TIR JOHN LANDFILL CELL 16 DETAILED DESIGN & CQA PLAN

Report Number 1575r1v2d0617

Commissioned by

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1 INTRODUCTION

Tir John Landfill site is a municipal waste landfill situated adjacent to Crymlyn Bog, a few miles to the east of Swansea (Drawing 1575/1). It has been used for the disposal of municipal waste for many years after first being used for the disposal of power station ash from the now demolished Tir John coal fired power station. In simple terms, an ash platform was pushed out over the peat and alluvial deposits when the power station was active. After closure, the irregular ash platform was used for casual landfilling of various wastes, including demolition wastes (possibly from the power station) and municipal refuse: these are collectively referred to as the "historic waste deposits". The site then became the principal landfill for Swansea and an unlined landraise (referred to as Phase 1) was developed on the western part of the site (Drawing 1575/2). A lined landraise was then developed on the eastern part of the ash platform and to date 15 cells have been developed and filled with municipal refuse.

The original Permit for the site required that the historic waste deposit on the ash platform was completely removed and replaced with engineered fill prior to lining works so that the landfill was supported by a platform of engineered material. Cell 15 and its extension were developed in this way but the then operator, Swansea Waste (a LAWDC) varied the permit to include alternative engineering proposals. A new Permit was issued accepting that ongoing cells could be engineered differently but as details were uncertain, the Permit included a number of Pre-Operational Conditions requiring better investigation and detailed design work to be undertaken.

City and County of Swansea has appointed Cory Environmental as its operating partner for the ongoing development at Tir John. Cell 15 is now nearing completion and additional capacity is to be provided with the construction of Cell 16, which will lie to the south of Cell 15. The new cell will overlie the ash platform (and historic waste deposits) and will be raised to similar levels to the existing cells. Though the original site development plan envisaged Cell 16 and a Cell 17, plans have now been revised and currently only a part of Cell 16 is proposed. It is likely that Cell 16 will be the final act of filling at this site, after which the site will close; accordingly, the cell footprint has been amended to provide a reasonable topography for restoration.

Cory has asked Geotechnology to undertake design work for the revised footprint of the proposed Cell 16. The geometry of the cell has been provided by Cory but Geotechnology has been asked to examine the Permit requirements so that investigation and design work accords with Natural Resources Wales (NRW) requirements. The work has been carried out in stages; initially the available data, permit requirements and conceptual designs were examined. This led to a gap analysis which identified the need for supplementary ground investigations. Having consulted NRW, the ground investigation and in-situ testing was undertaken, leading to a better understanding of the ground conditions beneath the site. Following further consultation with NRW, the engineering options for Cell 16 were examined and detailed performance assessments were carried out, reported in the Engineering Review Report (1413r1v1d0815) submitted in August 2015.

The variation application with its design philosophy was accepted by NRW, though the varied Permit contained many pre-operating conditions aimed at developing a fully workable design. The design principles are therefore identified in the Permit by specific reference in pre-operating Conditions (POC), which included trials to develop the design.

The Engineering Review submitted to NRW in August 2015 provided concept designs for the construction of Cell 16 and NRW has agreed in principle that this meets the Permit Pre-

Operational Conditions. Geotechnology was then able to refine the conceptual design for the sub-cell drainage systems and the ground improvement works. A detailed design for these elements of the new cell was provided in a Construction Quality Assurance Plan submitted to NRW in July 2016. At the time of drafting the CQA Plan some uncertainties remained about the construction of the AEGB. The Design and CQA Plan was therefore limited to the improvement of the existing ground by compaction, the provision of an internal platform drainage system, the provision of a perimeter collection system, and the infrastructure required to monitor groundwater and gas before, during and after compaction. These details, compiled in Geotechnology Report 1574r1v3d0716 were submitted in July 2016. The 2016 CQA Plan is referred to in this document as CQA Plan 1.

Following completion of the preparatory works detailed in CQA Plan 1, a decision was made regarding the construction of the AEGB. Cory has therefore requested that Geotechnology now completes a Design and CQA Plan detailing the remaining works involved in the construction of Cell 16. This report will, therefore, refer briefly to the works already carried out and then detail the design and construction approach to be adopted during the remaining earthworks, placement of the AEGB, placement of the flexible membrane liner and geotextile and construction of the leachate drainage system. The report will also consider the stability of the cell once filled.

2 WORKS DESCRIPTION

This design report and CQA Plan concerns construction of the basal lining system for Cell 16. This includes the placement of fill material to build existing ground levels to formation, the construction of the containment bund, the placement of AEGB and artificial sealing liner, and the construction of the leachate drainage system.

Cell construction will comprise the following:

- Formation preparation of the basal area of the cell
- The provision of 3 settlement monitoring cells to provide data on liner settlement after filling has commenced.
- Construction of containment bund and fill placement to achieve required levels.
- Placement and compaction of clay in layers to form a geological barrier 0.5 metre depth to meet a maximum permeability of 5 $x10^{-10}$ m/s on the base of the landfill and against the bund sidewalls.
- Install 2mm HDPE flexible membrane liner above mineral liner.
- Placement of protector Geotextile above flexible membrane liner.
- Install leachate drainage layer, incorporating leachate collection pipework across the base of the cell. Leachate collection pipework will consist of a 225mm outer diameter (od) spine drain, and three 150mm od spur drains. The pipework will direct leachate to a leachate collection sump in the low corner of the cell.

Following completion of the main Cell 16 containment works, while still under full time CQA supervision, an area on the northeast corner of Cell 15 containment bund will be exposed to establish the extent of the existing lining system. The lining and drainage systems will then be completed to ensure full containment of the cell. The specifications and methods for liner and drainage system installation will be the same as those detailed for Cell 16 in this CQAP. NRW will be contacted following exposure of the liner system in order to inspect the works and discuss the remediation proposals.

3 CQA ARRANGEMENTS

3.1 General

Construction Quality Assurance is an essential component of the construction of environmentally secure waste management facilities. CQA comprises a series of actions and tests which combine with independent overseeing to provide a robust means to verify that construction follows best practice and meets the requirements of Specifications and Designs agreed with the Waste Regulator. As the system is based upon verification by record keeping and review, Construction Quality Assurance also provides a suitable framework to compile as-built records. The output from the CQA process, therefore, is a CQA Validation Report, though the foundation of the report lies in independent close scrutiny of the construction process.

3.2 Parties and Responsibilities

CQA is implemented on site by one or more CQA Inspectors, though the management of successful construction will be the responsibility of Cory Environmental in collaboration with all parties. There are 9 parties involved in the development works outlined in this document. These are:

3.2.1 The Permit Holder

The permit holder for the site is Cory Environmental Ltd.

3.2.2 The Employer

This is the person or company for whom the works are constructed. The Employer is Cory Environmental (Gloucestershire) Limited.

