiers of adjacent properties to health risks and should be



managed by the provision of appropriate PPE and adoption of appropriate site practices as described in CIRIA document 132 "A guide for safe working on contaminated sites".



Stage 3 Assessment of Risk to Other Receptors

The ecological risk assessment is carried out with respect to both on-site and off-site ecologically sensitive sensitive receptors. A review of information can indicate whether any nearby ecologically sensitive areas are likely to be impacted by on-site derived contamination; a comparison of contaminant levels found in the on-site ecologically sensitive areas can also be made with the UK Environmental Quality Standards for the protection of wildlife.

Contaminants which are at concentrations in excess of the Stage 2 screening criteria are determined to present a potential risk to the water environment and these contaminants therefore require assessment at a Stage 3 level. The purpose is to ascertain if the concentrations create a risk. It is important to consider factors such as the background groundwater quality, the sporadic nature of the perched groundwater and the separation of the site from the regional groundwater by an aquiclude.

The most significant receptors in the water environment assessment are generally considered to be the local shallow and deep groundwater and local surface waters. At some sites there is the potential for contaminants detected on-site to detrimentally affect off-site water receptors. Deeper (bedrock) groundwater resources may be important in some areas, or where groundwater may be abstracted for use. The significance of the risk to these receptors is assessed by considering, either conceptually or using groundwater models, the potential effects contaminants may have to groundwater and surface water receptors.

Stage 3 Evaluation of Risks to Groundwater and Surface Waters

An assessment of the potential for both contaminated soil and groundwater to affect the quality of water resources is undertaken in accordance with current SEPA guidance described in document WAT-PS-10-01: Assigning Groundwater Assessment Criteria for Pollutant Inputs (Live Document). This notes that for land contamination four receptor groups are to be assessed, if identified as being present, namely; surface water, groundwater abstraction, groundwater resource and groundwater dependant terrestrial ecosystem (GWDTE or wetland). Each receptor is considered in turn at the in ICSM stage, and investigations scoped to examine these linkages where necessary.

At Stage 2 the potential linkages identified in the ICSM are re-examined in the light of investigation findings, and only the viable linkages are considered further. Where relevant, recorded soil leachate, groundwater and surface water contaminant results are compared with GACs selected as described in the above guidance, dependant on the receptor being considered (e.g. UKDWS would be used where a water abstraction was the receptor). Where exceedences of GACs occur a Stage 3 assessment is undertaken.

In the Stage 3 Risk Assessment - Water Environment a re-examination of the ICSM is undertaken with respect to water environment receptors on the basis of site investigation data. Where a potential linkage remains, a back calculation is undertaken for the recorded soil leachate and/or groundwater concentration exceedences in accordance with the guidance in document WAT-PS-10-01 using the EA's Remedial Targets Methodology (RTM) and the associated Remedial Targets Worksheet hydrogeological modelling tool. After applying a dilution factor and where appropriate, degradation, the theoretical concentration of each contaminant at an assessment point is compared against the relevant assessment limit at that assessment point.

The assessment limit may be a UK Drinking Water Standard (UKDWS), Resource Protection Value (RPV) or EQS depending on the nature of the receptor which is being considered to be potentially at risk. The assessment point is the point at which assessment limit must be met. For the purposes of risk assessment, the assessment point is selected to be the nearest surface water course for surface water receptors, the site boundary (or 50m downgradient of the site boundary or 250m in a sewered urban environment) for the future groundwater resource receptors or in the raw water prior to any treatment this might receive for current abstractions. It should be noted that in contrast the SEPA guidance defines a compliance point as a "real" sampling point to demonstrate that inputs are acceptable. A compliance point may be the same location as the assessment point or <u>between</u> the source and receptor.



In addition, where required the Remedial Targets Worksheet can be used to calculate soil remedial targets which can be used to determine whether soil contaminant levels on site require remedial actions to prevent impact to water environment receptors.

For the above calculations it is assumed that leachate is theoretically produced by water infiltration from rainfall into site groundwater which can then migrate off site. In this case the leachate migrates through permeable strata until it enters a theoretical deeper groundwater. The remedial target which is calculated represents the maximum concentration of that particular contaminant which can be allowed at the assessment point or at its location on the site in the case of soil remedial targets. If concentrations are recorded above remedial targets, then theoretically by the time impacted groundwater has migrated to the assessment point it will be above the relevant assessment limit for that contaminant and remedial measures would be necessary.

Other analytical, numerical and probabilistic groundwater models are available to aid in the quantitative assessment of contaminated waters, the suitability of each which can be determined upon completion of site assessment and project requirements.

RISK-BASED CONCLUSIONS

The comparison of the estimated risks with the appropriate criteria indicates whether;

- 1) the site presents an insignificant risk based on the analysis; or,
- 2) there is a potential risk to health or the environment.

Where a risk has been identified remedial strategies can then be developed in order to break any source-pathway-receptor linkage. Strategies may include; source removal, breaking the pathway from the source to the receptor or choosing developments in which sensitive receptors are not included in areas where the risk exists.

As described above a number of remedial strategies can be adopted for a site and JPB select the most appropriate strategy for remediation on a site specific basis. One commonly adopted practice is to break the pollutant linkages by the introduction of clean capping materials. JPB have adopted, where appropriate, the BRE/DTI/NHBC/AGS document as a decision making tool to aid the design of remedial actions. This provides a research and data-based approach to designing cover systems rather than the use of professional judgement alone. It is, however, emphasised this document is used by JPB in the context of professional judgement and experience and a knowledge of site conditions.

As at the time of investigations the concentrations of contaminants present in material to be imported for capping may not be known, a conservative approach in which the imported material is assumed to have a contaminant concentration of 75% of the target guideline value is adopted. The spreadsheet which accompanies the document contains a viability check graph which indicates whether the capping layer calculated is acceptable or whether further consideration is required as to the effectiveness of the cover system proposed. JPB's procedure is to ensure that the effectiveness of the cover system proposed. JPB's procedure is to ensure that the effectiveness of the cover system is adequate for the site conditions encountered. Where these are exceeded more stringent remedial actions are recommended. JPB consider that this methodology provides a consistent, scientifically based rationale for designing cover systems in the vast majority of sites we encounter. Where more extreme conditions are encountered, or where there are specific site requirements, these issues will be considered on a site specific basis in order to be protective of receptors at the proposed development.

Specific measures are proposed where asbestos fibres or materials are recorded to be present and are to be retained, encapsulated on site. The recommended design of the environmental capping reflects the magnitude of the risks posed by the different types, concentrations and conditions of asbestos materials recorded to be present.



Remediation Strategy

Before any works can be carried out on site a Remediation Strategy is prepared in accordance with the "Model Procedures for the Management of Land Contamination" (CLR11) and the EA document "Verification of Remediation of Land Contamination". JPB integrate the requirements for the various stages of remediation works in Remediation Strategy, Implementation and Verification Plan documents.



Ground Gas Assessment Methodology

Introduction

The assessment of ground gas as a potential constraint to development has been the subject of a great deal of research and published guidance. Broadly speaking ground gas can be a concern for several reasons; flammable gases may cause an explosion, build up of gases within poorly ventilated areas may lead to asphyxia or toxic gases may cause harm to those exposed to them. In general, we consider principally methane and carbon dioxide levels, however the presence of other gases such as carbon monoxide, hydrogen sulphide, petroleum vapours etc may also be considered where appropriate. Some physical properties of ground gases are tabulated below.

Gas	Explosive Range	Density of 20°C	Toxicity % by volume in air*
Methane	5-15% by vol	0.72 kg/m ³	30 (low)
Carbon dioxide	N/A	1.98kg/m ³	0.5 (high)
Carbon monoxide	12.5-74.2% by vol	1.25kg/m ³	0.02 (high)
Hydrogen sulphide	4.2-46% by vol	1.54kg/m ³	0.001 (high)

* short term occupational exposure limits. The long term occupational exposure limit for carbon monoxide is 30ppm and for hydrogen sulphide is 5ppm.

These ground gases may originate from many sources including; mine workings, organic sediments, landfilling, biodegradable materials in made ground on brownfield sites, petroleum hydrocarbons or other site specific sources. The gas concentrations measured are the result of volatile emissions and the microbial degradation of organic materials. The processes by which materials degrade to form ground gases are discussed more fully in EA's Guidance on the Management of Landfill Gas, LFTGN 03, 2004.

Data Requirements and ICSM

JPB's overall methodology for ground gas assessments is summarised in the attached flow chart. In order to assess the degree of risk to receptors we must first develop an initial conceptual site model (ICSM) of the site which can identify the various sources and receptors and any potential pathways by which they may be linked. This process can be undertaken as part of the development of an ICSM for the site for contaminants other than gases. If a potential pollutant linkage is identified for ground gas, site investigations to confirm the nature and extent of ground gases will be required. Guidance on how these site investigations should be undertaken is given in B5930 - Code of Practice for Site Investigations, BS10175 - Investigation of Potentially Contaminated Sites, CIRIA Reports 103 (Vol II) and 150 (Methane Investigation Strategies), CIRIA C665 and BS8485 and other published guidance including the VOC handbook and CIRIA C735.

Investigation methodologies which have been used to measure gas concentrations include spike probe surveys, sinking of boreholes with monitoring standpipes installed and flux boxes. Spike probe surveys are considered to be unreliable for the following reasons: limited depth, spikes into an aerobic layer in an open hole underestimate methane levels and spike probes may not intercept the gas source.

JPB, therefore, generally commission the sinking of boreholes with standpipes to characterise the gas regimes at sites. Where access is restricted, a window sampler is used to install standpipes. The number and position of bores and well response zones are carefully chosen in order to maximise the information to be obtained to fully characterise the site. Table 4.2 in CIRIA C665, reproduced below, gives some guidance on the spacing of wells, which should be interpreted in conjunction with the associated text of that paper ad in the light of actual site conditions.



Gas Hazard	Typical Examples	Sensitivity of end use	Initial nominal spacing of gas monitoring wells ^{1,2}					
High	Domestic landfill sites	High ³	Very close (<25m)					
		Moderate	Close (25-50m)					
		Low	Close (25-50m)					
Moderate	Older domestic landfills disused	High	Close/very close (<25m -50m)					
	shallow mine workings ⁴	Moderate	Close (25-50m)					
		Low	Close/wide (25-75m)					
Low	Made ground with limited	High	Close (25-50m)					
	degradable material, organic clays	Moderate	Wide (50-75m)					
	of limited thickness	Low	Wide/very wide (50->75m)					

- ¹ The initial spacing may need to be reduced if anomalous results indicate this is necessary to give a robust indication of the gas regime below a site. To prove the absence of gas, closer spacings may be required.
- ² The spacing assumes relatively uniform ground conditions and the gas source present below a site. The spacing will need to be reduced if ground conditions are varied or if the investigation is trying to assess migration patterns from off site.
- ³ Placing high-sensitivity end use on a high gas hazard site is not normally acceptable unless the source is removed or treated to reduce gassing potential.
- ⁴ Petrol stations and other sources of vapours are most likely to be classified as gas hazard "Moderate" however site specific assessment would be required.

Three bores with standpipes and four sets of readings should be considered an absolute minimum for even the smallest of sites.

Flux boxes can be used to measure surface gas emission rates but do not take into account a deeper source of gas generation. Flux boxes can be used to confirm that a capping layer above a source and the surface has been effective. It should be noted that methane levels at the surface may underestimate ground gas levels as aerobic conditions at the near surface will deplete methane concentrations.

Guidance on the measurement of gas levels at bores is given in the above documents, however, in general a peak gas reading is taken followed by readings at 30 second intervals until a steady state is reached. This allows the assessor to determine how quickly the ground gas is replenished. Flow rate is generally measured first followed by methane/carbon dioxide levels. In addition, atmospheric pressure, weather, date and any other relevant information is recorded.

Flow rates can be positive or negative, they are generally negative where ambient atmospheric pressure is high or where falling groundwater levels reduce pressures in bores. Flow rates between - 0.4 and 0.4 L/h indicate that there is probably no overall flow. The length of the monitoring period and frequency of monitoring will vary from site to site depending on the sensitivity of development, geology of the site, the level of risk and other factors. Typical minimum periods and monitoring frequencies are given in Table 5.5 of CIRIA C665. Generally, JPB undertake six visits over 12 weeks for sites proposed for residential development.

Continuous gas monitoring at boreholes over a period of several weeks can also sometimes be utilised to clarify the type of gas generation sources present and levels of risk posed by ground gases at some sites.

The degree of monitoring required must enable the assessor to measure or predict the reasonable worst case gas regime.



Risk Assessment

Having obtained factual data from the investigation the ground gas regime can be assessed in a tiered approach. In the past guidance such as Waste Management Paper 27 recommended a highly conservative precautionary principle, i.e. no development within 250m of a landfill site. This approach was seen as anti-development and does not take into account the site conditions, whether a risk exists at the site for the development proposed, the level of risk and whether if can be mitigated by design. More recent approaches characterise the site and the risk and base recommendations on this assessment. Various reports and standards have recently been published to update the guidance on ground gas assessment and this JPB methodology uses the philosophy outlined in these. These include CIRIA C665 "Assessing risks posed by hazardous ground gases to buildings"), NHBC Report No. 10627-R01(04) "Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present" and British Standard BS8485 "Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings".

Tier 1 assessment

Following the completion of investigations, the assessor reviews the ICSM in the light of site investigation data and identifies any intact pollutant linkages. If intact pollutant linkages exist a Tier 1 risk assessment is performed using generic screening criteria to determine whether a risk exists. JPB use the following screening levels: Methane <1% by volume in bores and Carbon dioxide <5% by volume in boreholes.

These values are derived from Waste Management Paper 27, 1% methane by volume represents 20% of methane's lower explosive limit of 5% by volume, 5% carbon dioxide relates to the known health effects of exposure to this gas. Both screening concentrations are detailed in the Building Regulations Approved Document C (2004) and BRE Report "Construction of New Buildings as Gas Contaminated Land" (BR 212).

A limit to gas flow rates for the above trigger values is inferred by the table given below where the limiting borehole gas volume flows for CH_4 and CO_2 are <0.07L/hr for characteristic situation 1. These are equivalent to a limiting borehole flow rate of 7L/h for CH_4 at 1% by volume and 1.4L/h for CO_2 at 5% by volume. The above Tier 1 trigger values are only valid, therefore, if these volume flows are not exceeded. Where these volume flows are exceeded a Tier 2 assessment should be undertaken.

Guidelines on screening levels for hydrogen sulphide and other trace gases are given in the VOC Handbook, CIRIA RP711. Other information on VOCs is available in EA Technical Guidance on Management of Landfill Gas (2004) and in the vapour models used in the CLEA model for contamination land assessments.

If these screening concentrations are not exceeded then no significant risk exists and no further action is required. Where screening concentrations are exceeded a Tier 2 assessment is performed.

Tier 2 assessment

Where Tier 1 generic screening concentrations are exceeded a Tier 2 assessment is performed using the Wilson and Card (1999) approach as outlined in CIRIA C665. Each site is classified into a "characteristic situation" based on the maximum methane and carbon dioxide concentrations measured. These measurements combined with the maximum borehole flow rate are used to calculate the gas screening value.

Gas screening value (L/hr) = gas concentration (% by volume) x borehole flow rate (L/hr).

(N.B. gas screening value is also known as "site characteristic hazardous gas flow rate ($Q_{\mbox{\scriptsize hgs}}$) in BS8485)

For example, for a borehole flow rate of 1.5 L/h and a methane concentration of 20% the gas screening value = $1.5 \times 20/100 = 0.3 \text{ L/h}$.



Gas screening value rates for methane and carbon dioxide can be compared with Table 8.5 of CIRIA C665 "Assessing risks posed by hazardous ground gases to buildings" or Tables 14.1 of NHBC Report No. 10627-R01(04) "Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present", reproduced below, to determine a characteristic situation for the site.

Table 8.5Modified Wilson & Card Classification (CIRIA Report C665)NBUse for most scenarios other than low rise housing with a ventilated underfloor
void (min 150mm)

Characteristic Situation (CIRIA R149)	Comparable classification in DETR et al (1999)	Risk classification	Gas Screening Value (GSV) CH₄ or CO₂ (L/hr) ¹	Additional Limiting Factors	Typical Source of generation.
1	A	Very low risk	<0.07	Typically methane <1% by volume and/or carbon dioxide < 5%. Otherwise consider increase to Situation 2.	Natural soils with low organic content. "Typical" made ground
2	В	Low risk	<0.7	Borehole air flow rate not to exceed 70L/hr. Otherwise increase to characteristic situation 3	Natural soil, high peat/organic content. "Typical" made ground
3	С	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protection measures	Mineworking – susceptible to flooding, completed landfill, inert waste (WMP 26B criteria)
5	E	High risk	<70		Mineworkings unflooded inactive
6	F	Very high risk	>70		Recent landfill site



Table 14.1	Gas Risk Assessment (Traffic Lights) NHBC Report No. 10627-R01(04)	
NB	To be used for low rise housing with a ventilated underfloor void (min 150n	nm)

Traffic Light	Met	hane ¹	Carbon	Dioxide ¹
	Typical max conc.⁵ (% by vol)	Gas screening value ^{2,4,6} (L/hr)	Typical max conc. ⁵ (% by vol)	Gas screening value ^{2,3,4,5} (L/hr)
Green	1	0.13	5	0.78
Amber 1	5	0.63	10	1.60
Amber 2	20	1.60	30	3.10
Red	L	1		<u> </u>

Protective measures can then be selected for the site buildings based on the Characteristic Situation and the type of development proposed (building types A-D, Table 3 BS8485) using the guidance and scoring system given in BS8485 and its annexes. Protective measures for new buildings can then be designed which are appropriate to the types and magnitude of the risks posed.

Radon

Radon is a naturally occurring radioactive gas that is formed from the decay of uranium and radium present in some types of rocks. It can migrate through cracks and fissures into the soil and by this route into buildings.