3.2.3 The Contractor/Sub-Contractor

This the person/company appointed by the Employer to construct and manage any individual element of the works. Responsibility and authority under the contract may be delegated to the Contractors Representatives on site. A suitably experienced contractor will be appointed for all installation works. Cory Environmental may directly undertake some elements of the bulk earthworks and enabling works.

3.2.4 The Designer

This is the person or company appointed by the Employer to carry out the design of the Works, in this case Geotechnology Limited.

3.2.5 The Engineer

The Engineer is the individual (or individuals) that has authority over the suppliers and contractors during and prior to the works. Accordingly, it is the Engineer that has to be satisfied with the delivered materials, site won materials, workmanship, plant and construction.

The actions of the Engineer(s) will also be monitored by the CQA Inspector in accordance with this Plan. It is expected that the Engineer will liaise closely with the CQAM throughout the works.

3.2.6 The CQA Consultant

This is the company appointed to independently confirm that the Works are carried out in accordance with this document. The CQA Consultant will appoint a CQA Inspector for the works. The CQA Inspector will be the delegated representative of the CQA Consultant who will oversee the engineering works on site and will be present on a full- time basis during those ongoing works that require CQA provision as dictated by this document. The CQA Consultant for this project will be CQA International Limited or a suitable substitute.

3.2.7 CQA Inspector

The CQA Inspector will be a representative of the CQA Consultant appointed to oversee the works on a full time basis, and shall liaise closely with NRW, the Employer and the Contractor and will verify that the Works are constructed in accordance with this CQA Plan. The CQA Inspector will be responsible for monitoring the works and overseeing any testing together with record keeping as follows:

- Specification of materials used in the works
- Assessing manufacturer's test data to confirm that the materials used in the works meet the required specification
- Assignation and recording of all testing and sampling
- Preparation of daily reports and testing logs
- Photographic records of the Works
- Supervise the obtaining and collection of samples for laboratory testing
- Analysis of site testing
- Instruct the extent and method of remedial works in the event of test failure
- Provision of information for the CQA Validation Report
- Attendance at CQA related meetings

The CQA Inspector will be subject to the approval of NRW. Details of the Monitors CV will be notified to the Agency prior to the commencement of works.

3.2.8 The Testing Laboratory

The laboratory appointed by the Employer to perform any on or off site testing required under the Specification and the CQA Plan. The appointed laboratory will be UKAS accredited for each individual test to be undertaken by it. The Employer and/or the CQA Inspector shall be responsible for liaison with the approved laboratory with regards to the timing of the testing.

3.2.9 The Surveyor

The surveyor shall be responsible for all site survey work, including but not limited to, level control, layer thickness determination, survey as required by this plan and provision of as constructed detail. The Surveyor will be an appointed company who are independent of the Employer, Contractors and sub-contractors. The appointed surveyor for this project will be Stafurv Limited of Vernon Courtyard, Main Road, Sudbury, Derbyshire, DE6 5HS or a suitable substitute.

On completion of the respective phases of the Works, the Surveyor will produce as-constructed drawings for incorporation into the CQA Validation Report.

3.3 Site Visits

It is anticipated that NRW will periodically visit the site during the construction works. During these visits, the CQA Inspector supervising the works shall make available to NRW all site records and surveys.

3.4 Design Changes

Any significant design changes, required to ensure the suitability of the construction works, shall be initially referred to the designer and in the event that a design change is required, this will be notified to NRW for approval.

3.5 Validation Report

Following completion of the works, the CQA Inspector will report fully on the quality assurance undertaken during construction. The report will constitute a CQA Validation Report and will include details of construction quality assurance, the testing carried out and the results obtained together with an assessment of the works in relation to this CQA Plan. In addition, copies of photographic records, as built drawings, including any repairs and test location plans will be included.

4 STABILITY REVIEW

During the development of the design the operator has been sourcing potential materials for use in the construction works. Having undertaken a programme of testing and characterisation on a potential mineral source for the AEGB, further testing was requested by the designer to determine effective strength parameters and pore-water pressures over stress ranges selected to represent the landfill at various stages of filling.

In order to confirm that the selected AEGB material is not a threat to stability, a limit equilibrium slope stability analysis was carried out with the AEGB layer assigned parameters established during the testing. This was required by the designer as fine gravel geological materials (clay and silt mixtures) often respond unfavourably to sudden loading. The testing was therefore carried out under consolidated undrained conditions with porewater pressure measurement.

Appendix 1 provides the outputs and input parameters for two limit equilibrium models of Cell 16. The ground geometry has been obtained from ground investigation results and the landfill geometry has been obtained from design drawings and final restoration contours (Drawing 1575/6). One of the models considers rotational failures whilst the other considers a non-circular slip progressing beneath the landfill within the AEGB. Both sets of results reveal an acceptable factor of safety against failure, verifying that the selected AEGB material does not represent a risk to stability.

5 ACCEPTANCE OF CHOSEN MATERIALS

5.1 Source Documentation

The design requires the works to be constructed using materials that have certain predictable characteristics. These characteristics are identified in the relevant section of this report for each material incorporated into the works. The designers have specified the tolerance of each characteristic of each material type. Each potential supplier is required to provide data sheets for their products offered at tender stage. The data sheets provided by the suppliers will substantiate that their offered product has typical properties in accordance with the designers requirements. The documentation will be compiled by the CQA Inspector and a summary table produced comparing specified properties with the properties of the materials offered. The Engineer will only accept materials conforming to the Specifications provided in this document. The summary table and the original documentation will be made available to the CQA Consultant prior to construction works for independent evaluation.

5.2 Source Evaluation

Certain materials, particularly site won materials, do not have supplier's data sheets to demonstrate suitability for the works. In these cases, prior to any material sources being used, the Engineer will undertake a series of tests to establish the materials characteristics. Where the materials reveal properties that conform to the Specification in this document the Engineer will propose these for inclusion into the works. The CQA Consultant will independently examine the results of the tests to verify conformance with the Specification.

5.3 Determining Conformance

The CQA Consultant will compare the data sheets and source evaluation results with the Specification. Where the data falls within the specified limits for each material characteristic it will be determined in that particular respect as being in conformance. The CQA Consultant and the Engineer will both independently record the fact that the materials appear on the basis of typical properties to be in conformance with the Specification.

5.4 Out-of-Conformance Procedure

Wherever manufacturer's or source evaluation data reveals one or more of the properties to fall outside the limits stated in the Specification, the material shall be determined as out-of-conformance. Out-of-conformance materials will not be permitted to be delivered to site and the Engineer will ensure their prohibition. The Engineer and the CQA Consultant will record any materials prohibited from the site.