Radon can accumulate inside structures over the long term posing a risk to health. Long term exposure increases the risk of developing lung cancer, in a building with high levels of radon, long-term exposure can increase the risk to the point where preventative action is necessary.

For this reason section 3.2 of the Technical Handbook Guidance, which sets functional standards for Scottish buildings under the Building (Scotland) Act 2003, was revised in 2011 to ensure that "every building must be designed and constructed in such a way that there will not be a threat to the health of people in or around the building due to the emission and containment of radon gas". This document provides guidance on how the risks posed by radon should be assessed. JPB's methodology for assessing risks posed by radon follows that guidance and this methodology is outlined below.

The location of the site is pinpointed on maps published in Appendix A of BRE BR 211. These maps were the result the result of a joint project between The Health Protection Agency (HPA) and the British Geological Society who prepared detailed maps of radon potential in Scotland by testing radon levels in houses. Depending on the level of risk within the geographical grid square within which the development lies, maps indicate whether; no protection measures are required, basic radon protection measures are required or full radon protection measures are required.

Where the site is indicated to be within an area within which radon protection is required, a further assessment of the risks posed by radon is undertaken. The BR211 Appendix A maps provide information on a large scale, and whole grid squares are categorised based on the worst conditions within the grid square, rather than for a specific site or smaller geographical area. Where the BR211 Appendix A map indicates there is a possibility that radon may pose a risk (or it is unclear), more detailed HPA/BGS mapping data is obtained and the site is assessed accordingly.



If the more detailed report indicates that the site is located on ground where radon protection measures are required, protective measures are recommended. Radon protective measures are recommended in accordance with the guidance contained in BRE Report BR211 "Radon: Protective measures for new buildings". BRE have also confirmed to JPB that, where gas protection measures are being installed to provide protection against ground gases such as methane and carbon dioxide for CS-2 conditions or above, these measures will also provide adequate protection from risks posed by radon.

It should be noted that this approach has been adopted as monitoring radon concentrations in the ground prior to construction is not considered to be a valid methodology for assessing risks posed by radon in buildings. This is because it is difficult to equate the concentrations of radon measured in boreholes with levels inside houses, as many factors can influence the actual indoor air radon concentration experienced, including; radon generation rates, geology, construction details, ventilation rates, seasonal factors, occupant behaviour etc. Similarly, for newly constructed buildings it is impractical to determine indoor air radon concentrations over the recommended three month monitoring period and the results measured in unoccupied properties would not, in any case, be a valid assessment of conditions in occupied houses.



Appendix 9 Previous Site Investigation Data

Status Final 26/07/2001



BOREHOLE LOG

Borehole No 14 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Client: Ambion Holdings

Consultant:	David R. Murray	& Associates			_									
Date Started Date Complete Hole Type: Equipment:	13/02/2001 e: 13/02/2001 CP Dando 3000		Initial Boring Initial Core D Rotary Casin Core Barrel:	iameter		Grou Plun	-		E N Not Recorded 90 °					
	Description of Strata		Core Bit:	Legend	Depth	OD Level		mpling/	e: U		1:50 itu Testing	TCR (SCR)	FI	Instal
Firm brown mot	D: Brown sandy topsoil (Da tled orange brown and gre sub rounded to sub angula	y sandy CLAY wit	th some		0.25		в	0.30		Test	Result	RQD		
Firm to stiff brow	wn mottled dark grey sandy	y CLAY with some			0.90		D	0.60-1.05	61					
Stiff dark brown	sandy CLAY with some fir gravel and some cobbles	to coarse sub r	ounded		1.30		D B U	1.25-1.70 1.70 1.80-2.25	66	S	27			
Stiff dark grey s and sub angula	andy CLAY with some fine r gravel and some cobbles	to coarse sub ro (glacial till)	unded		2.05		D B	2.25 2.40						
							D	2.60-3.05 3.05						
							B UNR	3.80 4.00-4.45	63			-		
							UNP D	4.50 4.60-5.05	150	s	72			
End of Borehole	at 5.05 m			A A C C S	5.05		В	4.90						
					9									
									×					
P Piston	irbed U100 Sample Sample	TCR Total	Run Core Recovery		S C	Con	e Penetr	netration Test		CP RO	Cable Per Rotary Op	en Hole		
TW Thin Wall Sample SCR Solid Core Recovery D Small Disturbed Sample RQD Rock Quality Design B Bulk Disturbed Sample FI Fracture Index LB Large Bulk Disturbed Sample FI Fracture Log W Water Sample NI Non intact G Gas Sample U* Blows to drive U100 C Core NR No Recovery					32 /175 /25# NP PR K V	For g Seat No F Pres Perm Insite	given pe ing blow Penetrati sureme neability u Vane 1	ter Test Test (m/s)		RC Instal	Rotary Co lation Slotted Pipe Piezometer Tip Grout	San	d Filter Ionite Sei vel Filter	al

Fi	atus nal 7/2001		r	itc	hie	S	BOF	REHO	OLE	E LO	G	E	Borehole 14				
Client: Consult	ant:	Ambion I David R.	Holdings Murray &	Associate		broysto	n, Glas	Job No: 9957									
Date Star Date Con Hole Type Equipmen	ted nplete: e:	13/02/2001 13/02/2001 CP Dando 300			Initial Initial Rotan	Boring Diamete Core Diameter y Casing Type Barrel: Bit:	: 150mm				dinates: nd Level: ge:	E N Not Recc 90 °	N Not Recorded				
			PROGR	ESS						DRILL	ING DET	AILS					
Date	Time	Hole Depth	Casing Depth	Water Depth	Remarks		From	CP Chisel To	ling Hour			Rotary Hole Dia					
3/02/2001	17:00	5.00	5.00	-	Dry		4.50	4.60	0.25				Core Dia	Flush			
		1	WA1 Risen	After n	RIKES Casing					INS	ITU SPT	TEST DE	TAILS				
Date	Time	Strike	То	Minutes	Depth	Flow		Se	ealed	Depth	Blows for	75mm Increme	ents				
										1.25 4.60		9 7,50					
		1	I				NOTE				1						
Ground	water lev	els are subj	eters in millir ect to seasor alled to 5.00	nal, tidal and	other fluctu rehole backi	ations and shou filled with arising	NOTE: Id not be take is on comple	en as const	ant								
							PERSC	NNEL	-								
iller: SF	,				Logged	by: GW				Check	ed by: Sk	٢F					

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Status Final



BOREHOLE LOG

Borehole No 15 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Client: Ambion Holdings

Consultant: David R. Murray & A	ssociates											
Date Started13/02/2001Date Complete:13/02/2001Hole Type:CPEquipment:Dando 3000	Initial Borin Initial Core Rotary Casi Core Barrel Core Bit:	Diameter ing Type		150mm			-	N				
Description of Strata		Legend		OD Level		mpling/ pre Run	U		itu Testing	TCR (SCR)	Fl	Insta -atio
MADE GROUND: Brown sandy topsoll (Driller Firm, locally soft grey mottled orange brown sa some fine to medium sub angular gravel and s	andy CLAY with		0.35		BU	0.50	27	Test	Result	RQD		
Soft to firm brown locally light brown sandy CL to coarse sub rounded and sub angular gravel	AY with some fine		0.90		D B U	1.00 1.40 1.50-1.95	73					
Stiff dark grey sandy CLAY with some fine to c and sub angular gravel, some cobbles and occ sand (glacial till).	coarse sub rounded casional bands of silty		1.65		D B B	1.95 2.20 2.50	79		1			
					UNR D	2.50-2.95 3.10-3.55		s	17			
					B U D	3.80 4.00-4.45 4.45	75					
End of Borehole at 5.00 m			5.00		В	5.00						
										5		
Undisturbed U100 Sample Piston Sample TC W Thin Wall Sample Small Disturbed Sample Bulk Disturbed Sample Large Bulk Disturbed Sample Water Sample Gas Sample Core R No Recovery	CR Total Core Recovery CR Solid Core Recovery QD Rock Quality Design:	ation	S C 32 /175 /25# NP PR K V L	Cone N for t For gi Seatir No Pe Press Perma	Penetra full 300 ven per ng blow enetratio uremet	er Test Test (m/s)			Cable Per Rotary Op Rotary Co ation Slotted Pipe Piezometer Tip Grout	pen Hole pred Sanc	l Filter onite Sea	4

F	atus nal 7/2001			itc		S				E LO	G	B	Information		
Client: Consult	ant	Ambion H David R.		Accoriate		broystor	n, Gla	sgo	W		Job	No: 9957	,		
				Associate				·							
Date Star Date Con Hole Type Equipmen	nplete: e:	13/02/2001 13/02/2001 CP Dando 300			Initial Rotar	Boring Diameter Core Diameter y Casing Type Barrel: Bit:	: 150mm			Groun	Coordinates: Ground Level: Plunge:		E N Not Recorded 90 °		
			PROGR	ESS			8			DRILLI	NG DETA	ILS			
Date	Time	Hole Depth	Casing Depth	Water Depth	Remarks		From	CP C	hiselling Hou			Rotary Hole Dia	Core Dia	Flus	
13/02/2001	17:00	5.00	5.00	-	Dry						÷	ž			
15				-											
		1	WA7 Risen	After n	RIKES Casing					IN SI	TU SPT T	EST DE	TAILS		
Date	Time	Strike	То	Minutes	Depth	Flow			Sealed	Depth	Blows for 75r	nm Increme	nts		
3/02/2001		2.80				Seepage				3.10	2,3,4,4,4,5				
							NOTE								
Ground	water lev	es; all diame els are subje r casing insta	ct to seasor	al, tidal and	l other fluctu: rehole backf	ations and should	not be take	en as co	onstant						
	-						PERSC	NNE	L						

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Status Final 25/07/2001



BOREHOLE LOG

Borehole No 16 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Client: Ambion Holdings

Consultant: David R. Murray & A	Associates												
Date Started23/02/2001Date Complete:23/02/2001Hole Type:CPEquipment:Dando 3000	Initial Borin Initial Core Rotary Cas Core Barre Core Bit:	ing Type		150mm			rdinates und Leve ge: e:		E N Not Recorded 90 • 1:50				
Description of Strata		Legend	Depth	OD Level		mpling/ ore Run	υ	In S Test	itu Testing Result	TCR (SCR) RQD	FI	Install -ation	
MADE GROUND: Brown sandy topsoil (Driller Firm brown mottled orange brown and grey sa fine to coarse sub rounded and sub angular gr rootlets. Firm to stiff grey mottled orange brown sandy to coarse sub rounded and sub angular gravel Very stiff dark brown brittle sandy CLAY with a	andy CLAY with some ravel and some CLAY with some fine I.		0.20 0.70 1.40		B U D U	0.50 0.55-1.00 1.00 1.40-1.85	47						
sub rounded to angular gravel. Driller notes of Stiff dark grey sandy CLAY with some fine to o and sub angular gravel. Driller notes cobbles (coarse sub rounded		2.20		D B U D B UNR D	1.85 2.30 2.50-2.95 2.95 3.60 4.00-4.45 4.30-4.75	150		26				
End of Borehole at 5.00 m			5.00										
TW Thin Wall Sample SC	CR Total Core Recovery CR Solid Core Recovery QD Rock Quality Design Fracture Index Fracture Log Non Intact	ation	S C 32 /175 /25# NP PR K V L	Cone N for For gi Seatin No Pe Press Perm Insitu	Penetra full 300 iven per ng blow enetratio uremete eability Vane T	er Test Test (m/s)	ı		Cable Perc Rotary Op Rotary Cor ation Slotted Pipe Plezometer Tip Grout Concrete	en Hole red	nite Sea		

			24														
	atus nal			ita	hio									В	orehole 16	No	
	7/2001					S	BOF	REI	HC	DL	ΞL	.00	3		I O Information		
					Ro	broysto	n, Gla	sgov	W								
Client:		Ambion I	Holdings										Job	No: 9957			
Consult	ant:	David R.	Murray &	Associate	S												
Date Star		23/02/2001				Boring Diameter	:	150mm	1	-		Coordir	ates:	Е			
Date Com Hole Type	•	23/02/2001 CP				Core Diameter						Ground	Level		N Not Recorded		
Equipmen		Dando 300	0	2	Core Barrel: Core Bit:						Plunge:		90 °				
· · · · · · · · · · · · · · · · · · ·			PROGR	ESS							DR	RILLI	NG DETA	ILS			
Date	Time	Hole Depth		From	CP CI	hisell	ing Hour				Rotary		Pluch -				
23/02/2001	17:00	5.00	Depth 5.00	Depth -	Dry		FIOIN	10		rioui	rs	From	То	Hole Dia	Core Dia	Flush	
3												a	÷.				
	*									,							
				FER STR								N SI	TU SPT T	EST DE	TAILS		
Date	Time	Strike	Risen To	After n Minutes	Casing Depth	Flow			Se	aled	Dep	oth	Blows for 75	mm Incremen	nts		
												4.30	22,14,6,7,6,	7			
							NOTE	S									
Ground	water lev	els are subj	eters in millir ect to seasor alled to 5.00	nal, tidal and	other fluctu rehole back	uations and shoul filled with arising	d not be tak	en as c	onsta	nt							
							PERSC	ONNF	=1								
Drilier: SP)				Logged	iby: GW			na line		c	hecked	by: SKF			······.	

Status Final 26/07/2001

Client:



BOREHOLE LOG

Borehole No 17 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Consultant:	David R.	Murray 8	Associates

Ambion Holdings

0011	Sultant.	David IC. Inditay	a Associates							-						
Date	Started	26/02/2001		Initial Boring	Diameter	:	150mm			Coord	dinates	:	E			
Date	Complete:	26/02/2001		Initial Core D	iameter								N			
Hole	Туре:	CP		Rotary Casin	д Туре					Grour	nd Leve	el:	Not Reco	rded		
Equip	ment:	Dando 3000		Core Barrel:						Plung	e:		90 *			
				Core Bit:						Scale	:		1:50			
					1		OD				1			TCR		
	D	escription of Strata			Legend	Depth	Level		mpling ore Ru		U		tu Testing	(SCR)	FI	Install
MADE	GROUND	Brown sandy topsoil (D	riller's Description	2)								Test	Result	RQD		-ation
112 (1) -		Diotan adiroj topaon (D	mici a Deachpuor	9												
						0.50		в	0.55							
Firm g	rey mottled	orange brown sandy CL	AY with occasion	al				Ŭ		-1.05	41					
rootlet	5.															
								D	1.05							
Soft br	ownish arev	brittle sandy SILT with	some ima stainin		×××××	1.20		D	1.20	-1.65		S	24			
0011 01	ommon groj	binde oundy OILT with	Some non statian	9.	XXXXX											
					KXXXXX XXXXXX					•						
					XXXXX									1		
					XXXX			В	2.00				ž			
					XXXXX	2.35		D	2.30	2.75		s	124	1		
Recov	ered as very	dense fine to coarse g	ravel of weak pale	e grey	××××××××××××××××××××××××××××××××××××××				1					1		
		ible bedrock.			******	2.70										
Bedroo	k or boulde	r (Driller's Description).				3.00		-	2.95			s	50/0#			
End of	Borehole at	3.00 m				3.00						-				
		•														
			•													
											1					
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		8.														
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U	Indicturb	ed U100 Sampie	Core	Run			-	deed D			3		<u> </u>			
P	Piston Sa		120	Core Recovery		S C		dard Pe e Penetr			· .	CP RO	Cable Per Rotary Op			
TW	Thin Wall	Sample	SCR Solid	Core Recovery		32	N for	full 300)mm pe	enetration		RC	Rotary Co			
D B		urbed Sample		Quality Designation	ation	/175				on (mm)		Install	ation			
LB		k Disturbed Sample		ure index ure Log		/25# NP		ing blow Penetrati		(៣៣)		LEU .	Slotted Pipe		i Fitter	
W	Water Sa	nple	NI Non	Intact		PR	Pres	suremet	ter Tes				Piezometer Tip		onite Sea	,
G C	Gas Samp Core	ble	U* Blow	s to drive U100 /	U86	K		neability		m/s)		\boxtimes	Grout	Grav		•
NR	No Recov	ery				L		u Vane 1 ker Test		ons)		100	Concrete	Internal Colan	-un r'nn,61	
			l							·						

		·													
	atus inal				bio								B	orehole	No
11	7/2001					S	BOF	RE	HO	LE	ELO	G		17 Information	
					Ro	obroysto	n, Glas	sgo	w						
Client:		Ambion I										doL	No: 9957	,	
Consult				Associat	es									-	
Date Star Date Con		26/02/2001				Boring Diameter		50mm	l		Coord	inates:	E N		
Hole Typ		CP				y Casing Type					Groun	d Level:	Not Reco	rded	
Equipmer	nt:	Dando 300	0		Core Core	Barrel: Bit:					Plunge	9:	90 °		
	1		PROGR]			2	DRILLI	NG DETA			
Date	Time	Hole Depth	Casing Depth	Water Depth	Remarks		From	CP CI To	hiseiling	g Hours	s From	То	Rotary Hole Dia	Core Dia	Flush
26/02/2001	17:00	3.00	2.70	× -	Dry		2.70	3	.00	1.00					
7															
											~				
													-	1 a	
													n.		
												5			
															•
		1		TER ST							IN SI	TU SPT T	EST DE	TAILS	
Date	Time	Strike	Risen To	After n Minutes	Casing Depth	Flow			Seale	be	Depth	Blows for 75	mm Incremen	nts	
								-			1.20 2.30	3,4,7,5,6,6 4,8,12,27,3	5.50		
											2.95	50/0mm - A			
											÷.				
							NOTES	\$						<u></u>	~
All dept	h in metr	es; all diame	ters in milli	netres.											
Ground 150mm	water lev diameter	els are subje r casing insta	ect to seaso	nal, tidal and	d other fluctu	ations and shou filled with arising	lid not be take	n as co	onstant						
							s on complet	Л.							
		<u> </u>	، • الا _{هرين}	-			00000								
Driller: SP					Logged	by: GW	PERSO	NNE	L		Charles	hr eve			
					Logged						Checked	by: SKF	2		

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Status Final 25/07/2001



BOREHOLE LOG

Borehole No 23 Sheet 1 of 1

Robroyston, Glasgow

Client: Ambion Holdings

Job No: 9957

Consultant: David R. Murray & Associates

		David I C. Midilay		100											
Date Sta	arted	14/02/2001		Initial Boring	Diameter:	:	150mm		Cor	ordinates		E			
Date Co	mplete:	14/02/2001		Initial Core E)iameter							N			
Hole Typ	pe:	CP		Rotary Casir	19 Туре				Gro	ound Leve	el:	Not Reco	orded		
Equipme	ent:	Dando 3000		Core Barrel:						nge:		90 °			
				Core Bit:					Sca			1:50			
					TT		OD			T	<u> </u>		TCR		Τ.
	De	scription of Strata			Legend	Depth	Level		mpling/ ore Run	U		In Situ Testing (SCR) FI Test Result RQD		FI	Insta -atio
MADE GF	ROUND: B	rown sandy topsoil (C)riller's Desc	ription).					1		Test	Result	RQD		-ano
		mottled orange brown				0.25	1								
rootlets. D	Driller reco	ds some gravel.	I sandy CLA	r with some			1	BU	0.40	32					
						0.00	1								
Firm dark	brown and	I dark grey sandy CL	AY with som	e fine to		0.80	1	D	0.95						
coarse su	ib rounded ed glacial ti	and sub angular grav	el and some	iron staining				-							
(weaulere	a giaciai u	и).				1.40		в	1.30						
Stiff to ver	ry stiff dark	grey sandy CLAY wi	th some fine	to coarse	-	1.40		U	1.50-1.95	132					
sub round	ied to angu	lar gravel and some	cobbles (glad	cial till).	A				•						
					A 2000			D	1.95						
					A			-							
					100 A				0.0						
					8-0-00 8-0-00			BD	2.40 2.55	150					
					1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-			UNR	2.55-3.00	100					
					P 0 16										
					2000			D	3.00-3.45		S	24			
					Ange										
					A See										
					A										
					10000 C								-		
					A 46.95			в	4.15						
					A 2005			5	4.10						
					A			U	4.50-4.95	83					
					A										
					2 2 2 2 2 2				1.05						
Ind of Roy	rehole at 5	00 m			A No. 10	5.00		D	4.95						
	שוויים מנ ס														
									,						
												;			
	ndisturbed	U100 Sample	R	Com Pire		+		1							
Pi	iston Samp	o ioo sampie de	1	Core Run Total Core Recovery		S C			etration Test		CP	Cable Perc			
Th	hin Wall Sa	ample	SCR	Solid Core Recovery		32			non rest nm penetratio		RO RC	Rotary Ope Rotary Con			
		bed Sample	RQD	Rock Quality Designat	tion	/175	For gi	iven per	etration (mm)			•			
Bu	ulk Disturb	ed Sample Disturbed Sample		Fracture Index		/25#	Seatin	ng blows	s only (mm)		installa 旧		(mman)		
	arge Buik L ater Samp			Fracture Log Non intact		NP PR		enetratio uremete			lill si	lotted Pipe	Sand	Filter	
	as Sample		1	Blows to drive U100 /	J86	K			r rest Test (m/s)		Pi	iezometer Tip		nite Seal	I
			1			v		Vane To			8 g	rout	Grave	Filter	
Co	ore o Recovery		{			L			Lugeons)			- out	CITS CLARE		

F	Status Final 26/07/2001						BORE	HOL		Borehole No 23 Information				
Client: Consult	ant:	Ambion H David R.		Associate		broystoi	n, Glasgo	WC		Job	No: 9957			
	te Started 14/02/2001 te Complete: 14/02/2001 le Type: CP					Boring Dlameter Core Diameter / Casing Type Barrel: Bit:	: 150m	m	Coord Groun Plunge	d Level:	E N Not Recorde 90 °	N Not Recorded		
			PROGR	ESS					DRILLI	NG DETA	ILS			
Date	Time	Hole Depth	Casing Depth	Water Depth	Remarks		CP From T	Chiselling D Hou		Το	Rotary	core Dia Flush		
14/02/2001	,	5.00	5.00		Dry		3.00	3.60 0.75						
			\//Δ٦	ER STR]	<u> </u>							
Date	Time	Strike	Risen	Aftern	Casing	Flow						AILS		
Date	Time	Suike	То	Minutes	Depth	Flow		Sealed	Depth 3.00	Blows for 75mm increments 33,14,9,4,5,6				
											3			
							-	1						
							NOTES							
Ground	water iev	es; all diame els are subje r casing Insta	ct to seasor	nal, tidal and	other fluctua ehole backfi	ations and should lied with arising:	not be taken as s on completion.	constant				-		
Drilier: SP							PERSONN	EL			¥.			

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BOREHOLE LOG

Borehole No 24 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Client:	Ambion Holdings
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Consultant:	David R. Murray	& Associates											
Date Started Date Complete: Hole Type: Equipment:	14/02/2001 14/02/2001 CP Dando 3000	Initial C			150mm		Grou Plung			E N Not Recc 90 ° 1:50	orded		
	Description of Strata		Legend	Depth	OD Level		pling/	J. U		tu Testing	TCR (SCR)	FI	Install -ation
Firm grey sandy sand, some fine Firm to stiff becc	b: Brown sandy topsoll (D CLAY with some thin bar to coarse sub rounded gr ming stiff dark grey sand led and sub angular grav		0.20		B U D D B U UNR	0.40 0.50-0.95 0.95 1.10-1.55 1.50 1.60-2.05 2.05 2.15 2.50-2.95	22 60 67	S	9	RQD			
Recovered as ve SILTSTONE, po End of Borehole		el of weak pale grey		3.00 3.50		D	3.00-3.30		S	81/150			
										÷ .			
P Piston S TW Thin Wa D Small D B Bulk Dis	III Sample isturbed Sample turbed Sample ulk Disturbed Sample ample nple	covery covery resignation	S C 32 /175 /25# NP PR K V L	Cone N for For (Seat No F Pres Perm Insitu	e Penetra full 300r given per ing blows Penetratic suremete neability J Vane To	er Test Test (m/s)			Cable Per Rotary Op Rotary Co lation Stoted Pipe Piezometer Tip Grout Concrete	en Hole red	d Filter tonite Se vel Filter	al	

Fi	atus nal 7/2001			itc	hie	S	BOF	REF	HOL	_E	E LOO	3	E	orehole 24	
Client:		Ambion H				obroysto	n, Glas	sgov	V			Job	No: 9957		
Consult				Associate	es									·	
Date Star		14/02/2001 14/02/2001				l Boring Diameter l Core Diameter	ت 1	50mm			Coordi	nates:	E N		
Hole Type Equipmen		CP Dando 300	0			ry Casing Type Barrel: Bit:					Ground Plunge		Not Reco 90 °	rded	
			PROGR							ş.	DRILLI	NG DETA			2
Date 14/02/2001	Time 17:00	Hole Depth 3.50	Casing Depth 3.00	Water Depth	Remarks Dry		From 3.00	CP Ch To 3.	Ho	ours 00	From	То	Rotary Hole Dia	Core Dia	Flush
		<u>I</u>	WAT		RIKES		l						EST DF	TAILS	
Date	Time	Strike	Risen To	After n Minutes	Casing Depth	Flow			Sealed		Depth	Blows for 75r			
1 4/02/2001		1.00	-	-	_	Damp			-		1.10 3.00	1,1,1,2,2,4 81/150mm (i	8,19,31,50)		
_															
Ground	water lev	es; all diame els are subje casing insta	ect to seasor	nal, tidal and	l other fluctu rehole back	uations and shoul filled with arising:	NOTES d not be take s on complet	n as coi	nstant				ŧ.		
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							PERSO								

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BOREHOLE LOG

Borehole No 25 Sheet 1 of 1

Robroyston, Glasgow

Client: Ambion Holdings

Job No: 9957

Consultant: David R. Murray & Associates

					<u> </u>									
Date Started	22/02/2001		Initial Boring	Diameter:		150mm		Coo	rdinates	:	E			
Date Complete	22/02/2001		Initial Core D	iameter							N			
Hole Type:	CP		Rotary Casin	д Туре				Grou	und Lev	el:	Not Reco	orded		
Equipment:	Dando 3000		Core Barrel:					Plun	ge:		90 °			
			Core Bit:					Scal	-		1:50			
						OD	<u> </u>		1	Ι.		TCR	T	Γ.
	Description of Strata			Legend	Depth	Level		mpling/ ore Run	U		itu Testing	(SCR)	FI	Install
): Brown sandy topsoil (D	rillere Deseriet'-	2)	XXXXX						Test	Result	RQD	<u> </u>	-ation
	. Srown seriuy topsoil (L				0.30						- · ·			
Firm brown sand	ly CLAY with thin layers of	of greyish brown a	andy				BU	0.40	=	1	5	1	1	
slit, some fine to cobbles.	coarse sub rounded grav	vel and occasiona	N	×				0.55-1.00	54					
				X	0.90									
Firm to stiff dark	brown and dark grey sar	dy CLAY with so	me fine				D	1.00						
to coarse sub ro staining (weathe	unded and sub angular g red glacial till)	ravel and occasio	nal Iron				υ	1.30-1.75	78					1
					1.45									
Stiff dark brown and sub angular	sandy CLAY with some fi gravel and occasional co	ne to coarse sub	rounded	A										
THE OUP SUBURI	area of the operation of the	innes (Alaciai All)		P-0-040			D	1.75						
				10000			BUNP	2.00	150	s	50/0#		l .	
				-2.00			-	2.10 2.10	1.00		50/0#			
				2000			UNP	2.50		s	21	1		
							D	2.50-2.95			21	1		
				A Nors										
				- A.X								1		
				14 A 6 6 5			в	3.20					1	
				1000 C			υ	3.50-3.95	150				1	
				A				0.00-0.90	150					
				A	3.80	12								
SANDSTONE n	ayey fine to coarse grave ossible bedrock or bould	I of pale brown er.			4.10		D	3.95-4.10		S	81/149#			
End of Borehole				h	7.10					1				
							ł							
									1					
										1	-4			
										1				
													2	
									1					
									1					
									1					
		T	**************************************		1									
	bed U100 Sample		Run		S	Stan	dard Pe	netration Test		CP	Cable Per	cussion		
P Piston S TW Thin Wa			Core Recovery		С			ation Test		RO	Rotary Op	en Hole		
	II Sample sturbed Sample		Core Recovery	tion	32 /175			mm penetration		RC	Rotary Co	red		
B Bulk Dis	turbed Sample	1	ture index	u011	/1/5			netration (mm) /s only (mm)	'	Install	ation			
LB Large Bi	B Large Bulk Disturbed Sample FI Fracture Log					No P	enetrati	on			Slotted Pipe	Sanc	d Filter	
W Water S		1	Intact	100	PR		suremet				Piezometer Tip	Colorador -	ionite Sea	ı
G Gas San C Core	npie	U* Blow	rs to drive U100 /	J86	к V		eability Vane T	Test (m/s)		12	Grout	CAR	rel Filter	•
NR No Reco	very				L			(Lugeons)		653	Concrete	Const oray		
	· · · · · · · · · · · · · · · · · · ·													

WATER STRIKES	Fina 25/07/200	1		itc	hie	S	BOF	REH	OLI	E LO	G		orehole 25 Information	No
Date Standard 22002001 Hell Gorn Diameter Relativement: Initial Boring Diameter Relative Core Barni: Core Diameter: Barni: State Constitution DRILLING DETAILS Entry Materia PROCRESS Filter PROCRESS Filter DRILLING DETAILS Entry Materia Deptin Remarks: Dire Barni: Core Diameter: 3.30 DRILLING DETAILS Entry Materia Deptin Remarks: Dire Barni: State DRILLING DETAILS Entry Materia Deptin Remarks: Dire Barni: State DRILLING DETAILS Entry Materia Deptin Remarks: Dire Barni: State DRILLING DETAILS Entry Materia Dire Dire Materia Dire Dire Materia Dire Dire Materia Entry Materia Materia Deptin Not Test Deptin Biose for Zimm Incomments: 2.10 3.00 3.00 Birtlemm - Abardoned Materia Dire Dire State Not Test State Dire Dire State State State State State <			-	Associate		obroysto	n, Glas	-			Job M	No: 9957		
Inter Hole Dept Cashe Dept Weith To Remarka 17200 4.10 3.80 - Dry 10 100 10 10 10 2022001 17.00 4.10 3.80 - Dry 10 2.60 0.75 100 10	Date Complete: Hole Type:	22/02/200 22/02/200 CP	1 1		Initial Initial Rotar Core	Core Diameter y Casing Type Barrel:	r. 1	150mm		Ground	d Level:	N Not Recor	rded	
Inter Hole Dept Cashe Dept Weith To Remarka 17200 4.10 3.80 - Dry 10 100 10 10 10 2022001 17.00 4.10 3.80 - Dry 10 2.60 0.75 100 10			PROGR	ESS								10		
Violation Deptin Deptin Deptin Deptin Tool Hours From To Hole Dia Gore Dia Plant 2022001 17500 4.10 3.80 - Dry Dry Dry Dry Dry D	Date Tim	-	Casing	Water	Pemorke				lling	DRILLI	NG DETAI			
At top in motion: 3.80 4.10 1.00 1.00 1.00 Note: Note: Note: Note: Note: Note: Note: Note: Note: Note: Note: Note:		Deput		Depth -		••					To	Hole Dia	Core Dia	Flush
ate Time Strike Risen To After n Minutes Cesing Depth Flow Sealed Depth Blow for 75mm Increments I <t< th=""><th></th><th></th><th></th><th></th><th>24</th><th></th><th>3.80</th><th>4.10</th><th>1.00</th><th>÷</th><th></th><th>Ę</th><th></th><th></th></t<>					24		3.80	4.10	1.00	÷		Ę		
All depth in metres; all diameters in millimetres. Groundwater levels are subject to seasonal, tidal and other fluctuations and should not be taken as constant 150mm diameter casing installed to 3.80m depth. Borehole backfilled with arisings on completion.	Date Tim	Strike	Risen	After n	Casing	Flow		S	ealed	1				
All depth in metres; all diameters in millimetres. Groundwater levels are subject to seasonal, tidal and other fluctuations and should not be taken as constant 150mm diameter casing installed to 3.80m depth. Borehole backfilled with arisings on completion.										2.50	34,6,5,6,5,5			
All depth in metres; all diameters in millimetres. Groundwater levels are subject to seasonal, tidal and other fluctuations and should not be taken as constant 150mm diameter casing installed to 3.80m depth. Borehole backfilled with arisings on completion.))		
Groundwater levels are subject to seasonal, tidal and other fluctuations and should not be taken as constant 150mm diameter casing installed to 3.80m depth. Borehole backfilled with arisings on completion.							NOTES	S						
PERSONNEL	Groundwater	levels are subj	ect to seasor	nal, tidal and	other fluctu rehole backi	ations and shou filled with arising	d not be take s on complet	n as const ion.	ant					

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Client:



BOREHOLE LOG

Borehole No 26 Sheet 1 of 1

Robroyston, Glasgow

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Job No: 9957

Consultant: David R. Murray & Associate

Ambion Holdings

Consultant:	David R. Murray	& Assoc	iates											
Date Started Date Complete: Hole Type: Equipment:	23/02/2001 23/02/2001 CP Dando 3000		Initial Borir Initial Core Rotary Cas Core Barre Core Bit:	ing Type		150mm			-		E N Not Rec 90 ° 1:50	orded		
t t	Description of Strata			Legend	Depth	OD Level		mpling/ ore Run	U		itu Testing	TCR (SCR)	FI	Install -ation
MADE GROUND:	Brown sandy topsoil (D	Driller's Des	cription)					1	+	Test	Result	RQD		Luci
some fine to coan rootlets. Firm brown locally sub rounded and a	mottled orange brown se sub rounded to sub a y dark grey sandy CLAY sub angular gravel (glac	ingular grav 7 with some cial till)	fine to coarse		0.35 0.70 1.65		U D B U	0.50-0.95 0.95 1.30 1.50-1.95	63 150					
and sub angular g	andy CLAY with some fi ravel and some cobbles	ne to coars s (glacial till	e sub rounded)				D B U D B	1.95 2.30 2.40-2.85 2.85 3.30	161		÷ و			
End of Borehole at	5.00 m				5.00		U B D D	4.00-4.45 4.30 4.45 4.50-4.95	131	S	26			
U Undisturbed U100 Sample Image: Core Run P Piston Sample TCR Total Core Recovery TW Thin Wall Sample SCR Solid Core Recovery D Small Disturbed Sample RQD Rock Quality Designati B Bulk Disturbed Sample Fi Fracture Index LB Large Bulk Disturbed Sample Fi Fracture Log W Water Sample NI Non Intact G Gas Sample U* Blows to drive U100 /U C Core NR No Recovery					S C 32 /175 /25# NP PR K V L	Cone N for For g Seati No P Press Perm Insitu	Penetra full 300 iven per ng blow enetratio suremeto eability Vane T	er Test Test (m/s)		, 11 , 12	Cable Perc Rotary Op Rotary Cor ation Stoted Pipe Piezometer Tip Srout Soncrete	en Hole red Sand	inite Seal	