5.5 Determining Compliance

The CQA Consultant will examine all laboratory and manufacturer's data and compare these with the Engineers approval documentation. This will allow the actions and decisions made by the Engineer to be scrutinised to determine o.

6 DELIVERY, OFFLOADING AND STORAGE OF MATERIALS

6.1 Determining Compliance

At the pre-construction stage, material suppliers will be required to present manufacturer's recommendations for the delivery, off-loading and storage of materials. It is the Engineers responsibility to ensure that materials are handled in accordance with these recommendations. Materials delivery, off-loading and placement in designated storage areas will be supervised by the Engineer and monitored by the CQAM to ensure compliance. The CQA Consultant will be informed of all anticipated deliveries so that the site procedures can be observed as they happen. The CQA Consultant will independently verify that the observed activities comply with the manufacturer's requirements. These facts shall be recorded as a verification of compliance.

6.2 Damage Inspection

During the off-loading of materials they will be inspected rigorously by the Engineer and CQAM to determine whether any of the goods are damaged. If the goods are less than perfect and reveal any sign of unacceptable damage they will be rejected and will be either:

a) not offloaded
b) offloaded and re-loaded for return or
c) offloaded into the designated non-conforming materials bay to await independent inspection.

Any off-loading procedures are to be recorded on Forms CQA2 or CQA3, depending on the nature of the materials.

6.3 Out-of-Compliance Procedure

Where the Engineer or the CQAM has witnessed offloading or storage of materials that does not comply with the manufacturer's recommendations, the contractor or supplier will be notified immediately. The manufacturer will be contacted and the consequences of the out-of-compliance procedure will be evaluated. This process may result in:

a) the out-right rejection of the materials for incorporation into the works
b) a detailed inspection of the materials to establish damage which may result in either rejection or amended storage in accordance with the manufacturer's recommendations
c) no action if the materials are undamaged and the manufacturer agrees that the storage method will not unduly affect the material

A detailed record of the out-of-compliance actions taken by the Engineer will be made and the actions will be reviewed by the CQA Consultant to ensure that the Specification is met. The CQA Consultant will endorse the actions taken by the Engineer in writing or will reject the actions, in which case the out-of-compliance procedure will be applied.

Any out-of-compliance procedures should be noted on Form CQA5, which will also list details of actions taken and whether the material in question can be incorporated into the works.

7 INCORPORATION OF MATERIALS INTO THE WORKS

7.1 Manufacturer's Quality Control Submissions

Materials will be delivered to the site on the basis that the manufacturer's data sheets give typical values of the required material characteristics. Before any materials can be incorporated into the works, they must be shown by testing to meet the minima stated in the Specification. The testing falls into two categories: manufacturer's quality control data sheets and on-site conformance testing.

The Specification identifies the manufacturer's quality control requirements for each material that will be used in the works. The Engineer will ensure that each material delivery is accompanied by the MQC data relating to the materials manufacture. The MQC data will be compiled onto a summary sheet comparing it with the Specification. Only those materials with MQC data conforming to the Specification will be provisionally accepted for incorporation into the works, subject to conformance testing. The CQA Consultant will independently examine the summary and the original MQC data sheets to verify the Engineers decision to provisionally accept or reject the materials.

7.2 Determining Conformance of Manufactured Materials

Those materials that have been provisionally accepted for incorporation into the works will be subject to conformance testing, at the frequency identified in the Specification. Samples of the materials will be taken under the direction of the Engineers staff and these will be forwarded to the nominated testing laboratory for an independent verification of material characteristics.

Conformance test results will be returned by the laboratory to the Engineer who will then compare the independently determined characteristics with the Specification. A summary sheet comparing the lab results with the Specification will be maintained by the Engineer. Materials will be finally accepted for incorporation into the works when the independent testing has confirmed their conformance with the Specification. The CQA Consultant will independently examine the summary sheet and the original lab test results to verify the acceptance of the materials.

7.3 Use of Independent Laboratory

The laboratory used for conformance testing will be selected by the Engineer and the Client. The laboratory will be independent of the manufacturer's, suppliers, installers and contractors and payment to the laboratories will be made directly by the Client so that no undue commercial pressure can be applied by a supplier. The laboratory shall be UKAS accredited and shall be a recognised testing specialist for the chosen materials.

7.4 Approval for Use

The Engineer will only grant approval for use of the materials when the full validation sequence commencing with typical data sheets, continuing with MCQ data sheets and completing with conformance testing results has demonstrated that the material conforms to the Specification. Approval for use will be given piece-meal and the batch, load or unit to

which approval has been granted will be carefully recorded. The CQA Consultant will independently examine each approval to verify conformance.

7.5 Out-of-Conformance Procedure

In the event that any materials are shown to fall outside the Specification in any respect they will be rejected from incorporation into the works. Upon rejection, the material will be clearly marked or identified in the storage compound and moved as soon as is practical to the designated rejected materials bay. The CQA Consultant will independently verify that this procedure has been undertaken correctly.

7.6 Determining Compliance

The actions of the contractors in offloading and storing the materials, and that of the Engineer in accepting or rejecting the materials will be examined by the CQA Consultant to determine whether the actions leading to the decisions to incorporate materials into the works have been carried out in accordance with the Specification.

8 SETTLEMENT MONITORING SYSTEM

8.1 Principles

Cell 16 is to be constructed over a platform of compacted existing waste deposits overlying a thick sequence of pfa and mixed alluvial soils. The compressibility of all strata beneath the site (with the exception of sand layers within the alluvium) is high, resulting in significant settlement of the basal liner as waste is placed above it. Improvement works have been carried out to "homogenise" the near surface fill materials such that they have limited scope to result in differential settlement. However, total settlements are expected to be large, with the leachate extraction sump area expected to settle by 1.3m.

It is important that actual settlements are monitored in order to confirm that the cell is settling as expected. This is not easy, as the cell will be progressively buried with increasing thicknesses of waste, so monitoring must be carried out with infrastructure placed into the formation uplift materials prior to lining. This infrastructure will be monitored at an external datum box connected to the infrastructure with cables and tubes.

8.2 Settlement Monitoring Equipment

A series of three vented settlement monitoring cells will be placed into sand bedding within the formation uplift materials beneath the AEGB. The locations of the settlement cells are shown on Drawing 1575/3. The cells will be water filled cylinders, connected to a long tube that runs to the datum cabinet. Each cell is fitted with a pressure transducer which connects to the datum cabinet by cabling. The tubes and cables will be protected within a small diameter mdpe pipe placed within a sand bedded trench. Dataloggers in the datum cabinet will record water pressure in the cells and will maintain a constant water level. The settlement cell system will be manufactured by Soil Instruments Limited.

A four channel datalogger will be connected to the three settlement cells and an additional pressure transducer placed in air within the cabinet to monitor atmospheric pressure. Data will be logged once daily.