Fi	atus nal 7/2001		ſ	itcl		S				DLE	E LO	G		Borehole 26 Information	
Client: Consulta	ant:	Ambion H David R.		Associate		broysto	n, Gla	sgov	W			Jc	ob No: 995	7	
Date Start Date Com Hole Type Equipmen	ed plete:	23/02/2001 23/02/2001 CP Dando 3000			Initial Initial Rotan	Boring Diamete Core Diameter y Casing Type Barrel: Bit:	r	150mm				dinates: nd Level: ge:	E N Not Rec 90 °	orded	
			PROGR	ESS							DRILL	ING DET	TAILS		
Date	Time	Hole Depth	Casing Depth	Water Depth	Remarks		From	CP CI	hiselli	ing Hour			Rotary Hole Dia		Flush
3/02/2001	17:00	5.00	5.00	******	Dry					- I Denis	3				1 Pades
											8 10				
								-							
				ER STR							IN S	ITU SPT	TEST D	ETAILS	
Date	Time	Strike	Risen. To	After n Minutes	Casing Depth	Flow	·		Se	aled	Depth	Blows for	75mm Increm	ents	
											4.50	2,3,4,6,8	9,8		
12											5			а 5	
													1		
Ground	water lev	res; all dlame vels are subje r casing Insta	ect to seasor	nal, tidal and	other fluctu rehole backi	ations and shou	NOTE	ien as c	onsta	Int					
			_						-1						
oriller: SP				9	Logged	by: GW	PERS	JININE			Check	ed by: Si			

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BOREHOLE LOG

Borehole No 27 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Client:	Ambion Holdings
Concultort	Devid D. Mumou 9. A

Consultant:	David R. Murray	& Associat	es												
Date Started	26/02/2001		Initial Boring	Diameter		150mm			Coordin	ates		E			
Date Complete:	26/02/2001		Initial Core D)iameter								N			
Hole Type:	CP		Rotary Casin	g Type					Ground	Leve	el:	Not Reco	orded		
Equipment:	Dando 3000		Core Barrel:	• ••					Plunge:			90 °			
			Core Bit:						Scale:	•		1:50			
				T		OD	1	······	T		1		TCR		T
0	Description of Strata			Legend	Depth	Level		mpling/		U	In S	itu Testing	(SCR)	FI	Install
MADE GROUND	Brown sandy topsoll (E	villaria Donaria				 					Test	Result	RQD		-ation
					0.25										
Soft to firm light g	reyish brown sandy CL/ ed and sub angular grav	AY with some f	fine to	K Z			в	0.45		43					
sandy slit, some li	on staining and some n	ootlets.	101505 01		0.75		U	0.50-0.	.95	-10					
Firm to stiff brown	mottled grey sandy CL	AY with some	fine to		0.75			0.05							
coarse sub rounde	ed and sub angular grav	el, some iron :	staining and				D	0.95							
occasional bands	of brown slity fine and r	nedium sand.					в	1.25							
							U	1.50-1.	05	81					
								1.50-1.	55	01					
Manager					2.00		D	1.95	45		s	4			
very soft brown ve rounded gravel.	ery sandy CLAY with so	me fine to coa	rse sub					1.00-2.							
g. u. v.								2.50							
					2.60		B	2.50 2.60-3.	05		s	30			
Stiff dark brown sa and sub angular or	andy CLAY with some fi ravel, some cobbles, dr	ne to coarse s	ub rounded	A											
(glacial till)	iavel, aome cobbles, di	IIICI HOICS SAIN	uy bands.	A											
				22.0								×			
				- A											
				A A COL			в	3.60							
				1000 C									2.44		
							U	4.00-4.4	45	133					
				A											
				1000			D	4.50-4.9	95		S	25			
				1 × × × × × × × × × × × × × × × × × × ×	ĺ										
				1 2 0 0 0	5.00										
End of Borehole at	5.00 m											1			
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				1	<u> </u>			L					i		
	ed U100 Sample	ч с	ore Run		S	Stand	lard Per	netration	Test	-	CP	Cable Perc	ussion		
P Piston Sar			otal Core Recovery		C	Cone	Penetra	ation Tes	t		RO	Rotary Ope			
W Thin Wall Small Dist	Sample urbed Sample		olid Core Recovery	lies	32			mm pene			RC	Rotary Cor			
	rbed Sample		ock Quality Designat acture Index	uon	/175 /25#			netration is only (m			Installa	ation			
B Large Bull	Disturbed Sample	FI Fr	acture Log		NP		enetratio		••••		Ð,	Slotted Pipe	Sand	Filter	
V Water Sar)	on Intact		PR	Press	uremet	er Test		1	I ,	Piezometer Tip	Contract of Contract	nite Sea	
G Gas Samp C Core	ne	U* BI	lows to drive U100 /L	J86	ĸ			Test (m/s	5)		3	Grout	Grave		•
NR No Recove	ery				L		Vane T er Test (est (Lugeons)				Colored Colored		
	•	l				rauk	- 1031	Lugouis	/		(Concrete			

Fi	atus inal			itc	hie	S	BO	REI	HOLI	e lo	G		orehole 27 Information	No
Client: Consult	ant.	Ambion ł David R		Associate		obroysto	on, Gla	sgov	w		Job	No: 9957		
Date Star Date Con Hole Type Equipmer	ted nplete: e:	26/02/2001 26/02/2001 CP Dando 300			Initia Initia Rota	l Boring Diamet I Core Diameter ry Casing Type Barrel: Bit:		150mm			linates: Id Level: e:	E N Not Reco 90 °	rded	
			PROGR	RESS]			DRILL	ING DETA	II.S [×]		
Date	Time	Hole	Casing	Water	Remarks			CP CI	hiselling	DIVILL		Rotary		
26/02/2001	17:00	Depth 5.00	Depth 5.00	Depth	Dry		From	To	Hou	rs Fron	То	Hole Dia	Core Dia	Flush
										-				
	L													e.
	·	7		TER STI						IN S	TU SPT T	EST DE	TAILS	
Date	Time	Strike	Risen To	After n Minutes	Casing Depth	Flow			Sealed	Depth	Blows for 75	mm Increme	nts	
26/02/2001	:	2.05	2.05	20	2.05	Seepage				2.00 2.60 4.50	1,0,0,1,1,2 3,2,10,10,5, 2,4,4,5,7,9	5 ·		
							*							
							NOTE	S						
Ground	water lev	res; all diame vels are subje er casing Insta	ect to seaso	nal, tidal and	l other fluctu rehole back	uations and sho filled with arisin	uld not be tak	en as c	onstant		12			
													<u> </u>	
Dalla CC					1		PERSC	NNE	L					
Driller: SP					Logged	by: GW				Checke	d by: SKF			

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Status Final

Client:



BOREHOLE LOG

Borehole No 28 Sheet 1 of 1

Robroyston, Glasgow

Job I

Job No: 9957

Consultant: David R. Murray & Associates

Ambion Holdings

				<u></u>									
Date Started 27/02/2001	Initial Borin	g Diameter:		150mm		T	Coorr	linates	:	E			
Date Complete: 27/02/2001	Initial Core	•							-	N			
Hole Type: CP	Rotary Cas	ing Type					Grou	nd Leve	al•	Not Reco	orded		
Equipment: Dando 3000	Core Barre										on acca		
-1-t	Core Bit:	••					Plung			90 ° 1:50			
		1 1			r		Scale			1.50			
Description of Strata				OD	Sar	mpling/			In S	itu Testing	TCR (SCR)	FL	Insta
		Legend D	epth	Level	Co	ore Run		U	Test	1	RQD		-atio
MADE GROUND: Brown sandy topsoil (Driller's	Description)												1
Firm brown mottled orange brown and grey san		.0	30										
occasional fine to coarse sub rounded and sub a	angular gravel and				BU	0.50	05	53				1	
some rootlets.			- 1		0	0.00-1	.00						
Stiff brown mottled grey sandy CLAY with some	fine to coarse sub	0.0	55								1		
rounded and sub angular gravel, and some cobi		AAT			D	1.05							
		R Dordo			в	1.30			а ^с				1
		P. S. C. P.	1		U	1.50-1	.95	50					
		A 2015	75										
Firm to stiff locally stiff dark greyish brown sand	y CLAY with some	A			D	1.95							
ine to coarse sub rounded to angular gravel and glacial till).	d some cobbles.	A 444	1		-								
granation and the		A 00-5	3			2.25							
		A 10-14			В	2.35							
		A			U	2.60-3	.05	57					
		A CONTRACT											
		2000			D	3.05							
					в	3.30							
		- 0			ម ប		05						
			0		U	3.50-3	.50						
tiff dark brown sandy CLAY with some fine to c	coarse sub rounded	3.7	۰ I										
angular gravel and some cobbles, (glacial till)		2 X 2 2 2											
		A second			_					6			
					D	4.50-4	.95		S	17			
	5. B	A A CON											
	*	B 5.0	0										
nd of Borehole at 5.00 m													
					1								
			1										
								-					
								T					
								1					
									CP	O-his Deer			
Undisturbed U100 Sample	Core Run		s		ard Pen					Cable Perc	cussion		
Piston Sample TCR	R Total Core Recovery	·	С	Cone	Penetra	tion Te	st		RO	Rotary Ope	en Hole		
Piston Sample TCR Thin Wall Sample SCR	R Total Core Recovery R Solid Core Recovery		C 32	Cone N for f	Penetra full 300n	ntion Tes nm pen	st etration				en Hole		
Piston Sample TCR ThIn Wall Sample SCR Small Disturbed Sample RQI Bulk Disturbed Sample FI	R Total Core Recovery R Solid Core Recovery	ation	C 32 /175	Cone N for f For gi	Penetra full 300n ven pen	ntion Tes nm pen etration	st etration (mm)		RO RC Installa	Rotary Ope Rotary Cor	en Hole		
Piston Sample TCR Thin Wall Sample SCR Small Disturbed Sample RQI Bulk Disturbed Sample Fi Large Bulk Disturbed Sample Fi	 R Total Core Recovery R Solid Core Recovery D Rock Quality Design Fracture Index Fracture Log 	ation	C 32	Cone N for f For gi Seatir	Penetra full 300n	ntion Tes nm pen etration s only (n	st etration (mm)		RO RC Install:	Rotary Ope Rotary Cor ation	en Hole red	Filter	
Piston Sample TCR Thin Wall Sample SCR Small Disturbed Sample RQI Bulk Disturbed Sample Fi Large Bulk Disturbed Sample Fi Water Sample Ni	 R Total Core Recovery R Solid Core Recovery D Rock Quality Design Fracture Index Fracture Log Non Intact 	ation	C 32 /175 /25# NP PR	Cone N for f For gi Seatin No Pe Press	Penetra full 300n ven pen ng blows netratio uremete	ntion Tes mm pene etration s only (n n r Test	st etration (mm) mm)		RO RC Installa	Rotary Ope Rotary Cor ation	en Hole red Sand		
Piston Sample TCR V Thin Wall Sample SCR Small Disturbed Sample RQL Bulk Disturbed Sample Fi Large Bulk Disturbed Sample Fi Water Sample Ni Gas Sample U*	 R Total Core Recovery R Solid Core Recovery D Rock Quality Design Fracture Index Fracture Log 	ation	C 32 /175 /25# NP PR K	Cone N for f For gi Seatir No Pe Presso Permo	Penetra full 300n ven pen ng blows netratio uremete eability 1	ntion Tes mm pen etration s only (n on r Test Test (m/	st etration (mm) mm)		RO RC Installa	Rotary Ope Rotary Cor ation	en Hole red Sand Bento	nite Seal	
Piston Sample TCR V Thin Wall Sample SCR Small Disturbed Sample RQI Bulk Disturbed Sample Fi Large Bulk Disturbed Sample Fi Water Sample Ni	 R Total Core Recovery R Solid Core Recovery D Rock Quality Design Fracture Index Fracture Log Non Intact 	, ation /U86	C 32 /175 /25# NP PR	Cone N for f For gi Seatin No Pe Press Perme Insitu	Penetra full 300n ven pen ng blows netratio uremete	ntion Tes mm pen- petration s only (n n er Test Test (m/ est	st etration (mm) mm) (s)		RO RC Installa	Rotary Ope Rotary Cor ation	en Hole red Sand	nite Seal	

Fi	atus nal 7/2001			itc		S				E LO	G		orehole 28 Information	No
Client: Consult	ant:	Ambion H David R.		Associate		broystor	n, Glas	sgo\	N		Job	No: 9957		
Date Star Date Con Hole Type Equipmer	nplete: e:	27/02/2001 27/02/2001 CP Dando 3000			Initial Rotar	Boring Dlameter Core Dlameter y Casing Type Barrel: Bit:		150mm			dinates: nd Level: ge:	E N Not Recor 90 °	rded	
			PROGR	ESS						DRILL	ING DETA	ILS		
Date	Time	Hole	Casing	Water	Remarks				niselling			Rotary		
27/02/2001	17:00	Depth 5.00	5.00	Depth -	Dry		From 3.10	<u> </u>	Hou 25 0.50		n To	Hole Dia	Core Dia	Flush
Date	Time	Strike	Risen	TER STF	Casing	Flow			Sealed	IN S	ITU SPT T			
			Το	Minutes	Depth				5.	4.50	2,3,3,4,5,5	1 111 11 10 10 10 10 10		
							NOTE	S		·				
Ground	water lev	res; all diarne rels are subje r casing Insta	ect to seaso	nal, tidal and	other fluctu rehole backf	ations and should shoul	d not be take	en as co	onstant					
							PERSC	NNE	L					
riller: SP	1				Logged	by: GW				Checke	d by: SKF			

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BOREHOLE LOG

Borehole No 30 Sheet 1 of 1

Robroyston, Glasgow

Client: Ambion Holdings

Job No: 9957

Consultant:	David R. Murray & Associates
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		Daviu R. Iviuriay	a Associate													
Date S	Started	22/02/2001		Initial Boring	Diameter:		150mm			Coord	linates:		E			
Date C	Complete:	22/02/2001		Initial Core D	iameter								N			
Hole T	уре:	CP		Rotary Casing Type						Groun	d Leve	at:	Not Recor	rded		
Equipm	nent:	Dando 3000		Core Barrel:						Plunge			90 *			
				Core Bit:						Scale:			1:50			
							OD	T						TCD	T	T
	De	escription of Strata			Longard	Depth	Level		mpling/		U	In Sit	tu Testing	TCR (SCR)	FI	Insta
					Legend	Dopai		C	ore Run			Test	Result	RQD		-atio
MADE	GROUND: E	Brown sandy topsoil (D	riller's Descrip	tion)		0.25			1							
Firm ligh	ht greyish b	rown mottled orange b	rown sandy Cl	AY with				в	0.45					1		
some ro	oots and occ	casional fine to medium	n sub rounded	gravel.				Ū	0.55-1	.00	51					
						0.80		1		1						
Firm to a	stiff brown s	sandy CLAY with some	e fine to coarse	sub				D	1.00							
	t and sub ar red glacial ti	ngular gravel and some	e Iron staining (slightly				-								
wedutor	ica glaciai u	,								1		.]				
								U	1.50-1	.95	150					
CALIF					1	1.65			· ·							1
		ly CLAY with some fine avel and some cobbles		rounded	2000 C			D	1 05							1
	Turberten Ste		. (Summer on)		- X X			1	1.95							
					- A	0.05		В	2.15			i				
Stiff to v	erv stiff dar	k brown sandy CLAY	with some fine	to marse	1000	2.35		U	2.50-2	995	108					
		tb angular gravel and s			Anes			Ŭ	2.00-2		100					
					Aces											
					AAres			D	2.95							
					A A D											
					A A B			в	3.40	~						
					- 8 A - 9			-								
					A Speed											
					A AND S		÷.,									
					18 X 6 2 5			U	4.00-4	.40	131					
					A Apres				1							1
					P No			D	4.45							
					A 2 0.0		. 1	B D	4.50	05		s	23		1	
					A CONSTRUCTION		ļ	1	1.00-5							
					A CAR	5.05	1	ł								
End of B	Borehole at	5.05 m						1								
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		d U100 Sample		ore Run		s			netration			CP	Cable Perc	ussion		
	Piston San	•		otal Core Recovery		C			ation Te			RO	Rotary Ope			
	Thin Wall S Small Distu	sample Jrbed Sample		olid Core Recovery ock Quality Designat	tion	32 /175				netration		RC	Rotary Con	ed		
		bed Sample		acture Index	001	/25#			netration vs only (r			Installa	ation			
B	Large Bulk	Disturbed Sample	FI Fr	acture Log		NP		enetratio				⊞ s	Slotted Pipe	Sand	d Filter	
	Water Sam			on Intact		PR	Press	suremet	ter Test			nn Ť	Piezometer Tip		u riker Ionite Sea	
	Gas Sampl	e	U* BI	ows to drive U100 /(J86	ĸ			Test (m	/s)			-	Grav		91
	Com					1 37			Carak			، حد	annaid	hall Com	ani Elliner	
C	Core No Recove	rv.						Vane T	Lugeon	-		653	Concrete	Cial Giav		

I				·												
	atus													E	Borehole	No
	inal 07/2001				nie	S	BOI	REI	HC	DLI	ELO	00	3		30 Information	
;					R	obroysto	n, Gla	sgo	W							
Client:		Ambion I						-					Job	No: 9957	*	
Consult			·····	Associate				,• 								
Date Start Date Com		22/02/2001 22/02/2001				l Boring Diamete I Core Diameter		150mm)	-	Co	oordin	ates:	E N		
Hole Type	e: 🔗	CP			Rotar	ry Casing Type							Level:	Not Reco	rded	
Equipmen	<i>it</i> :	Dando 300	0		Core	Barrel: Bit:					PI	unge:		90 °		
			PROGR								DRI	LLIN	NG DETA			
Date	Time	Hole Depth	Casing Depth	Water Depth	Remarks	i	From	CP C To	hisell	ing Hour	rs F	rom	То	Rotary Hole Dia	Core Dia	Flush
22/02/2001	17:00	5.00	5.00	-	Dry								56	1	1	-
					I											
					l											
											Ċ.					
12					Į										۸.	
					l)										
					Į											
					ļ											
l	13	<u> </u>	۱۸/۵	TER STR	VIVEO				.							
Date	Time	Strike	Risen	After n	Casing	Flow			Cos	aled	IN Depth	1	U SPT T			
			То	Minutes	Depth				00.		4.		Blows for 75r		nts	11-11
	l															
	l				1											
	l				1											
	l															
2	I				ļ											
					1											
					_											
		- J														
							NOTE	S	_	I	L	L				
All dept	th in metr	res; all diame	nter in millir					-								
					other fluctu	lations and shoul	1-1 mot ha tak			4						
150mm	diameter	r casing insta	alled to 5.00r	m depth. Bon	ehole back	filled with anising	is on comple	en as c. tion.	nsta	m						
0	2															
					1		PERSC	NNE	L							
Driller: SP					Logged	iby: GW					Chec	cked t	by: SKF			