8.3 Installation

The settlement cells will be installed in accordance with the manufacturers instruction. Care will be taken to record the elevation of the cell top and bottom and that of the datum cabinet during installation. The datalogger will be programmed to display m of water as well as frequency/period.

The elevation difference between the settlement cell datum and an external monitoring pin cast into the datum housing slab will be measured upon installation. During all topographic surveys (annual) and at three monthly intervals the monitoring pin elevation will be established.

Each channel of the logger will be assigned to the relevant settlement cell and as a failsafe the cable/tube tank for each cell will be indelibly marked.

8.4 Commissioning

The cells will be commissioned by a complete test of the entire system together with a review of the installation records. Connections and calibrations will be applied and coded into the datalogger.

8.5 Determining Compliance

The installation of the system shall be overseen by the CQA Inspector who shall confirm that the installation is in accordance with the manufacturers instruction and that the cells have been correctly zeroed, are clearly marked inside the cabinet and have been correctly set-up for accurate meaningful recording. The functioning of the loggers will also be confirmed.

9 EARTHWORKS

9.1 Existing Ground Improvement

Cell 16 is to be constructed on historic waste deposits that are likely to experience large and irregular settlement when loaded by the waste cell. In order to control differential settlement, the historic waste deposit has been improved by using a form of deep compaction. The objective of this work was to provide a uniformly improved layer directly beneath the AEGB in order that settlement magnitude is minimised and localised differential settlement is avoided.

Compaction was achieved by the use of the LandPac system which utilises a three or five sided towed compactor. The compactor completes a set number of passes across the entire footprint of the cell. This process is continuously monitored using the CIR (continuous impact response) and CIS (continuous induced settlement) methods so that the amount of induced settlement and the magnitude of reflected energy can be mapped across the entire treated surface. Where soft spots or soft areas were identified in the initial pass, they were treated by either excavation and replacement of the soft material or additional passes by the LandPac system.

The CQA Plan and Design of this work has been covered previously in Geotechnology Report 1574r1v3d0716. The surface remaining at the end of the compaction process is entirely below the proposed formation level of Cell 16. Levels will be built up to meet the design formation using conventionally compacted fill material (see Drawing 1575/3).

9.2 Placement of Fill to Formation

As a result of the works already completed, no cut will be required to meet formation. Furthermore, due to the ground compaction carried out by Landpac it is not expected that any soft material will be encountered.

It is imperative that the fill areas provide adequate support; accordingly fill should be laid in thin layers and compacted up to formation level. The Specification for Highways Works offers methods of compacting various materials to provide a firm unyielding surface. The Engineer will classify the fill materials in accordance with Schedule 600 of the Specification for Highways Works and that will allow the placement and compaction regime to be selected, in terms of layer thickness and number of passes with the selected compaction plan.

The Engineer will record the material types, their earthworks classification and the compaction method used during placement. The CQA Inspector will validate the material classification and the compaction method used by the Engineer.

9.3 Placement of Containment Bunds

On the north and western edges of the cell side-slopes will be principally formed onto the existing landfill containment bunds. Along the southeast cell boundary a large containment bund will be constructed as part of the formation preparation works. This bund will be placed in the same manner as the fill to formation identified in Clause 9.2. The containment bund will be developed in a series of horizontal lifts and constructed wider than the design requirements. The bund will be trimmed to line and level after placement.

9.4 Removal of Unsuitable Materials

The SHW (Schedule 600) calls for the removal of all potentially unstable materials, such as vegetation, peat, soft clays, process sludge's etc. The Engineer supervising the placement activities will visually examine the materials to ensure that this Specification is fully complied with. The CQA Inspector will examine the materials being included into the works to confirm that unsuitable materials have been excluded.

9.5 Line and Level Checking

The Surveyor will check gradients and alignments at 10m intervals within the footprint of the cell. A selection of these will be cross checked by the CQA Inspector to establish Engineer accuracy. Documentary evidence of these cross checks will be maintained and included in the CQA Report. This data will be recorded in Form CQA6.

When formation level is achieved, the surface will be scarified to accept the mineral liner. The mineral liner will be placed onto the formation surface and then rolled to a smooth unyielding surface without protrusions and sudden changes in level. When the Engineer confirms the suitability of the formation, the CQA Inspector will be invited to spot check the formation to confirm the acceptability of line and level, prior to the placement of the mineral liner on top.

9.6 Determining Conformance

The Surveyor will determine conformance of the earthworks to the design by undertaking a series of checks including topographic survey and placement measurement. Twice daily the CQA Inspector will observe the layer thickness and the number of passes from the roller to document the placement of materials, recording this observation on Form CQA7. Any fill material testing shall be recorded on Form CQA8.

9.7 Out-of-Conformance Procedure

Where the earthworks are shown to be out-of-conformance they shall be reconstructed in accordance with the Specification and the area determined to require reconstruction shall be surveyed both before and after reconstruction. The area will be subjected to further testing to ensure its conformance. The non-conforming procedure will be recorded on Form CQA5.

9.8 Formation Survey

The Surveyor will undertake a topographic survey of the finished formation and record this onto the master plan.

9.9 Formation Acceptance

The Engineer shall formerly accept the formation and this may be undertaken piecemeal, as indicated on the sub-grade acceptance Form CQA9. In the event that piecemeal acceptance is made, the area accepted shall be clearly identified on site with numbered clay bricks or with an indelible spray mark and the location of these shall be surveyed and included on the form.

9.10 Determining Compliance

The actions of the contractors in constructing the earthworks, and that of the Engineer in accepting or rejecting the materials and the finished works will be examined by the CQA Consultant to determine whether the actions leading to the decisions to incorporate materials into the works have been carried out in accordance with the Specification.

10 MINERAL LINER

The mineral liner will be formed of imported material as the materials currently available on site are not suitable for the task. The minimum characteristics required of the mineral liner are included in Table 10-1 Below.

Table 10-1 Mineral Liner Specification

Property	Unit
Source	Dyfan Road, Barry
Stratum	Alluvial clay
Clay Content	>40%
Moisture Content	28% lower limited 32% upper limit (subject to revision only if acceptable permeability can be shown at new limit, sample at lower limit remains plastic and sample at upper limit has shear strength exceeding 50 kPa)
Cu	>50 kPa
Air Voids	>10%
Dry Density	>1.3 Mg/m^3
Permeability	$<5 \times 10^{-10}$ m/s
Liquid Lime	<90%
Plasticity Index	10% lower limit 65% upper limit

The required hydraulic performance of the AEGB is specified by the Directive as equivalent to 1m thickness of permeability at $1x10^{-9}$ m/s, with a minimum thickness of 0.5m. This provides for the placement of mineral liners of less than 1m thickness, providing the permeability is lower to provide an overall performance as good as that specified in the Directive. It is proposed that a 0.5m thick mineral liner is to be used in this scheme using clays with a permeability less than or equal to $5x10^{-10}$ m/s.