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BOREHOLE LOG

Borehole No 31 Sheet 1 of 1

Robroyston, Glasgow

Client: Ambion Holdings

Job No: 9957

Consultant: David R. Murray & Associates

Consultant: L	David R. Murray	& Associates													
Date Started 2	3/02/2001		Initial Boring	Diameter		150mm		T	Coor	dinates		E			
Date Complete: 2	3/02/2001		Initial Core D									N			
Hole Type: C	P		Rotary Casin	ng Type					Grou	nd Leve	el:	Not Reco	rded		
Equipment: D	Dando 3000		Core Barrel:						Plung			90 °			
			Core Bit:						Scale			1:50			
				1		OD	1			1			TCR		1
Desci	ription of Strata			Legend	Depth	Level		mpling/		U	In S	itu Testing	(SCR)	FI	Install
MADE GROUND: Brow		tillada Deseriation	->	XXXXX				ore Rur			Test	Result	RQD		-ation
IN DE CICOND. DIO	wit sainty topsoli (Di		1)		0.35										
Firm brown mottled on	ange brown and gre	v sandv CLAY wi	ith some	XXXXX	0.35		в	0.50							
fine to coarse sub roun rootlets.	nded and sub angula	r gravel and som	le				Ū	0.55-	1.00	49					
					0.85										
Firm brown and dark g sub rounded and sub a	rey sandy CLAY wit	h some fine to co	barse				D	1.00							
	angulai gravei anu s	ome iron staining								Į					
							U	1.50-	1 05	150					1
Outer de la construction					1.60		ľ	1.50-	-1.90 	150					
Stiff dark greyish brown rounded to angular gra	n sandy CLAY with a avel (glacial till)	some fine to coar	rse sub												
and a second sec							D	1.95							1
				展開			В	2.30							
Stiff locally un	ade annu t- 01	/			2.55		U	2.50-	2.95	150					
Stiff locally very stiff da coarse sub rounded an	nd sub angular grave	r with some fine i and some iron	to staining	A COL											
(slightly weathered glad	cial till).			A 400			D	2.95							
Stiff dark grey sandy C	AY with some fine	to cooree sub	unded	1000	3.30		в	3.40				а.			
and sub angular gravel	I, some silty partings	5. Driller notes so	me	1000			Ū	3.50-	3.95	79					
cobbles. (glacial till).				A Aces											
				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			D	3.95				1			
				4											
				A			D	4.50-4	4.95		S	20			
				1000											
					5.00										
End of Borehole at 5.00	0 m				0.00										
			× 5												
										Ì					
	- ·									Ţ		245			
U Undisturbed U	100 Sample	Core	Run	·····	s	Store	lard Per	hatenit	n Tort		CP	Oable D			
P Piston Sample			Core Recovery		c		Penetra				RO	Cable Perc Rotary Ope			
TW Thin Wall Sam		SCR Solid	Core Recovery		32	N for	full 300r	mm pei	netration		RC	Rotary Cor			
D Small Disturbe B Bulk Disturbed			Quality Designat	tion	/175	For g	iven per	netratio	n (mm)		Install	•			
	sample		ure Index ure Log		/25# NP		ng blows enetratio		(mm)		E		555		
W Water Sample		NI Non l	-		PR		enetratio suremete					Slotted Pipe	Sand		
G Gas Sample			s to drive U100 /L	J86	K		eability					Plezometer Tip	Amaging all	nite Seal	
C Core					V	Insitu	Vane T	est				Grout	Grave	i Filter	
NR No Recovery			· · · · · · · · · · · · · · · · · · ·		L	Packe	er Test (Lugeor	ns)			Concrete			

Fi	atus nal 7/2001			itc	hie	S	BOF	REI	HOL	E LC	G	E	Borehole 31	No
Client: Consult	ant:	Ambion H David R.		Associate		obroysto	n, Glas	sgov	W		Job	No: 9957	7	
Date Star Date Corr Hole Type Equipmer	plete: :	23/02/2001 23/02/2001 CP Dando 3000			Initial Rota	Boring Diamete Core Diameter y Casing Type Barrel: Bit:	ar. 1	150mm			dinates: nd Level: ge:	E N Not Reco 90 °	rded	
			PROGR	ESS]			DRILI	ING DETA	2110		2
Date	Time	Hole	Casing	Water	Demarka			CP Ch	niselling			Rotary		<u></u>
23/02/2001	17:00	Depth 5.00	Depth 5.00	Depth	Remarks Dry		From 3.05	То	.20 0.5		n To	Hole Dia	Core Dia	Flush
						ŝ								
			WA.	TER STI	RIKES		······				ITU SPT T	EST DE	TAILS	1
Date	Time	Strike	Risen	After n	Casing									
23/02/2001		3.70	То	Minutes	Depth	Flow			Sealed	Depth 4.50	Blows for 75	mm Increme	nts	
						Seepage					2,3,4,4,5,7			
				L			-	<u>, </u>						
Ground	water lev	es; all diame els are subje r casing insta	ct to seaso	nal, tidal and	l other fluctu rehole back	lations and shou filled with arising	NOTES Id not be take as on complet	n as co	onstant					
				.8										
						H	PERSO	NNE	L					
Driller: SP					Logged	by: GW				Checke	ed by: SKF			

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Borehole No 14

Robroyston

Client: Ambion Holdings Ltd.			Job No: 9957
Consultant: D R Murray & Associat	es		
Depth m	0.60	······	
Natural Moisture Content %	20.0		~~~~~~
Liquid Limit %	34		
Plastic Limit %	17		
Plasticity Index %	17		
Particle Density		λ.	
Bulk Density Mg/m3	2.03		
Particle Size Distribution			
Organic Matter Content %		*	
Mass Loss on Ignition %			
Sulphate Content %			
g/1			
2:1			
pH			
Optimum Moisture Content %			
Maximum Dry Density Mg/m3		2	
MCV Natural			
MCV Calibration Intercept			
Slope		10	
Sensitivity		30	
California Bearing Ratio %			
Oedometer Consolidation			
C kN/m2	33.0		
C' kN/m2			
Phi °	6.0		
Vane kPa			
Insitu California Bearing Ratio %			
Density Mg/m3			
Other			
F	CEY TO SYMRO	OLS AND ABBREVIATIONS	
C - Apparent Cohesion		S - Sieve Analysis	
C' - Cohesion Intercept Based on Effective Stree		SS - Sieve and Sedimentation	Analysis
Phi - Angle of Shearing Resistance Relating to MCV - Moisture Condition Value	CorC	* - Test Undertaken	

Borehole No 15

Job No: 9957

Robroyston

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates

Depth m	0.55	1.50		E.	
Natural Moisture Content %	21.0	13.0			
Liquid Limit %					
Plastic Limit %					
Plasticity Index %					
Particle Density					
Bulk Density Mg/m3	2.10	2.20			
Particle Size Distribution	2.10	2.20			
Organic Matter Content %					
Mass Loss on Ignition %					
Sulphate Content %	0.030				
g/l					
2:1					
pH	5.9				
Optimum Moisture Content %					
Maximum Dry Density Mg/m3			ė.		
MCV Natural					
MCV Calibration Intercept					
Slope			38 S		
Sensitivity					
California Bearing Ratio %					
Oedometer Consolidation	*	*			
C kN/m2	22.0	71.0			`
C' kN/m2					
Phi °	4.0	0.0			
Vane kPa					
Insitu California Bearing Ratio %					
Density Mg/m3					
Other					
ĸ	EY TO SYM	BOLSANDA	BBREVIATIONS		
C - Apparent Cohesion			ieve Analysis	······	
C' - Cohesion Intercept Based on Effective Stre	ss C == C'	SS -	Sieve and Sedimentation Analy	ysis	
Phi - Angle of Shearing Resistance Relating to MCV - Moisture Condition Value	C or C	* - T	est Undertaken		

Borehole No ritchies TEST RESULTS SUMMARY - SOIL

Robroyston

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates	3				Job No: 9	957
Depth m	0.55	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
Natural Moisture Content %	21.0					
Liquid Limit %						
Plastic Limit %						
Plasticity Index %					2	
Particle Density						
Bulk Density Mg/m3	2.09					
Particle Size Distribution						
Organic Matter Content %				<u> </u>		
Mass Loss on Ignition %						
Sulphate Content %						
g/l						
2:1		2				
pH						
Optimum Moisture Content %						
Maximum Dry-Density Mg/m3					-	
MCV Natural						
MCV Calibration Intercept						
Slope						
Sensitivity						
California Bearing Ratio %						
Oedometer Consolidation						
C kN/m2	64.0					
C' kN/m2						
Phi °	0.0					
Vane kPa						
Insitu California Bearing Ratio %						
Density Mg/m3						
Other		÷		in a		
	TA CYLER	OLS AND ABBR	EXATIONS			
C - Apparent Cohesion		S - Sieve Ar				
C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C MCV - Moisture Condition Value	or C'		nd Sedimentation	Analysis	15	

Robroyston

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates		-	1	Job No: 9957
Depth m	0.60	<i>r</i>		
Natural Moisture Content %	27.0			
Liquid Limit %				
Plastic Limit %				
Plasticity Index %				
Particle Density				
Bulk Density Mg/m3	2.04			
Particle Size Distribution	`			
Organic Matter Content %				
Mass Loss on Ignition %				
Sulphate Content %	0.030			
g/1		37		
2:1				
pH	4.2			
Optimum Moisture Content %				
Maximum Dry Density Mg/m3		5		
MCV Natural				
MCV Calibration Intercept				
Slope		-		
Sensitivity				
California Bearing Ratio %				
Oedometer Consolidation	*			
C kN/m2	52.0			
C' kN/m2				
Phi °	0.0			
Vane kPa				
Insitu California Bearing Ratio %				
Density Mg/m3		ii i		
Other				
KEY	TO SYMBOLS A	ND ABBREVIATI	ONS	
C - Apparent Cohesion		S - Sieve Analysis		
C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C on MCV - Moisture Condition Value	- C'	SS - Sieve and Sedime. * - Test Undertaken	ntation Analysis	

Borehole No
23

Robroyston

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates

Job No: 9957

Depth m	0.50	1.50	
Natural Moisture Content %	22.0	12.0)
Liquid Limit %	34		
Plastic Limit %	18		
Plasticity Index %	16		к.
Particle Density			
Bulk Density Mg/m3	2.09	2.14	
Particle Size Distribution			
Organic Matter Content %			el de la companya de
Mass Loss on Ignition %			
Sulphate Content %	0.040		
g/l	12		
2:1			
pH	6.0		
Optimum Moisture Content %			
Maximum Dry Density Mg/m3			
MCV Natural			
MCV Calibration Intercept			
Slope			-
Sensitivity			
California Bearing Ratio %			
Oedometer Consolidation	*	*	
C kN/m2	51.0	87.0	
C' kN/m2			
Phi [°]	0.0	25.0	
Vane kPa			
Insitu California Bearing Ratio %			
Density Mg/m3			
Other		1	
C - Apparent Cohesion	KEY TO SYM		D ABBREVIATIONS
C' - Cohesion Intercept Based on Effective Str Phi - Angle of Shearing Resistance Relating to MCV - Moisture Condition Value	ess C or C'		S - Sieve Analysis SS - Sieve and Sedimentation Analysis * - Test Undertaken

Borehole No 24

Robroyston	
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Client: Ambion Holdings Ltd. Consultant: D R Murray & Associa		•		Job No: 9957
Depth m	1.60	,,,,		
Natural Moisture Content %	15.0	3		
Liquid Limit %				
Plastic Limit %				
Plasticity Index %				8
Particle Density				
Bulk Density Mg/m3	2.19			
Particle Size Distribution				
Organic Matter Content %	4946		ji	
Mass Loss on Ignition %			. *	
Sulphate Content %				
g/1				
2:1				
pH				
Optimum Moisture Content %				
Maximum Dry Density Mg/m3				. - *
MCV Natural				
MCV Calibration Intercept				
Slope				
Sensitivity				ž .
California Bearing Ratio %				
Oedometer Consolidation				
C kN/m2	62.0			
C' kN/m2				
Phi °	0.0			
Vane kPa				
Insitu California Bearing Ratio %				· · · · · · · · · · · · · · · · · · ·
Density Mg/m3				
Other	1			
	VEN TO OVO COO			
C - Apparent Cohesion	KEY TO SYMBO			-
C' - Cohesion Intercept Based on Effective St Phi - Angle of Shearing Resistance Relating t MCV - Moisture Condition Value	ress ω C or C'	S - Sieve An SS - Sieve an * - Test Unde	d Sedimentation Analysis	
		l		

ritchies TEST RESULTS SUMMARY - SOIL Borehole No 25

Robroyston

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates				Job No: 9957
Depth m	0.55			
Natural Moisture Content %	22.0			
Liquid Limit %				
Plastic Limit %				
Plasticity Index %				
Particle Density				
Bulk Density Mg/m3	2.04			
Particle Size Distribution				
Organic Matter Content %				
Mass Loss on Ignition %		2		
Sulphate Content %				
g/l				
2:1				
pH				
Optimum Moisture Content %				
Maximum Dry Density Mg/m3				
MCV Natural				
MCV Calibration Intercept				
Slope				
Sensitivity				
California Bearing Ratio %				
Oedometer Consolidation				
C kN/m2	32.0			
C' kN/m2				
Phi °	9.0	۲		
Vane kPa				
Insitu California Bearing Ratio %		······		
Density Mg/m3				
Other				
	TO SYMBOLS A	ND ABBREVIATIONS		· · · · · · · · · · · · · · · · · · ·
C - Apparent Cohesion		S - Sieve Analysis		
C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C or MCV - Moisture Condition Value	- C'	SS - Sieve and Sedimentation Analy: * - Test Undertaken	sis	

Borehole No 26

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates						Job No	: 9957
Depth m	0.50	2.4)				
Natural Moisture Content %	20.0	10.)				
Liquid Limit %	35			с.			
Plastic Limit %	18						
Plasticity Index %	17					з	
Particle Density							
Bulk Density Mg/m3	2.11	2.2	5				
Particle Size Distribution							
Organic Matter Content %				74°	······		
Mass Loss on Ignition %							
Sulphate Content %							
g/1							
2:1							
pH							
Optimum Moisture Content %			te d ^a sud in manie			·····	
Maximum Dry Density Mg/m3							
MCV Natural							
MCV Calibration Intercept				722			
Slope							
Sensitivity						•	
California Bearing Ratio %							
Oedometer Consolidation							
C kN/m2	63.0	229	0			0	
C' kN/m2							
Phi °	8.0	0.0					
Vane kPa	3						
Insitu California Bearing Ratio %							· <u>····</u> ····
Density Mg/m3							
Other					-		
VPres							
C - Apparent Cohesion	Y TO SYMBO	LS A	S - Sieve Ana				
C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C of MCV - Moisture Condition Value	r C'			d Sedimentation	Analysis		

Borehole No ritchies TEST RESULTS SUMMARY - SOIL

Robroyston

Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates			Job No: 9957
Depth m	0.50	i.	4
Natural Moisture Content % Liquid Limit % Plastic Limit %	22.0		
Plasticity Index % Particle Density			9
Bulk Density Mg/m3 Particle Size Distribution	1.98		
Organic Matter Content % Mass Loss on Ignition % Sulphate Content % g/l 2:1 pH			
Optimum Moisture Content % Maximum Dry Density Mg/m3 MCV Natural MCV Calibration Intercept		÷	
Slope Sensitivity California Bearing Ratio % Oedometer Consolidation			
C kN/m2 C' kN/m2	25.0		
Phi [°] Vane kPa	6.0		
Insitu California Bearing Ratio % Density Mg/m3			
Other			
KEY	Y TO SYMBOLS A	ND ABBREVIATIONS	
C - Apparent Cohesion C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C on MCV - Moisture Condition Value		S - Sieve Analysis SS - Sieve and Sedimentation Analysi * - Test Undertaken	S

Borehole No 28

		Robroyst	On	14.5 (14.5)
Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates				Job No: 9957
Depth m	0.60	2.35	2.60	
Natural Moisture Content %	20.0	12.4	13.0	
Liquid Limit %				
Plastic Limit %				
Plasticity Index %				-
Particle Density				
Bulk Density Mg/m3	2.10		2.22	
Particle Size Distribution			÷	
Organic Matter Content %				
Mass Loss on Ignition %				
Sulphate Content %				
g/1				
2:1				
pH				
Optimum Moisture Content %				· · · · · · · · · · · · · · · · · · ·
Maximum Dry Density Mg/m3			•	
MCV Natural		7.7		
MCV Calibration Intercept				
Slope				
Sensitivity				
California Bearing Ratio %				
Oedometer Consolidation				
C kN/m2	66.0		64.0	
C' kN/m2				
Phi °	0.0		0.0	
Vane kPa				
Insitu California Bearing Ratio %				
Density Mg/m3				
Other				
	Y TO SYMI		BREVIATIONS	5
C - Apparent Cohesion C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C of MCV - Moisture Condition Value	r C'	SS - S	ve Analysis leve and Sedimentations St Undertaken	on Analysis

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Borehole No ritchies TEST RESULTS SUMMARY - SOIL

Robrovston

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	1001	Oyston		
Client: Ambion Holdings Ltd. Consultant: D R Murray & Associates				Job No: 9957
Depth m	0.55	,		
Natural Moisture Content %	20.0			
Liquid Limit %				
Plastic Limit %				
Plasticity Index %				
Particle Density				
Bulk Density Mg/m3	2.00			
Particle Size Distribution	2.00			
Organic Matter Content %				<u></u>
Mass Loss on Ignition %				
Sulphate Content %	0.020			
g/l				
2:1				
pH	5.6			
Optimum Moisture Content %				
Maximum Dry Density Mg/m3		2		- 1
MCV Natural				
MCV Calibration Intercept				
Slope				
Sensitivity			20	
California Bearing Ratio %				
Oedometer Consolidation				
C kN/m2	39.0			
C' kN/m2				
Phi °	5.0			
Vane kPa				
Insitu California Bearing Ratio %				
Density Mg/m3				
Other				
KE	Y TO SYMBOLS A	ND ABBREVIATIONS		
C - Apparent Cohesion		S - Sieve Analysis		
C' - Cohesion Intercept Based on Effective Stress Phi - Angle of Shearing Resistance Relating to C o	r C'	SS - Sieve and Sedimentation A * - Test Undertaken	alysis	
MCV - Moisture Condition Value		rost ondertaken		

Borehole No 31

Client: Ambion Holdings Ltd.				Job No: 9957
Consultant: D R Murray & Associates				300 110. 9957
Depth m	0.55	2.50		
Natural Moisture Content %	25.0	13.0		
Liquid Limit %				
Plastic Limit %				24
Plasticity Index %				×
Particle Density				
Bulk Density Mg/m3	2.03	2.11		
Particle Size Distribution				
Organic Matter Content %				
Mass Loss on Ignition %				
Sulphate Content %				
g/l				
2:1				
рН				
Optimum Moisture Content %				27
Maximum Dry Density Mg/m3		2		
MCV Natural				
MCV Calibration Intercept				
Slope				
Sensitivity				1
California Bearing Ratio %				1
Oedometer Consolidation	*	*		
<u></u>				
C kN/m2	36.0	101.0		
C' kN/m2				
Phi °	6.0	15.0		
Vane kPa			× -	
Insitu California Bearing Ratio %				
Density Mg/m3				
Other				
	SZ IDO. OSP			
C - Apparent Cohesion	I IUSYM		BBREVIATIONS	
C' - Cohesion Intercept Based on Effective Stress			ve Analysis eve and Sedimentation Anal	vsis
Phi - Angle of Shearing Resistance Relating to C of	or C'		t Undertaken	•
MCV - Moisture Condition Value				

Status Final



Trial Pit No TD100

26/07/2001 TRIAL PIT LOG							s	IP108 Sheet 1 of 1				
			Robroyston,	Glaso	w				1			
Clien	nt:	Ambion Holdings	,	0.0.09	•				Job No:	9957		
Cons	sultant:	David R. Murray & Associate	25									
Date S	Started	28/02/2001			<u>.</u>	Co	ordinate	s:	E			
	Complete:	28/02/2001 TP	⊲ 2.60 [> 7 Δ Γ					N			
Hole T Equipi	•••	JCB 3CX	Dimensions	0.60 В ⊽	earing	Gro	ound Lev	/el:	Not Rec	Not Recorded		
						Sca	ale:		1:50			
	Des	cription of Strata		Legend	Depth	OD Level	Sa	ampling	In S Test	itu Testing Result	Install -ation	
M/	ADE GROUNI	D: Dark brown clayey sandy topsoil w nd some rootlets.	ith some fine to		0.20		1					
Fi	rm light grevis	h brown mottled orange brown sandy unded to sub angular gravel and som	CLAY with some fine						v	36	-	
sa	andy silt (weath	hered glacial till).	e unit ictioca of grey		0.90				V	51 40		
Firm to stiff brown sandy CLAY with some fine to coarse sub rounded and				2000 000	0.90							
sub angular gravel, some cobbles and boulders and occasional iron staining (glacial till).					4.50		в	1.40	¥ V	48 52		
St	iff dark bluish	grey brittle sandy CLAY with some fir lar gravel, some cobbles of mudstone	ne to coarse sub		1.50	₫(v	62		
bo	oulders (glacia	I till).					8					
St	iff becoming v	ery stiff to base bluish grey sandy CL ded and sub angular gravel, some co	AY with some fine to		2.10							
			DDIes and Doulders.	A	2.60				¥ V	110 108		
En	nd of Trial Pit a	at 2.60 m							v	100		
					-							
			NOTES	l	7			I	l1		<u> </u>	
	nsions In Metr											
Groundw	vater levels an	e subject to seasonal, tidal and other	fluctuations and should not be take	n as constant								
Groundw		Dry										
Stability: Shoring:		Stable. None										
General:	:	Trial plt terminated at 2.60m In stiff	clay. Trial pit backfilled with arising	s on completi	on.							
Logged b	hic	GW		01-	- 1 - 1 h	0//5						
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		ĸ	EY TO SYMBOLS AND	ABBRE	VIATIO	NS						
D B	Small Disturt Bulk Disturb		W Water Sample G Gas Sample				V VR		Hand Vane T Hand Vane T			
LB U	Large Bulk D	isturbed Sample U100 Sample	NR No Recovery Estimated Rela	tive Density			P		Pocket Pene	rometer Test		
BLK CBR	Block Sample CBR Mould S	e				IDEN I		In Situ CBR Test In Situ Density Test In Situ MCV Test				



Trial Pit No TP109 Sheet 1 of 1

Lices Lices China and the second of the sec	Client: Consultant:	Ambion Holdings David R. Murray & Associate	25	3					Jo	ob No:	9957	
Delas Complete: 200 - 0.00 Bearing Ormenations 0.00 Bearing Ormenations 0.00 Bearing Ormenations 1.50 Description of Strata Legent Deph Op Sempling Test	Date Started	28/02/2001				Co	ordinate	s.	F			
Hole Type: TP Dremaining Dremaining Orgonal Level: Not Recorded Description of Stata Lapers Deph Construct Level: 1:30 1:30 MDE GROUND: Durk town datay analytic group bows motifies to come sample to the some files to come signal and one motifies. 0:40 Series in the some series and one source sample to the some files to come sample to the some sample to th			⊲ 2.60 ⊳									
Equipment: JCB SCX Dimensions 0 or generating Description of Stata Lagens Deph Coder: 1:50 MADE GROUND: Dark traven claury samely topolal with none files to content gamel and some rolided. Image: Stata Image: Stata Image: Stata Soft 6: migrating growth brave noneable to any stating growth and some file to content any stating growth and some file to content any stating growth and some file to content and content to inform the to content and some file to content and content to inform the stating growth and some file to content and content to con	l .					Gro		vel:		lot Reco	orded	
Number of the second state of		JCB 3CX	Dimensions		earing							
Description of Stratis Legand Depth Or Sampling In Situ Tarting Head MADE GROUND: Durk town days sandy toposol with some fine to Contrain graned and some notibia. 0.00 0.00 0.00 V 62 Soft 6. fm (igg cycle) town controlled cauge from a sandy CLAV with control of a bab enguing gravet, and some fine to coarse sub models and and an advance of the sandy gravet and some fine to coarse sub models (global III). 0.00 V 62 Find acts Subje gravet, and the Multip gravet and some fine to coarse sub models and any gravet gravet, and the Multip gravet and the sandy gravet and some fine to coarse sub models and gravet gravet, and the Multip gravet and the sandy gravet, some cookies and bookies of the sandy town to called an updata gravet, some cookies and bookies of the sandy town andy CLAV with some first to coarse sub models and the Multip gravet and the Multip gravet. 1.70 1.70 V 88 Still bookies of the sandy town and the sandy gravet and the sandy gravet and the sandy gravet and the sandy gravet and the sandy to gravet			· · · · · · · · · · · · · · · · · · ·	•		Sca	le:		1:5	0		
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event fire to cause is a branched to sub anging gravel and some thin lenses 0.70 0<	COArse gravel a	ID: Dark brown clayey sandy topsoil w ind some rootlets.	ith some fine to		0,40					289		
Film brown molecied compace brown andry CLAY with some fine to coarse sub model de nationing and some 1.70 1.70 Film dark balait grave large large sub and large grave large large sub model de na stalining and some 2.20 V 88 Film dark balait grave large large sub and large grave large large sub model de na stalining and coasiance blacket significant significa	some fine to co	arse sub rounded to sub angular grav			0.70		в	0.60		V	52	
combines (glical at lift). v 64 Firm dark blads grow brittle samely CLAY wills some first to coarse aub constaining and coceasional boolders (glical at lift). 2.30 2.30 Stift becoming very stiff to base dark blads grows, some boolision for staming and coceasional mustatione (glical at lift). 2.30 2.30 Stift becoming very stiff to base dark blads grows, some cobbies and boolders (glical at lift). 2.30 2.30 V 98 The or of Test PR at 2.00 m End of Test PR at 2.00 m 2.30 2.30 V 98 All Dimensions in Metras. For of Test PR at 2.00 m NOTES 2.30 V 98 All Dimensions in Metras. Grownhows the weak and and other fluctuations and should not be taken as constant. Grownhows the weak and advised at 2.80m in stiff day. Trial pit backfilled with artsings on completion. Stiff Stiff Should by: GW Checked by: Stiff Stiff Grownhows the Stiff terminated at 2.80m in stiff day. Trial pit backfilled with artsings on completion. Stiff Stiff Grownhows the Stiff terminated at 2.80m in stiff day. Trial pit backfilled with artsings on completion. Stiff Stiff Grownhows the Stift terminated at 2.80m in stiff day. Trial pit backfilled with artsings on completion. Stiff V	Firm brown mo	ttled orange brown sandy CLAY with a		24.00								
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wide in Sill Mice test			1 m 1 m			1	MCV					

Status	
Final	
26/07/2001	

be view



Trial Pit No TP110 Sheet 1 of 1

Robroyston, (Glasgow
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Client:	Ambion Holdings		J	3					Job N	lo: 9957		
Consultant:	David R. Murray & Associate	es										
Date Started	27/02/2001		,			Cod	ordinate	s:	E			
Date Complete:	27/02/2001 TP	•	⊴ 2.00 ▷	Δ					N Not Recorded			
Hole Type: Equipment:	JCB 3CX	Dimensions		0.65 Be	earing	Ground Level:						
				∇	•	Sca	ile:		1:50			
						OD		malias		n Situ Testing	Install	
	scription of Strata			Legend	Depth	Level		Impling	Te		-ation	
Firm brown mo	ID: Turf / topsoil. Itled grey and orange sandy CLAY with	h some fine to coarse			0.20							
angular to sub r	ounded gravel and occasional cobble	s.		A North								
				7								
				A-0-X0	1.20							
Firm dark greyis	sh brown friable sandy CLAY with som ounded gravel. Locally greenish brown	e fine to coarse		X	1.20		в	1.40				
	ounded graver. Locally greenish blow	n.		X		ħ:						
Stiff dark grey s	andy CLAY with some fine to coarse a	anguiar to sub rounded			1.80		- 12					
gravel and occa	sional cobbles and boulders. (Glacial	till)										
					3.10							
End of Trial Pit	at 3.10 m			100-52-5-7	0.10							
								L				
		······································	NOTES									
All Dimensions In Met Groundwater levels ar	res. e subject to seasonal, tidal and other t	fluctuations and should	not be taken	as constant								
Groundwater: Stability:	Dry Stable											
Shoring:	None											
General:	Trial pit terminated at 3.10m In very	stiff clay. Trial pit back	filled with aris	ings on com	pletion.							
Logged by:	SKF			Che	cked by:	SKF						
	ĸ	EY TO SYMBO	LS AND	ABBRE	/IATIO	NS						
D Small Distur	bed Sample		ter Sample			1	V			e Test. Peak		
L6 Large Bulk D	ped Sample Disturbed Sample		s Sample Recovery				VR P			e Test. Residual netrometer Test		
U Undisturbed BLK Block Sampl	U100 Sample e		imated Relation	e Density		1	CBR		In Situ CBF In Situ Den	RTest		
CBR CBR Mould		······					MCV		In Situ MC			

Status	
Final	
26/07/2001	

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Trial Pit No TP111 Sheet 1 of 1

Client:	Ambion Holdings		Cluby					Job No:	9957		
Consultant: Date Started Date Complete: Hole Type:	David R. Murray & Associate 26/06/2001 26/06/2001 TP	< 2.80 ▷	Δ			and Lev		E N Not Rea	orded		
Equipment:	JCB 3CX	Dimensions	0.60 Be ▽	earing 35°	Scale:						
					OD			1:50	itu Testing	Install	
MADE GROUN	Cription of Strata			Depth	Level Sampling In Situ Testi Test Resu					-ation	
	r fine to coarse SAND with occasional	molista (aukasil)		0.30				č.ek			
Firm orange bro	wn mottled grey sandy CLAY with son lar gravel, occasional cobbles and bo ered glacial till).	The fine to coarse sub	Marchan Marchan State Concerne State Concerne State Concerne	0.50		-	0.60		81 86 59		
Stiff dark grey s gravel (glacial ti	andy CLAY with some fine to coarse a II).	sub rounded to angular			.*):						
			X	2.15		1					
poulders of mod	ark grey sandy fine to coarse flat angulerately strong fine grained sitty SAND	lar gravel, cobbles and STONE (presumed									
End of Trial Pit a				2.50							
All Dimensions in Mart		NOTES									
All Dimensions in Metro Groundwater levels are	es. e subject to seasonal, tidal and other f	luctuations and should not be taken a	is constant								
Groundwater: Stability: Shoring: General:	Slow ingress at 2.15m and water lev Stable None Trial pit terminated at 2.50m on rock		xcavated sp	ooli.						~	
Logged by:	SMcQ		Chec	cked by:	SMcQ						
		EY TO SYMBOLS AND A	BBREV	IATIO	NS						
D Small Disturb B Bulk Disturb LB Large Bulk Di U Undisturbed U BLK Block Sample CBR CBR Mould S	ed Sample isturbed Sample J100 Sample	W Water Sample V Hand V/ G Gas Sample VR Hand V/ NR No Recovery P Pocket * Estimated Relative Density ICBR In Situ C IDEN In Situ C						land Vane Te land Vane Te Pocket Penetr n Situ CBR Te n Situ Density n Situ MCV Te	est. Residual ometer Test est 7 Test		

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Trial Pit No TP112 Sheet 1 of 1

			I/ODI	oysion,	Glasy	WO							
Client:		Ambion Holdings								Job No	o: 9957	,	
Consulta	nt:	David R. Murray & Associate	6										
Date Starte		18/06/2001		, , , , , , , , , , , , , , , , , , , ,			Cod	ordinate	s:	E			
Date Comp	olete:	18/06/2001		⊲ 2.60 ⊳						N			
Hole Type:		ТР			Δ		Gro	und Le	vei:	Not Re	behow		
Equipment:	:	JCB 3CX	Dimensions		0.60 Be	earing				Notifecolded			
				·	v	88°	Sca	ile:		1:50			
					T			1					
	Desc	cription of Strata			Legend	Depth	OD	S	ampling		Situ Testing	Install	
MADE	GPOLING	D: Topsoll			XXXXX		Level Test Result					-ation	
		•				0.25				5			
Firm bro	own mottl	ed orange brown and light grey sand	y CLAY with some fir	ne	0.00								
and occ	casional n	unded to angular gravel, occasional o ootlets (weathered glacial till).	oddles and boulders		0.0			-	0.65	l v	70		
at 0.0	65m, land	ldrain.				0.90				V	70		
Firm loc	cally firm	to stiff dark grey mottled greyish brow	n sandy CLAY with		0	0.90				V	74		
i some tu	ne to coal	rse sub rounded to angular gravel, so asional orange brown Ironstaining In	me cohbles and		0. St. 1								
(weathe	ered glacia	al till).	rootlet tracks at top		2008								
Verv sti	ff dark on	ey extremely closely fissured brittle s	where your soudy		20-20	1.70	*						
CLAY W	vith some	fine to coarse sub rounded to angula	r gravel some		2020-1			в	2.00	2			
boulden	s and gre	yish brown/orange brown Ironstalning	In fissures (glacial ti	ill).	x 0 0 1	0.05					1		
Very stil	ff dark gre	ey sandy CLAY with some fine to coa	rse sub rounded and		2020	2.25							
sub ang	lular grav	el and occasional cobbles and bould	ers (glacial till).		TO THE P	2.45							
End of T	Trial Pit at	t 2.45 m							1				
					- 5						***		
										•			
							2						
				NOTES					· · · · · · · · · · ·]	
All Dimensions	s In Metre	¢	· · · · · · ·	NOILS									
		subject to seasonal, tidal and other fi	uctuations and shoul	d not be taken a	s constant								
										÷			
Groundwater:		Occasional water inclusions adjacent	to boulders at 1.60m	n. trial pit dry on	completion								
Stability:		Stable		.,		•							
Shoring:		None											
General:		Trial pit terminated at 2.45m on bould	ler obstruction Trial	nit backfilled with	havenuete	lencil							
		,	or obstraction, fildl	pri pacitilieu Wil	CAUdVale	a spoit.							
Logged by:		SMcQ			Chec	ked by:	SMcQ						
]	
		K	EY TO SYMBO	OLS AND A	BBREV	IATIO	\s						
		T			V								
		ed Sample		ater Sample			v			Hand Vane T	est. Peak		
		d Sample sturbed Sample		as Sample			1	R			est. Residual		
-		100 Sample		Recovery timated Relative	Deneity		P				rometer Test		
BLK Block	Sample		Es	Contractor indiduve	. Donaty		1)BR DEN		In Situ CBR 1 In Situ Densit			
CBR CBR	Mould Sa	imple					1			In Situ MCV			