The following materials will not be accepted within the liner:

a) peat, timber, or any other perishable material
b) frozen materials
c) industrial, commercial or domestic waste
d) metal, plastic or any other man made materials
e) any material containing particles greater than 125mm in any dimension.
f) Materials failing to comply with the properties specified in Table 10-1.

10.1 Mineral Liner Requirement

The artificially established geological barrier (AEGB) shall consist of a basal and side slope seal constructed above the prepared formation and bund level from imported low permeability material placed and compacted in layers as determined by a compaction trial. Details of the mineral lining works are shown on Drawing 1575/4.

Suitable materials will be placed in layers and compacted to form a geological barrier to a 0.5m depth to meet a maximum permeability of 5×10^{-10} m/s on the base of the cell and up the bund.

The proposed clay lining material has previously been stockpiled at site following laboratory characterisation. The mineral originated from Dyfan Road, Barry and is a low permeability natural alluvial clay.

The proposed source material has previously been subject to characterisation and source evaluation, as the laboratory test results in Appendix 2 confirms.

The contractor shall excavate, handle and place all clay used in the works in such a manner that is deemed suitable for use in the Works.

10.2 Compaction Trial

Prior to the commencement of the clay lining works, the Contractor shall carry out a compaction trial, which may be carried out on an area that shall form part of the permanent works, at a location to be agreed beforehand with the CQA Inspector.

The compaction trial pad shall be of sufficient width that there is approximately 2m either side of the compaction plant to allow for side effects. The minimum length of the trial area shall be approximately 3 times the combined length of the compaction plant and towing plant to allow for variations in thickness at the ends, and to ensure enough area is available to be representative of a large section of clay liner and to allow sufficient spread of test and sampling locations. A minimum of two layers of compacted material shall be placed. The layers shall be compacted with a range of passes of the construction plant, as necessary, and tested for each compaction regime by the CQA Inspector to determine the most effective method of achieving the required Specification.

The purpose of the compaction trial is to assess the Contractor's method of placement and compaction and provide field verification of the moisture/density/permeability relationship, as determined by characterisation testing. From the compaction trial the following shall be evaluated:

- The Contractors method of material handling and placement
- The Contractors method of compaction and equipment employed
- Confirmation of the number of passes and layer thickness necessary to achieve the required compaction result
- Confirmation of the in situ dry density/moisture content criteria to be implemented
- Confirmation that interlayer bonding of the material, determined by excavation though the pad, has formed an homogenous mass

During the trial, the Contractor shall allow provision for the CQA Inspector to undertake quality control testing and sampling for laboratory testing. The testing/sampling of the trial pad shall comprise for each layer, and/or each compaction regime:

- Three core tests per layer for density/ moisture content;
- One core sample for laboratory permeability testing;
- One bulk sample for laboratory classification testing

Clay lining works shall not be undertaken until the CQA Inspector, on the basis of the laboratory and in-situ testing undertaken on the compaction trial pads, has approved the Contractors method of compaction.

The compaction trial may be incorporated into the works provided that the results are satisfactory, any non-conforming material is removed prior to liner construction, the uncompacted edges are removed prior to construction and all edges are benched into the liner construction. If the results of the trial prove unsuccessful, the placement methodology and/or compaction plant shall be changed or modified and a further trial carried out to

assess the revision. This process shall continue until the CQA Inspector is satisfied that the proposed plant and methodology will produce satisfactory results.

The CQA Inspector shall keep a record of the results of the trial and the approved compaction method.

NRW will be given adequate warning of the trial and invited to attend to observe the works.

10.3 Placement of Lining Material

On completion of the compaction trial the clay liner construction shall commence using the plant and placement methodology determined by the trial. The compaction methodology shall not be changed without further trials to demonstrate the suitability of any revision.

Any unsuitable materials within the liner shall be removed including any stones or clods larger than 125mm or excessively softened or wetted clay. Joints between sections of placed liner shall be constructed with a stepped connection between successive layers to assure the continuity of the seal.

If a smooth-drum roller is used to seal the surface of an intermediate layer against rainfall or desiccation, the layer surface shall be scarified to a minimum depth of 25mm prior to the placement of any subsequent layer to ensure a competent key between layers. Any clay material that becomes excessively dry/wet shall be wetted/left to dry sufficiently or shall be removed from the Works and replaced with suitable material.

All perforations made in the liner for testing or sampling purposes shall be backfilled with compacted clay to the satisfaction of the CQA Inspector.

Layer thickness of the mineral liner during placement is to be controlled with the use of a cone laser. As a control measure a minimum of two bench marks are to be set up within the works to allow for daily checks and accurate set up of the laser equipment. The final trim of top of clay is to be completed with 100% use of a laser fitted onto the dozer to provide continuous level control to the operator. The set up and operation of the equipment is to be verified by the CQA Inspector on a daily basis, who shall instruct the plant to proceed to a bench mark a minimum of once per day to independently check that the levels being worked to are correct.

Where the clay liner extends above the base of the cell up the sidewall then a series of marker posts will be installed perpendicular to the slope with the level of each clay layer marked at intervals on them. The CQA Inspector will verify that the depth of each layer is achieved by checking layer thickness against the marker posts.

The thickness of the completed liner shall be determined by level survey in accordance with the specified survey requirements. If the results of the surveys indicate that the clay liner does not achieve the requisite thickness, additional clay shall be placed and compacted and the area(s) re-surveyed until the requisite thickness is achieved.

The surface of the completed liner shall be prepared to a smooth, even profile using a smooth-drum roller or other suitable approved method.

The CQA Inspector shall verify that all aspects of liner construction are carried out in accordance with this document including conformance testing as detailed below.

10.4 Conformance Testing

The CQA Inspector shall carry out a regime of field conformance testing and sampling for laboratory testing in accordance with Table 10-2 to verify that the mineral liner meets the required specification and placement criteria. The testing shall be carried out on each layer placed. The CQA Inspector shall record the test location and result. The location of each test location will be recorded on a sample location plan. Subsequent layers of clay shall not be placed until the CQA Inspector has verified that the tested layer has achieved the requisite density/moisture content criteria. Any remedial works shall be carried out as determined by and to the satisfaction of the CQA Inspector.