Trial Pit No TP116 Sheet 1 of 1

Client:	Ambion Holdings	Robioysto	n, Olasy	UW						
Consultant:	David R. Murray & Associat	es						Job No	o: 9957	
Date Started Date Complete: Hole Type: Equipment:	18/06/2001 18/06/2001 TP JCB 3CX	□ 2.60 Dimensions □		earing 172°		ordination		E N Not Red	corded	
De	scription of Strata		lagand	Death	OD	1	ampling	1	Situ Testing	Instal
MADE GROUN			Legend	Depth	Level			Test	Result	-ation
Soft dark grey	sandy peaty CLAY with occasional roc	tlets (topsoil).		0.30						
amorphous pea	yish brown mottled grey sandy CLAY of ine to coarse sand, occasional lenses at and occasional rootlets (alluvium).		1.30	0.55	-	0.70 1.10	× × ×	43 47 43		
Very soft dark g angular gravel a	grey sandy CLAY with some fine to coa and occasional cobbles (glacial till).	irse sub rounded to				-	1.60	v v v	14 19 16	
at 2.20m, be	coming firm.					-				
End of Trial Pit a	at 3.00 m		A	3.00						
									•	
				-1						
				.						
All Dimensions In Metre Groundwater levels are	es. e subject to seasonal, tidal and other fi	NOTE								
Groundwater: Stability:	Wet in sand bands at 1.20m, trial pit o Unstable at 1.00m.	try on completion.								
-	None Trial pit terminated at 3 00m in uses									
	Trial pit terminated at 3.00m In very s	m clay. Thal pit backfilled with e	cavated spoll.							
-ogged by:	SMcQ		Check	ed by:	SMcQ					
	KE	Y TO SYMBOLS AND	ABBREVI	ATION	IS					
D Small Disturbe B Bulk Disturbe B Large Bulk Dis J Undisturbed U UK Block Sample BR CBR Mould Sa	ed Sample sturbed Sample I100 Sample	W Water Sample G Gas Sample NR No Recovery * Estimated Rela	tive Density			R BR EN	Har Poo In S In S		st. Residual ometer Test est Test	

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Trial Pit No **TP117** Sheet 1 of 1

		Robi	royston,	Glasg	JOW					
Client:	Ambion Holdings							Job I	No: 9957	
Consultant:	David R. Murray & Associat	es								
Date Started	18/06/2001		,,			Coo	rdinates:	E		
Date Complete:	18/06/2001		⊲ 2.40 ⊳					N		
Hole Type:	TP	Dimensions		Δ		Grou	Ind Level:	Not F	ecorded	
Equipment:	JCB 3CX	Dimensions		0.60 B	earing					
					163°	Scal	e:	1:50		
De	scription of Strata			Legend	Depth	OD	Sampling		n Situ Testing	install
MADE GROUN					0.10	Level		Те	st Result	-ation
	n and black amorphous PEAT with so	me motiete (ellunium)		مثالث مثلاء مثلاء مثلاء مثلاء م					e -	
	ntly slity to slity fine to coarse SAND (a		<u>.</u>		0.35					
of moderately boulders of sar	greyish brown slightly silty sandy fine weak medium grained SANDSTONE a ndstone (presumed bedrock).	to coarse angular gra and some cobbles an	avel d	× × ×	0.70 1.10					
End of Trial Pit	t at 1.10 m									
							~			
					()					
			NOTES							
All Dimensions in Met Groundwater levels a	tres. re subject to seasonal, tidal and other	fluctuations and shou	uld not be taken a	s constant						
	•									
Groundwater:	Dry									
Stability:	Stable									
Shoring:	None		6							
General:	Trial pit terminated at 1.10m on roc	obstruction. Trial pit	t backfilled with e	xcavated s	poil.					
								4		
Logged by:	SMcQ	· · · · · · · · · · · · · · · · · · ·		Che	cked by:	SMcQ]
	k	EY TO SYMB		BBRE		NS				
D Small Distur	bed Sample	w v	Vater Sample			v	··· <u>··</u> ····	Hand Vana	Test, Peak	
B Bulk Distur	bed Sample	G G	Gas Sample			Vi Vi			Test. Peak	
LB Large Bulk	Disturbed Sample		lo Recovery			P		Pocket Per	etrometer Test	
U Undisturbed BLK Block Samp	U100 Sample le	- E	Estimated Relative	e Density			BR	In Situ CBF In Situ Den		
CBR CBR Mould						1	CV	In Situ Den		-



Trial Pit No TP138 Sheet 1 of 1

		Robioyston,	Glasy	JOW	1.1							
Client:	Ambion Holdings							Job No	: 9957			
Consultant:	David R. Murray & Associate	es										
Date Started	27/02/2001	, ,										
Date Complete:	27/02/2001	⊲ 1.80 ▷	,		Coo	ordinate	es:	E				
Hole Type:	TP				Ground Level:			N				
Equipment:	JCB 3CX	Dimensions	0.65 B	earing	GIU		WGI.	Not Recorded				
				•	Scale: 1:50							
					OD			In	Situ Testing	laste		
	scription of Strata		Legend	Depth	Level	S	ampling	Test	Result	Insta		
	ND: Turf / topsoli.			0.30								
Firm becoming	firm to stiff brown mottled grey and or parse angular to sub rounded gravel ar	ange sandy CLAY with	1000 C			-	0.50	v	65			
	Ause angular to sup rounded gravel an	d occasional cobbles	A					V	70			
			P-0-26				-	V	70			
			P									
Firm to stiff dar	k greyish brown sandy CLAY with som		A	1.30								
andular to sub i	Munded dravel and occasional ophile		A-0-20									
From 1.50n	n becoming very stiff and closely fissu	red.			•							
				0.00								
Very stiff dark g	rey sandy CLAY with some fine to coa	rse angular to sub	000	2.10								
End of Trial Pit	and occasional cobbles and boulders.	(Glacial till)	8.000	2.40								
							1					
									14			
								2				
				-								
		NOTES										
Dimensions in Metro undwater levels and									· · · · · · · · · · · · · · · · · · ·			
	e subject to seasonal, tidal and other fi	uctuations and should not be taken a	as constant									
oundwater:	Dry											
bility:	Stable											
ring:	None											
nerai:	Trial pit terminated at 2.40m in very a	tiff clay. Trial pit backfilled with arisi	ngs on comp	oletion.								
ged by:	SKF		Chec	ked by:	SKF	· .						
	K	EY TO SYMBOLS AND A	BBREV									
Small Disturb	ed Sample				T							
Bulk Disturb	ed Sample	W Water Sample G Gas Sample						and Vane Te and Vane Te	est. Peak est. Residual			
Large Bulk Di Undisturbed L	isturbed Sample	NR No Recovery			Р				ometer Test			
Biock Sample		* Estimated Relative	e Density			BR EN		Situ CBR To				
CBR Mould S	ample					CV		Situ Density Situ MCV T				

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Trial Pit No **TP139** Sheet 1 of 1

Robroyston,	Glasgow
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		Robioysion,	Glasg	W						
Client:	Ambion Holdings							Job N	0: 9957	
Consultant:	David R. Murray & Associate	es								
Date Started	27/02/2001									
Date Complete:	27/02/2001				Co	ordinate	es:	E		
Hole Type:	TP	⊲ 1.80 ▷	Δ					N		
Equipment:	JCB 3CX	Dimensions		earing	Gro	ound Le	vel:	Not Re	corded	
Equipment.	308 304		∇							
[Sca	aie:		1:50		
De	scription of Strata				OD		ampling	in	Situ Testing	Install
			Legend	Depth	Level		ampung	Test		-ation
MADE GROUN	ID: Turf / topsoil.						1			1
Firm to stiff loc	ally firm brown sandy CLAY with some	fine to coarse angular		0.30				~		
	gravel and occasional cobbles and bo	ulders. Locally mottled	0.000							
orange at dept	1.		200 Reg				1			
						В	0.90			
			000 P							
Very stiff dark o	reyish brown closely fissured sandy C	AV with some fine to	0.000	1.30			1.			
coarse angular	to sub rounded gravel and occasional	cobbles.	2 X 0 X 0					1		
			2 X 0 0 5		200					
			2 × × 0							
Verv stiff dark o	rey sandy CLAY with some fine to coa	The angular to out		2.10						
iounded gravel	and occasional cobbles and boulders.	(Glacial till)		2.40						
End of Trial Pit	at 2.40 m									
					Í					
				21				2		
								1		
						Ì				
		NATES								
All Dimensions in Metr		NOTES								
Groundwater levels and	es. e subject to seasonal, tidal and other fi	uctuations and should not be taken a	e constant							
		and the second the second is	- oonadiil							
Groundwater:	Dry									
Stability:	Stable									
Shoring:	None									
General:	Trial pit terminated at 2.40m in very s	tiff clay. Trial pit backfilled with ansir	00 00 0000	letion						
		A L warming must detail	an oonip							
Logged by:	SKF		Chec	ked by:	SKF					
			DDDD							
	KE	Y TO SYMBOLS AND A	BBREV	IATION	IS					
D Small Disturb	ed Sample	W Water Sample			v		μ.	and Vane To	ort Dook	
B Bulk Disturbe	ed Sample	G Gas Sample							est. Peak est. Residual	
Undisturbed U	sturbed Sample	NR No Recovery	. .		P		Po	cket Penet	rometer Test	
BLK Block Sample		* Estimated Relative	Density		1	BR	In	Situ CBR T	est	
CBR CBR Mould S	ample				(CV		Situ Density Situ MCV T		

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Final
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Trial Pit No TP140 Sheet 1 of 1

Client:	Ambion Holdings							Job No	: 9957	
Consultant:	David R. Murray & Associat	es								
Date Started	27/02/2001]	·							
Date Complete:	27/02/2001	⊲ 1.90 ▷	>		00	ordinate	S:	E N		
Hole Type:	TP	÷			Gro	und Lev	vel:	Not Red	conded	
Equipment:	JCB 3CX	Dimensions	0.65 B	earing						
					Sca	ıle:		1:50		
D	enviroline of Otente				OD	6	mpling	In	Situ Testing	Install
	escription of Strata	· · · · · · · · · · · · · · · · · · ·		Depth	Levei		1.	Test	Result	-ation
	ND: Turf / topsoil.			0.25						
to coarse angu	coming mottled orange and grey sand ular to sub rounded gravel and occasio	y CLAY with some fine nal cobbles.				-	0.50	v	53	
								V	55 59	
			A A o P o							
			P-0-00							
			A Class	1.40						
Very stiff dark coarse angular	greyish brown closely fissured sandy (r to sub rounded gravel and occasiona	CLAY with some fine to cobbles.	A		*					
						2.5				
Very stiff dark grey sandy CLAY with some fine to coarse angular to sub										
rounded gravel and occasional cobbles and boulders. (Glacial till)				2.30				2		
End of Trial Pit	t at 2.30 m							-		
				-						
									- 2	
				(1995) -						
	·····									
		NOTES	5							
All Dimensions in Me										
Groundwater levels a	are subject to seasonal, tidal and other	fluctuations and should not be taker	as constant							
Groundwater:	Dry									
Stability:	Stable									
Shoring:	None									
General:	Trial pit terminated at 2.30m In very	stiff clay. Trial pit backfilled with an	sings on con	pletion.						
Logged by:	SKF		Che	ecked by:	SKF					
		EY TO SYMBOLS AND	ABBRE	VIATIO	NS					
	irbed Sample	W Water Sample				V		Hand Vane	Test. Peak	
	rbed Sample	G Gas Sample				VR		Hand Vane	Test. Residual	
•	Disturbed Sample d U100 Sample	NR No Recovery * Estimated Relat	ive Densitv		1	P ICBR		Pocket Pene In Situ CBR	etrometer Test Test	
BLK Block Samp	ple		are benety			IDEN		In Situ Dens		
CBR CBR Mould	Sample					MCV		In Situ MCV	Test	

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Final
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Trial Pit No TP141 Sheet 1 of 1

		Robroyston,	Glasg	WO						
Client:	Ambion Holdings							Job N	o: 9957	
Consultant:	David R. Murray & Associat	es								
Date Started	27/02/2001	· · · · · · · · · · · · · · · · · · ·			Co	ordinate	es:	E		
Date Complete:	27/02/2001	⊲ 2.00 ▷						N		
Hole Type:	TP		Δ	Ground Level:			Not Recorded			
Equipment:	JCB 3CX	Dimensions	0.65 B	earing						
[Sca	ale:		1:50		
De	scription of Strata		Legend	Depth	OD	s	ampling		Situ Testing	Install
	ID: Turf / topsoil.		XXXX	0.20	Level		1	Tes	t Result	-ation
Firm brown mo	ttled orange and grey sandy CLAY wi	th some fine to coarse	××××	0.20						
	rounded gravel.		×							
At 0.60m e	xcavated old red clay field drain.		×							
			×	1.30						
Soft to firm Inita	Soft to firm Initally firm greyish brown sandy CLAY with some fine to coarse									
angular to sub	angular to sub rounded gravel and occasional cobbles. Locally mottled grey.									
		l l	A CONTRACTOR							
Vop, stiff dark	grey sandy CLAY with some fine to co		20-20	2.00		в	2.10			
rounded gravel	and occasional cobbles and boulders	arse angular to sub					{			
			1000 C							
				3.00						
End of Trial Pit	at 3.00 m		1.00.00.00	0.00						
								ł,		
				3					1	
								·		
		1				ļ				
		NOTES								
All Dimensions in Me	tres. re subject to seasonal, tidal and other	fluctuations and about and be taken								
Giburuwater levels a	re subject to seasonal, udai and other	nucluations and should not be taken	as constam	[
Groundwater:	Dry									
Stability:	Stable									
Shoring:	None									
General:	Trial pit terminated at 3.00m in very	v stiff clay. Trial pit backfilled with aris	ings on con	npletion.			5			
Logged by:	SKF		Ch	ecked by:	SKF					
		KEY TO SYMBOLS AND	ABBRF	VIATIO	NS					
							<u> </u>		· · · · · · · · · · · · · · · · · · ·	
	rbed Sample bed Sample	W Water Sample G Gas Sample			1	V VR			Test. Peak Test. Residual	
	Disturbed Sample	NR No Recovery				VK P			e Test. Residual netrometer Test	
U Undisturbed	U100 Sample	Estimated Relative	e Density			ICBR		In Situ CBF	RTest	
BLK Block Samp CBR CBR Mould						IDEN MCV		In Situ Den In Situ MC\		

Status
Final
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Trial Pit No TP142 Sheet 1 of 1

Client:	Ambion Holdings	······································		•				Job No	: 9957			
Consultant:	David R. Murray & Associate	es										
Date Started	27/02/2001				Coc	ordinate	s:	E				
Date Complete:		⊲ 1.90 ▷	$ \Delta $					N				
Hole Type: Equipment:	TP JCB 3CX	Dimensions	0.65 B	earing	Gro	und Le	vel:	Not Recorded				
				•	Sca	le:		1:50	D			
	Description of State				OD	s	ampling	in :	Situ Testing	Install		
	Description of Strata DUND: Turf / topsoil.		Legend	Depth	Level		1	Test	Result	-ation		
	-			0.30				×.				
angular to s	mottled orange and grey sandy CLAY wit ub rounded gravel. Locally very sandy at	n some tine to coarse top.	X			-	0.70		50			
			×			-	0.70		50 54			
			X					v	52			
Firm locally	soft to firm dark greyish brown sandy CL	A	1.30									
coarse angu	A											
Stiff dark an	ey sandy CLAY with some fine to coarse		A 0 4 4	1.90								
gravel and c	ccasional cobbles and boulders. Occasio (Glacial till)	angular to sub rounded anal light grey slity										
	n boulder obstruction.		0.00									
Fod of Table			0.0.0	3.00								
End of Inal	Pit at 3.00 m											
				-								
		NOTES										
All Dimensions in I Groundwater level	Metres. s are subject to seasonal, tidal and other	fluctuations and should not be taken	as constant									
Groundwater: Stability:	Dry Stable											
Shoring:	None											
General:	Trial pit terminated at 3.00m in very	stiff clay. Trial pit backfilled with aris	ings on con	pletion.								
										с.		
Logged by:	SKF		Che	cked by:	SKF			· · · · · · · · · · · · · · · · · · ·				
	ŀ	EY TO SYMBOLS AND	ABBRE	VIATIO	NS							
	sturbed Sample	W Water Sample			1	/		Hand Vane T				
LB Large Bu	sturbed Sample Ilk Disturbed Sample	G Gas Sample NR No Recovery				/R			est. Residual trometer Test			
U Undisturt BLK Block Sa	ped U100 Sample mple	Estimated Relation	ve Density		1	CBR DEN		In Situ CBR	Test			
	uld Sample					ACV		In Situ MCV				

	· · · · · · · · · · · · · · · · · · ·												
Status Final										rial Pit No	c		
26/07/2001		nies _{TRI}	AL P	IT L	OG			TP143 Sheet 1 of 1					
		Robroyston,	Glasg	WO									
Client:	Ambion Holdings							Job No: 9957					
Consultant:	David R. Murray & Associate	es											
Date Started	27/02/2001	,			Cod	Coordinates:			E				
Date Complete: Hole Type:	27/02/2001 TP	☐ 2.00 ▷ Dimensions	∆ _0.65 B	Ground Level:				N Not Recorded					
Equipment:	JCB 3CX		▽	•	Sca	le:		1:50					
Des	scription of Strata		Legend	Depth	OD Level	s	ampling		In S	itu Testing Result	Insta -atio		
MADE GROUN	ID: Turf / topsoil.			0.25			1		1031				
Orange brown	clayey silty fine to coarse SAND with	occasional roots.		0.25		в	0.50						
Firm light brown angular to sub i		1.20					47						
	rith some fine to coarse s. Locally mottled grey.	A 140 140	1.20		в	1.50							
	P-0-00	2,00	540	8									
Stiff dark grey a gravel and occa	20-0 20-0 20-0	2.00											
laminations. (G	lacial till)												
End of Trial Pit	at 2.80 m		20-20-20	2.80									
ŝ													
			Ω.										
				æ				0					
								ł.					
					-								
									Ę				
		NOTES	;										
All Dimensions in Me Groundwater levels a	tres. are subject to seasonal, tidal and other	fluctuations and should not be taken	as constan	t									
510411011010101010101010				•									
Groundwater:	Dry Stable												
Stability: Shoring:	None												
General:	Trial pit terminated at 2.80m in very	y stiff clay. Trial pit backfilled with aris	sings on cor	npletion.									
ogged by:	SKF		Ch	ecked by:	SKF								
······································		KEY TO SYMBOLS AND											
D Small Distu	rbed Sample	W Water Sample				v		Нари	l Vane T	est. Peak			
B Bulk Distu	rbed Sample	G Gas Sample				VR P		Hand	Hand Vane Test. Peak Hand Vane Test. Residual Pocket Penetrometer Test				
U Undisturbed	Disturbed Sample d U100 Sample	NR No Recovery	ve Density			ICBR		In Si	tu CBR "	Test			
BLK Block Samp CBR CBR Mould					1	IDEN MCV			tu Densi tu MCV				