Table 10-2 Clay Liner Conformance Testing Specification

PROPERTY	TEST METHOD (BS 1377:1990)	REQUIRED VALUE	Conformance Testing Frequency (per m^3 clay placed)
Classification Testing			
Liquid Limit	Part 2: Method 4.3	<90%	250
Plastic Limit	Part 2: Method 5.3	-	
Plasticity Index	Part 2: Method 5.4	10% - 65%	500
Particle Size Distribution	Part 2: Method 9.2	$\leq$ 125mm	
Clay Content	Part 2 : Method 9.4	$\geq$ 10%	
Particle Density	Part 2: Method 8.2	-	
Compaction Testing			
Density/ Moisture Content	Part 9: Method 2.4		250
Air Voids Content	-	$\leq$ 7.5%	
2.5kg Compaction	Part 4: Method 3.4	-	2,500
Permeability Testing			
Constant Head Triaxial	Part 6: Method 6	$\leq 0.5 \times 10^{-10}$ m/s	500*
Shear Strength Testing			
Hand Shear Vane	Part 9: Method 4.4	$\geq$ 50 kPa	250
Undrained Triaxial	Part 7: Method 8	$\geq$ 50kPa	2,500

*Permeability samples to be obtained at a rate of 1 per 500 m^3. Samples to be tested at a rate of 1 per 1,000 m^3. Spare samples to be tested only if samples indicate contentious results.

The CQA Inspector shall check the results of all laboratory conformance testing to verify that the clay liner meets the required Specification.

At locations where the results of the field or laboratory testing indicate failure to achieve the required acceptance criteria, the extent of the non-conformance shall be determined by the CQA Inspector on the basis of surrounding locations of conforming tests. Non-compliant areas shall be remediated by one of the following procedures:

- Additional compaction of the area
- Adjustment of the clay moisture content by the addition of water or by scarifying and allowing drying until the required moisture content is obtained followed by additional compaction as necessary
- Removal of the material and replacement with suitable material
- The CQA Inspector shall record all locations of non-conformance together with remedial actions taken and shall not permit placement of a subsequent layer on the area until conformance is achieved

10.5 Use of Independent Laboratory

The laboratory used for conformance testing will be selected by the Engineer and the Client. The laboratory will be independent of the manufacturer's, suppliers, installers and contractors and payment to the laboratories will be made directly by the Client so that no undue commercial pressure can be applied by a supplier. The laboratory shall be UKAS accredited and shall be a recognised testing specialist for the chosen materials.

10.6 Use of In-Situ Tests

In-situ tests shall be used to determine placed density using the sand replacement method or core cutter method. All other testing will be undertaken at the nominated laboratory. In-situ tests shall be carried out by the Engineers staff using instruments and materials of traceable standards.

The Surveyor shall survey the location and indicate the lift of every test and sample obtained during the works. The distribution of data points shall be uniform and random. The details of the in-situ testing are to be recorded on Form CQA8.

10.7 Mineral Liner (AEGB) Surface Approval

The mineral liner will be signed-off on a piece-meal basis as the works progress (Form CQA9). Accordingly, a system shall be used to clearly define the area that has been accepted. A paper record of the signed off areas shall be maintained by the Engineer and the earthworks contractor and this shall identify sequentially numbered areas that have been inspected and meet the Specification. The boundary of each area shall be surveyed to ensure adequate joining with the next placed area of mineral liner. In addition, there will be a further surface condition evaluation in accordance with Environment Agency Guidance LFE4, which requires lath testing at a rate of 5 per hectare. The results of this further testing will be included in Form CQA10.

The signing-off process will require the Engineer to inspect the area that the earthworks contractor offers as complete. A walkover inspection will record line and level in accordance

with Clause 10.1 of this plan. The Engineer will determine the extent of the conforming area and will mark this on the ground using bricks or spray marks.

The CQA Inspector will make a check inspection of the site to identify those areas signed-off as complete. The Engineers signing-off records and updated master survey plan shall also be viewed. The CQA Inspector will ensure that site marking is clear and that the procedure for signing-off has been followed properly.

10.8 Determining Conformance

Conformance will be determined by the Engineer and checked by the CQA Consultant. Those elements of the construction process subjected to testing will be considered to conform to the Specification if their properties are established to meet or exceed the requirements of the Specification. The mineral liner will only be considered to conform if sufficient numbers of test have been undertaken.

10.9 Out-of-Conformance Procedures

Where the mineral liner is shown to have properties that lie outside the window of acceptability, it shall be considered to be out-of-conformance. Under such circumstances the liner is to be reconstructed around the test that has revealed inadequate performance. The area of reconstruction will be determined as the area covered by placed mineral liner since the last conforming test. This area may be reduced by further testing in an attempt to bracket the non-conforming area more tightly. When reconstructed, the liner shall be retested to demonstrate conformance. The non-conforming mineral liner area will be recorded on Form CQA5.

Upon the discovery of a non-conformance by the CQA Inspector, the Engineer shall be informed immediately.

10.10 Mineral Liner Survey

A survey of the as-built mineral liner shall be undertaken. The survey shall be to Ordnance datum and co-ordinates. In addition, an isopachyte drawing of the mineral liner thickness shall be prepared from surveys of the formation and the finished mineral liner surface.

10.11 Determining Compliance

The actions of the contractors in constructing the mineral liner and that of the Engineer in accepting or rejecting the materials and the finished mineral liner will be examined by the CQA Inspector to determine whether the actions leading to the decisions to incorporate materials into the works have been carried out in accordance with the Specification. This will be completed by examination of Forms CQA 6, 7, 8, 9 and 10.

11 FLEXIBLE MEMBRANE LINER

The FML for cell 16 will comprise a 2mm smooth HDPE membrane. The geomembrane shall consist of high density polyethylene (HDPE) produced from new resins and containing no fillers, plasticisers or additive of any kind with the exception of carbon black. The resin used in the manufacture of the HDPE shall be a new first quality product specifically for the purpose of leachate containment and shall contain no more than 2% clean recycled polymer by weight. The thickness of both membranes shall be 2mm and free from all blemishes, abrasion or other surface imperfection.

The liner geomembrane shall meet the minimum requirements of Table 11-1 for the smooth HDPE shown below:

Table 11-1 Smooth 2.0mm HDPE Membrane Specification

Property	Test Method	Value
Thickness (mm) Lowest individual of 10 values Lowest individual for any of the 10 values	D5199	Nom. (mm) - 10%
Density (min.)	D1505/D 792	0.940 g/cc
Tensile properties (1,2) Yield strength Break strength Yield elongation Break elongation	D 6693 Type IV	 29 N/mm 53 N/mm 12% 700%
Tear Resistance	D 1004	249 N
Puncture Resistance	D 4833	640 N
Stress crack resistance(5)	D 5397	500hr
Oxidative Induction Time (OIT)	D 3895	100 min
Oven Aging at 85 deg C*	D 3895 or D 5885	55% or 80%
UV Resistance – High Pressure OIT*	D 3895	1600hrs
Carbon Black Content(3) - %	D 1603	2.0 – 3.0%
Carbon Black Dispersion	D5596	Note (4)

* - not suitable for conformance testing – manufacturers CE declaration to be used as acceptance criteria

(1) Machine Direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in category 1 or 2 and one in Category 3

(5) For stress crack resistance, the single point notched constant tensile load test given in appendix to D5397 will be undertaken

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content of the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20hr. UV cycle at 75 deg C followed by 4hr. Condensation at 60 deg C.