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26/07/2001	



Trial Pit No TP144 Sheet 1 of 1

Client:	Ambion Holdings		, ,						J	ob No:	9957		
Consultant:	David R. Murray & Associate	es	<i>,</i>										
Date Started	01/03/2001]	,			Co	ordinate	s:	E				
Date Complete:	01/03/2001 TP		⊴ 2.50 ▷	Δ					N				
Hole Type: Equipment:	JCB 3CX	Dimensions			earing	Gr	ound Lev	/el:	Not Recorded				
				v	6	Sca	ile:		1:5	50			
_						OD Sampling		molina	In Situ Testing			Install	
	scription of Strata			Legend	Depth	Level		andraid.		Test	Resuit	-ation	
	ND: Dark brown clayey sandy topsoil w some fragments of crockery and glass lets.				0.30					v	72		
coarse sub rou size, some cob	t brown mottled orange brown sandy (inded to angular gravel, some roots an obles and occasional boulders. excavated clay field drain				1.00					v	38 48		
	Firm brown mottled grey and orange brown sandy CLAY with some fine to									v	38		
	nded to angular gravel, some cobbles			100 00 00 100 00 00						v v	38		
	-/ -									v	40		
					1.90		~						
	t grey sandy CLAY with some fine to c some yellowish brown sandy pockets			A			в	2.00					
and some cobb	oles (glacial till).	, aonine unit ant layers		A			- 2		-	*			
a layer of si	Ity sand at 2.10m.			18 X 20 0	2.60								
End of Trial Pit	at 2.60 m				-								
											-		
					*								
-			NOTES	<u>.</u>				1					
All Dimensions in Me													
Groundwater levels a	are subject to seasonal, tidal and other	fluctuations and should	l not be taken	as constant	ł								
Groundwater:	Dry												
Stability:	Stable.												
Shoring:	None										-		
General:	Trial pit terminated at 2.90m in very	stiff clay. Trial pit back	dilled with aris	ings on con	npletion.								
Logged by:	GW			Che	ecked by:	SKF							
			DLS AND	ABBRE	VIATIC	NS							
D Small Distu	Irbed Sample						v		ما ا		ont Booli		
B Bulk Distu	rbed Sample		ater Sample is Sample				V VR				'est. Peak 'est. Residual		
	Disturbed Sample d U100 Sample		Recovery timated Relati	no Dossity			P iCBR				trometer Test		
BLK Block Samp	ple	ES		C Density			IDEN		In Sit	u CBR 1 u Densi	ty Test		
CBR CBR Mould	Sample						MCV			u MCV			

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Trial Pit No TP145 Sheet 1 of 1

Client:	Ambion Holdings		, 0.00					Job No): 995 7				
Consultant:	David R. Murray & Associate	25											
Date Started	12/06/2001	-			Co	ordinate	s:	E					
Date Complete: Hole Type:	12/06/2001 TP	⊲ 2.60			Gr	und Lev	vel:	N Net Decorded					
Equipment:	JCB 3CX	Dimensions	0.60 E	Bearing 168°	Ground Level:			Not Recorded					
				100	Sca	ale:		1:50					
Des	cription of Strata		Legend	Depth	OD Level	Sa	mpling	In Test	Situ Testing Result	Install			
MADE GROUNI	D: Topsoil			0.30									
to coarse sub an	ied light grey and orange brown sand gular and angular gravel, occasional ght grey silty fine and medium sand a ddrain.	rootlets and locally		8 8 0.65		-	0.70	v	78 94				
Firm becoming s some fine to coa boulders and oc glacial till).		1.40				V	97						
Very stiff locally closely fissured sub angular and greyish brown in			â	-									
Very stiff dark gr	ey sandy CLAY with some fine to coa	arse sub rounded to	80 0 A	2.40		ļ .							
angular gravel, c	occasional cobbles and boulders and sh brown ironstaining in fissures (glad	locally closely fissured	-	2.70									
End of Trial Pit a	it 2.70 m												
									20				
								8					
	,	NOTE	S						-				
All Dimensions in Metro Groundwater levels are	es. e subject to seasonal, tidal and other	fluctuations and should not be take	n as constan	t									
Groundwater: Stability:	Dry Stable												
Shoring:	None												
General:	Trial pit terminated at 2.70m in very	stiff clay. Trial pit backfilled with e	cavated spo	il.									
Logged by:	SMcQ		Ch	ecked by:	SMcC	2							
	к	EY TO SYMBOLS AND	ABBRE	VIATIO	NS								
D Small Disturb		W Water Sample			,	v		Hand Vane 1	est. Peak				
	sturbed Sample	G Gas Sample NR No Recovery				VR >		Hand Vane 1	est. Residual trometer Test				
U Undisturbed L BLK Block Sample		Estimated Rela	tive Density		1	CBR DEN		In Situ CBR	Test				
CBR CBR Mould S				NCV		In Situ MCV							



Trial Pit No TP146 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Client: A	Ambion Holdings
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Consultant:	David R. Murray & Associat	tes								
Date Started	12/06/2001				Co	ordinate	s:	E		
Date Complete:	12/06/2001 TP		Δ		Ground Level:			N		
Hole Type: Equipment:	JCB 3CX	Dimensions	0.60 B	earing	Gro	ound Le	vel:	Not R	ecorded	
-4-12-12-12-12-12-12-12-12-12-12-12-12-12-			∇	Sca	ale:		1:50			
				[1					1
De	scription of Strata		Legend	Depth	OD Level	Si	ampling	Te	n Situ Testing st Result	Insta
MADE GROUN	ND: Topsoil						1			
Eirm losolly or	to firm at donth any mattled dark a	mana harva anadu OLAV		0.35						
with some fine	ft to firm at depth grey mottled dark or to coarse sub rounded to angular gra	vel, occasional cobbles	x-x							
at 0.50m, la	ind occasional rootlets (weathered gla inddrain.	acial ull).	xx							
			X			-	1.10	V		
			X	1.30		в	1.40			
with some fine	ally soft and becoming firm at depth d to coarse sub rounded to angular gra	vel and occasional					1.40	\	32	
decayed and s	aturated roots and rootlets (weathere	d glacial till).	X					v	54	
		2.00		- 19						
Stiff locally ver fine to coarse s	y stiff dark grey very closely fissured sub rounded and sub angular gravel, s	sandy CLAY with some some bands of silty fine	X							
	and at top and greyish brown ironstair			2.40						
Stiff dark grey	sandy CLAY with some fine to coarse	sub rounded to angular		0.00						
gravel and son End of Trial Pit	ne cobbles and boulders (glacial till).		-0:-9/ -	2.80						
	t dt 2.00 m									
									5	
				.e.,						
				1						
							122			
			1				1			1
Il Dimensions in Me	Ann -	NOTES								
		r fluctuations and should not be taken a	is constant						2	
Froundwater:	Dry									
tability:	Stable None									
horing: ieneral:		f clay. Trial pit backfilled with excavate								
	·	r day. That pit backings with creater	a spon.							
and here	014-0					_				
ogged by:	SMcQ		Che	ecked by:	SMc	Q				
	l	KEY TO SYMBOLS AND	BBRE	VIATIC	NS					
Small Distu	rbed Sample	W Water Sample				v		Hand Van	e Test, Peak	
Bulk Distu	rbed Sample	G Gas Sample				VR		Hand Van	e Test. Residual	
	Disturbed Sample d U100 Sample	NR No Recovery	e Density			P ICBR		Pocket Pe In Situ CB	netrometer Test R Test	
LK Block Samp	ble		2			IDEN		In Situ Der	nsity Test	
BR CBR Mould	Sample					MCV		In Situ MC	V Test	

Status	
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26/07/2001	



Trial Pit No TP147 Sheet 1 of 1

Client:	Ambion Holdings			-					Jot	b No:	9957	
Consultant:	David R. Murray & Associate	es										
Date Started	12/06/2001	T				Cod	ordinate		E			
Date Complete:	12/06/2001		⊲ 2.60 ⊳		N							
Hole Type:	TP	Dimensions			Gro	Ground Level: Not Recorded						
Equipment:	JCB 3CX	Dimensions		0.60 В ▽	earing 82°							
		1		1	1	Sca	ile:		1:50)		1
De	scription of Strata			Legend	Depth	OD Level	S	ampling	-	In Si Test	tu Testing Result	Instal
MADE GROUN	ND: Topsoil				0.30							
Firm becoming soft to firm at depth grey mottled dark orange brown sandy CLAY with some fine to coarse sub rounded to angular gravel, occasional cobbles and some bands of light grey silty fine and medium sand at top (weathered glacial till).					1.00		LB -	0.50-0. 0.60	.60	>>>>	69 46 59 63	
Soft to firm becoming stiff at base dark brownish grey sandy CLAY with some fine to coarse sub rounded to angular gravel, some boulders of sandstone and occasional inclusions of brown silty fine and medium sand at depth (glacial till).				21.03.03.03.03 0.00.03.05.03 0.00.05.05 0.00.05.05 0.00.05 0.00.05		-2		1.00		, v	65 48	
at 1.90m, be	ecoming firm.			2000 000 000 000		14	=					
End of Trial Pit	at 2.60 m			107.07	2.60		-	2.60	\sim	V	188	
												1
									2			
				÷.								
									Ð			
			NOTES									
All Dimensions in Met Groundwater levels a	tres. re subject to seasonal, tidal and other	fluctuations and should	not be taken	as constant	t							
Groundwater:	Dry											
Stability:	Stable											
Shoring: General:	None Trial pit terminated at 2 60m in stiff		udth	d an -11								
i i ui cit.	Trial pit terminated at 2.60m in stiff	way. mai pit backniied	wiui excavate	u spoli.								
Logged by:	5400						_					
Logged by:	SMcQ				ecked by:	SMc	4					
	•	KEY TO SYMBO	LS AND	ABBRE	VIATIO	NS						
B Bulk Distur LB Large Bulk I		G Gas NR No	ter Sample s Sample Recovery imated Relativ	ve Density			V VR P ICBR IDEN MCV		Hand V	'ane Te Penetr CBR Te Density	Test	

Status
Final
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Trial Pit No TP148 Sheet 1 of 1

Client:	Ambion Holdings								Job No	: 9957	
Consultant:	David R. Murray & Associate	es									
Date Started Date Complete: Hole Type: Equipment:	12/06/2001 12/06/2001 TP JCB 3CX	Dimensions	⊲ 2.50 ▷		earing		Coordinates: Ground Level:		E N Not Rec		
L					85°	Sca	le:		1:50		
De	Description of Strata			Legend	Depth	OD Level	Sa	mpling	in S Test	Situ Testing Result	Install -ation
MADE GROUN	ID: Topsoil				0.30				15		
sub angular and grey silty fine a at 0.45m, lar		and some bands of lig	jht		0.65 0.80		_	0.95	v	20	
Soft locally soft	light grey silty fine SAND. to firm at depth dark grey sandy CLA nded to angular gravel and occasiona glacial till).	Y with some fine to I lenses of light brown	n		1.70	·	-	0.33	v	30 39 48	
Recovered as o weak MUDSTC	lark grey sandy fine to coarse fiat ang NE , gravel locally very weak at top (ular gravel of modera presumed bedrock).	ately						÷		
End of Trial Pit					2.65				5.		
					-					-	
			NOTES	,							
All Dimensions in Met Groundwater levels an Groundwater: Stability: Shoring: General:	res. e subject to seasonal, tidal and other Strata wet at 2.65m, trial pit dry on Stable None Trial pit terminated at 2.65m on roc	completion.									
Logged by:	SMcQ		·····	Che	ecked by:	SMcC	2				
	ł	EY TO SYMB	OLS AND	ABBRE	VIATIO	NS					
D Small Disturbed Sample W Water Sample B Bulk Disturbed Sample G Gas Sample LB Large Bulk Disturbed Sample NR No Recovery U Undisturbed U100 Sample • Estimated Relative BLK Block Sample • Estimated Relative CBR CBR Mould Sample • Estimated Relative							V VR CBR ICBR IDEN MCV			Test. Residual prometer Test Test ity Test	

Status	
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Client:

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Trial Pit No TP149 Sheet 1 of 1

Robroyston, Glasgow

Job No: 9957

Ambion	Holdings
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Consultant:	David R. Murray & Associat	es									
Date Started	12/06/2001				Coor	dinates:	E				
Date Complete:					N						
Hole Type:	TP	Dimensions	∆ 0.60 В	earing	Grou	ind Level:	Not Rec	Not Recorded			
Equipment:	JCB 3CX		▽ 0.00 0	168°							
			1		Scal	e:	1:50				
De	scription of Strata		Legend	Depth	OD	Sampling	In S	Situ Testing	Install		
MADE GROUN			XXXXX	Бери	Level		Test	Result	-ation		
	•			0.30							
angular gravel.	Very stiff dark grey sandy CLAY with some fine to coarse sub rounded to angular gravel, occasional rootlets and some bands of light brown sitty fine										
and medium sa	and medium sand at top (weathered glacial till). Recovered as greyish brown slightly silty sandy fine to coarse angular gravel			0.70							
of moderately s	strong faintly weathered medium grain	ed SANDSTONE with									
some cobbles a	and boulders of sandstone at depth (p	resumed bedrock).		1.30							
End of Trial Pit	at 1.30 m										
					<						
				<i>.</i>		1					
				<u></u>							
							, e				
			I I	l					<u> </u>		
		NOTES									
All Dimensions in Met Groundwater levels a	tres. re subject to seasonal, tidal and other	fluctuations and should not be taken									
			is constant								
Groundwater:	Dry										
Stability:	Stable										
Shoring: General:	None										
Jeneral	mai pit terminated at 1.30m on roc	k obstruction. Trial pit backfilled with e	xcavated s	poil.							
Logged by:	SMcQ		Che	cked by:	SMcQ						
	ŀ	EY TO SYMBOLS AND	BBRE	VIATIO	NS						
D Small Distur	bed Sample	W Water Sample	<u> </u>		v		Hand Vane T	ect Deak			
B Bulk Distur	bed Sample	G Gas Sample			VF	२	Hand Vane Te	est. Residual			
	Disturbed Sample U100 Sample	NR No Recovery	e Deneitu		P	BR	Pocket Penet				
BLK Block Sampl	le	Connaiou (1818114	Density		ID	EN	In Situ CBR T In Situ Densit				
CBR CBR Mould	Sample				M	cv	In Situ MCV T	fest			

Status	
Final	
26/07/2001	



Trial Pit No TP150

Sheet 1 of 1]	
			Robroyston,	Glasg	WO						(A)
Clier	nt:	Ambion Holdings							Job No	: 9957	
Con	sultant:	David R. Murray & Associate	es								
Date	Started	12/06/2001		•		Co	ordinate	s:	E		
	Complete:	12/06/2001	⊴ 2.40 [
Hole		TP JCB 3CX	Dimensions		earing	Gro	ound Lev	/el:	Not Rec	corded	
	Equipment: JCB 3CX					Scr	ale:		1:50		
							1		1		1
	Des	cription of Strata		Legend	Depth	Level	Sa	Impling	Test	Situ Testing Result	Install
M	ADE GROUN	D: Topsoil			0.25						
M	ADE GROUND	D: Stiff dark brown friable very sandy asional rootlets.	clay with occasional		0.45				â.		
S	oft light grey an	nd brown mottled locally mottled oran	ge brown sandy CLAY								
ໄ ຍ	nd locally some	o coarse sub angular and angular gra bands of silty fine and medium sand	vel, occasional rootlets I generally at top				LB	0.90	¥	104	
· · · ·	veathered glaci			2	1.20				v	83 67	
Ve	ery sandy CLA	lly soft at top dark grey mottled greyis Y with some fine to coarse sub angula	sh brown at top sandy to ar and angular gravel								
ar	nd occasional o	obbles and boulders (glacial till).				5	-	1.70	v	40	
									V V	24 34	ſ
	nov etiff dock on			0.000	2.90						
ar	nd angular grav	ey very sandy CLAY with some fine to rel and some cobbles and boulders (g	o coarse sub angular Ilacial till).		3.30						
	at 3.30m, bound of Trial Pit a			- 10°-32-52	3.30						
		14									
										- 1):	
									ŧ.		
					×						
			NOTES								<u> </u>
	nsions in Metre			· · · · · · · · · · · · · · · · · · ·							
Groundw	vater levels are	subject to seasonal, tidal and other t	iluctuations and should not be taker	as constant							
Groundw	vater:	Dry									
Stability:		Stable									
Shoring:		None									
General:		Trial pit terminated at 3.30m on boul	der obstruction. Trial pit backfilled v	vith excavate	d spoil.						
Logged b	ру:	SMcQ		Che	cked by:	SMcC	2	<u>_</u>			
		к	EY TO SYMBOLS AND	ABBRE	/IATIO	NS					
D	Small Disturb		W Water Sample				v.	1	Hand Vane T	est. Peak	
B LB	Bulk Disturbe Large Bulk Di	ed Sample sturbed Sample	G Gas Sample NR No Recovery			1	VR P	1	Hand Vane T	est. Residual	
U	Undisturbed L	J100 Sample	* Estimated Relat	ive Density		1	CBR		Pocket Penet in Situ CBR T	rometer Test Test	
BLK Block Sample CBR CBR Mould Sample							DEN MCV		in Situ Densit In Situ MCV 1		