(9) UV resistance is to be based on percent retained value regardless of the original HP-OIT value.

When delivered, conformance samples of the geomembrane shall be obtained at a rate of 1 per 5000 m2, or every 5 rolls delivered to site, whichever is the greater number of tests. These samples shall then be forwarded to the nominated laboratory for testing. The nominated laboratory shall be UKAS accredited for all the tests required to be undertaken as part of the conformance test suite.

A strip measuring 1000mm long shall be cut from the end of each selected roll, but not including the first 1m. From this main sample, a total of 3 No. sub samples of equal size shall be obtained; one is to be retained by the Engineer, one is to be retained by the Contractor and the third is to be sent to the nominated testing laboratory for testing. The samples shall be stored in a cool, dark place and shall be clearly labelled with the roll number.

Prior to installation, conformance testing in accordance with test methods shown in Tables 11-1 and 11-2 shall be carried out by the nominated laboratory. The results shall be submitted to the CQAM, together with the roll number and the batch or consignment numbers to which they relate.

Materials not conforming to the Specification shall be re-tested and, in the event of subsequent failure, will be rejected. In the event of a subsequent pass the CQAM will require a further test (as this indicates one pass and one fail). If this subsequent test passes then the material may be approved by the CQAM, but in the event of failure, the roll shall be rejected and shall not form part of the works. Under these circumstances the roll numbers on either side of the failed roll shall both be tested to bracket the failure. If two or more rolls within a batch fail then the entire batch will be rejected by the Engineer unless testing demonstrates that a particular roll has passed its conformance testing. Retests or bracketing tests shall not contribute toward the conformance testing frequency. Any re-testing shall be carried out at the expense of the Contractor.

Installation of the geomembrane shall not take place until results of the conformance tests have been obtained from the independent testing laboratory and the material has been approved by the Engineer for use in the permanent works.

11.1 Damage Inspection Upon Unrolling

FML delivered to site will have been subjected to inspection for damage prior to storage. A more rigorous inspection for defects will be made upon unrolling on site. The installer/supplier will be required to certify the material is free of defects or damage and part of this duty is a full inspection of the sheet by the welding crew.

The Engineer will also inspect the unrolled sheet, sometimes before and sometimes after welding in-situ. The CQA Inspector will carry out spot checks to ensure that the materials are free of damage and defects.

In the event that any damage is detected, the roll might either be cut below the defect or in the event of minor defects it might be repaired in accordance with the repair Specification. Any defects noted will be recorded initially on Form CQA11 and then on Form CQA5.

11.2 FML Placement

The Contractor shall have considerable experience of installing geomembrane of the type specified for the Works. The Contractor shall submit a summary of their experience with the specified materials including an estimate of the total area installed by him in the United Kingdom over the past 12 months. The foreman of the lining crew shall have deployed no less than 50,000m^2 in a supervisory capacity. Each of the crew shall have welded no less than 10,000m^2 of HDPE membrane. Written confirmation of the foreman and crews experience is required prior to works commencing, as is the provision of copies of the proposed welders CSWIP certificates for all welding devices to be used during construction.

11.2.1 Provisional Layout

The Contractor shall submit a sketch showing the proposed panel layout for the geomembrane. The sketches will show the Contractor's proposed start point and proposed direction of working. The Contractor shall arrange the panels so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), whenever practicable, in accordance with accepted good practice.

In order to clearly identify each panel (as laid) the installing Contractor shall use coloured markers, written in permanent ink compatible with the HDPE.

Every field HDPE panel shall be given a unique number commencing with the nomenclature P1 for Panel 1. The installation Contractor shall ensure that the correct correlation between panel number and manufactured roll number is maintained. This is to be done by a reference table or chart completed as the HDPE rolls are deployed.

11.2.2 Weather Conditions

FML deployment shall not proceed at an ambient temperature below 4.5 ^{0}C or above 30 ^{0}C. Placement and seaming shall not be performed during any precipitation, in the presence of moisture or in an area of ponded water. No deployment shall take place during periods of excessive winds, typically 20 mph in the working area. Deployment in wind speeds less or greater than this may take place after liaison between the foreman and the Engineer. The overriding issue for FML deployment shall be the health and safety of the installation staff and of surrounding operatives.

Weather conditions shall be recorded by the Engineer as will ambient temperatures in the working area. Any significant change in weather conditions during one single day will result in additional trial seam testing.

11.2.3 Temporary Surcharge

The Contractor shall be responsible for the geomembrane at all times during the Contract and shall adopt whatever measures are necessary to ensure its stability and prevent it from damage.

These measures shall include the use of sufficient temporary surcharge in the form of durable sandbags, tyres or similar weights without sharp protrusions placed on the geomembrane immediately after laying and before seaming to prevent slipping and damage by wind or other agents prior to covering. Any problems arising from the Contractor's failure to secure the geomembrane during the Contract shall be remedied at the Contractor's expense.

The contractor’s attention is specifically drawn to the phenomenon of liner uplift caused by suction resulting from wind. Even when completed, the liner will still require ballasting to prevent wind damage.

11.2.4 Acceptable Seaming Methods

All seaming shall conform to the methods detailed in the EPA Technical Guidance Document "The Fabrication of Polyethylene FML Field Seams (No EPA/530/SW- 89/069, September 1989)".

The Contractor shall include method statements detailing the following as a minimum:

- Proposed seaming technique or techniques and their proposed applications.
- Proposed seaming machinery.
- Proposed acceptable temperature ranges for extrudate and/or hot wedge.
- Proposed acceptable maximum seaming speed if automated machinery to be used.

Acceptable seaming methods include extrusion and fusion welding only. Only apparatus that has been specifically approved by make and model shall be used. The installation Contractor shall submit all details of the seaming equipment he proposes to use for approval prior to commencing the works.

The installation Contractor shall maintain on site a number of spare sets of operable seaming apparatus to ensure no delays are caused by machine breakdown.

i) Extrusion Welding

Any extruding equipment is to be purged prior to its use to ensure that all heat degraded extrudate has been removed from the barrel. The HDPE welding rods to be used in the extrusion process are to be dry and clean and comply with the membrane Specifications in Table 11-1.

The engineer should perform checks of the weld strand packets to ensure the melt flow index is compatible with the liner resin.

Grinding and preparation is to be completed well in advance of the welding and dry wiped of any excess materials. Any grinding processes are to be carried out perpendicularly to the line of the weld.

Extruded seams in the vicinity of the existing waste mass will be vacuum box tested but in areas further from the waste mass, where explosive atmospheres are not a risk, spark testing may be used. Where spark testing is to be used, into each extruded seam, a copper wire is to be placed to allow for subsequent high voltage testing.

Typically, the HDPE panels should be aligned to allow for an overlap of 100mm for extrusion welding. Sufficient overlap should be available to allow peel tests to be undertaken. Failure to maintain the minimum overlap may be cause for rejection of the seam.

No solvents or adhesives are to be used to temporarily adhere the HDPE prior to the extrusion process.

ii) Fusion Welding

The installation Contractor shall log details with respect to the ambient temperature and seaming equipment during the fusion welding process.

A moveable protective layer should be used as required by the installing Contractor directly below the two sheets of HDPE that are to be welded to prevent debris collecting around the pressure rollers.

Typically, the HDPE panels should be aligned to allow for an overlap of 125mm for fusion welding. Sufficient overlap should be available to allow peel tests to be undertaken. Failure

to maintain the minimum overlap may be cause for rejection of the seam. No solvents or adhesives are to be used to temporarily adhere the HDPE prior to the fusion process.

11.2.5 Daily/Intermittent Start-up Welds

The Contractor shall perform trial seams with each seaming machine and operator at the start of each day, after any welding stoppage exceeding one hour and where weather conditions have changed which could affect the welding efficiency of the machinery.

The weld must be a minimum of 3m in length for either an extrusion or fusion weld. The date, time, machine no., speed, setting, geomembrane and ambient temperature shall be marked on the trial seam.

A total of six specimens, each 25mm wide and at least 105mm long shall be cut from the trial weld. Three tests shall be completed in shear and three in peel. For fusion welds, both tracks shall be tested in peel mode. Failure of the weld must take place in Film Tear Bond (FTB) mode.

If a trial seam fails field destructive testing as specified above, then the seaming machine and the operator shall not be allowed to perform field seaming until the deficiencies are corrected and both machine and operator have achieved passing a further two trial seams. Trial seaming and destructive testing must be observed by the CQA Inspector.

If the same machinery records five failures in any 48hr period, it shall be returned for repair and records kept of the service. The records of the results of the repair and/or service shall be included in the Validation Report.

11.2.6 FML Placement

The FML shall be placed using only the manufacturer's recommended method, typically an appropriately sized spreader bar. The equipment shall be verified by the Engineer of it's suitability for the FML deployment. All staff and personnel will not be allowed to smoke and must wear non-damaging footwear whilst working on the geomembrane.

The membrane shall be unrolled so as to prevent scratching the underside of the liner by causing it to drag after deployment. The method used to unroll the membrane shall not cause excessive scratches or crimps and should not damage the underlying mineral sub-grade. The method used to place the panels shall minimise wrinkles and "fish-mouths".

Sufficient temporary surcharge to load the FML before welding shall be placed on top, which is not likely to cause damage to the underlying liner. Typically sandbags and tyres would be suitable to prevent uplift due to wind. Trafficking over the FML is prohibited.

The FML shall always run far enough through the anchor trench to be able to lie flat against the near-side wall and the entirety of the floor area, after back-filling has taken place. The FML shall be anchored only at the crest of the side slope and shall have an arrangement of panels similar to that proposed in the contractor's provisional layout. The anchor trench is 600mm deep and set 2m back from the crest of the slope. This provides a satisfactory ratio between membrane tensile strength and embedment fixation. A deeper trench would result in liner damage before pull-out.

11.2.7 FML Installation Testing

The Engineer, upon deployment of a random selection of 20% of rolls will measure the geomembrane thickness at various intervals. The thickness tolerances are given in Tables 11-1 and 11-2 of this Specification. The criteria for thickness acceptance shall be:

- No single thickness measurement shall exceed the stated tolerances.
- The average of the Engineer's measurements across a given roll width shall be greater than the specified thickness.

In the event that a roll fails this test then it shall be rejected from the works and rolls numbered sequentially above and below the rejected roll shall be tested. In the event that either of these fail, then the same procedure applies. Any re-testing shall be carried out at the expense of the Contractor.

11.2.8 Seam Construction and Testing Requirements

The Contractor shall perform field seams only after satisfying trial seam conditions as specified in 11.2.5. The Contractor shall ensure that all pre-treatment measures (e.g. grinding and cleaning), as specified in EPA/530/SW-891069 are carried out and that extrudate and/or wedge temperatures are maintained within a range approved by the Engineer.

All field seams shall be completed to the back edge of the anchor trench, i.e. the edge furthest away from the slope. Any seam defects failing within the anchor trench shall be repaired in accordance with this Specification.

11.2.9 Non-destructive Seam Testing Requirements

Field seams will be subjected to rigorous non-destructive testing on site, and destructive testing both on site and in the nominated geosynthetic laboratory. The Contractor shall perform non-destructive testing along the entire length of all field seams including patches and repairs. The Contractor shall issue a method statement detailing their proposed non-destructive test technique or techniques and their proposed applications.

The Contractor shall advise the Engineer and CQAM when he is ready to commence non-destructive testing and shall not perform non-destructive testing unless the Engineer is in attendance. The installation Contractor shall record all of the results obtained for each non-destructive seam test undertaken and forward the results to the Engineer.

The installation Contractor shall note and mark the results of the test onto the FML, to allow subsequent examination. Where feasible the marking shall take place at the crest.

i) Fusion Weld Testing

For air pressure tests the channel between the two wedge tracks of the fusion welder shall be inflated to a minimum pressure of between 1.6 and 2.0 bar. After an initial stabilisation period of 1 minute the pressure shall not decrease by more than 10% in 10 minutes. The pressurised air channel shall be released after the test from the opposite end to the pressure gauge to ensure APT continuity.

ii) Extrusion Weld Testing

Extrusion welds shall be tested using only vacuum box testing. Vacuum box testing is preferred due to the presence of a potentially explosive atmosphere in the vicinity of the existing waste mass. Spark testing may be carried out in areas remote from existing waste deposits subject to a risk assessment being undertaken by the lining contractor.

Vacuum box testing shall be carried out using a minimum box overlap of 50mm.

The spark test shall comprise a continuous high frequency spark tester with a voltage adjustable in the range 15kV to 30 kV. If the presence of explosive gases is suspected, no spark testing shall take place.

After the weld has cooled, the seams integral copper wire shall be connected to ground and adjusted to provide a voltage of approximately 10 kV per millimetre of FML thickness.

The spark probe shall be passed along either side of the extruded weld and any sparks noted, marked. Any suspect areas shall be repaired in accordance with Section 11.4.11.

iii) Non Destructive Test Failures

In the event of a field seam failing non-destructive testing the Contractor shall identify the cause of the failure and repair the failed area in accordance with this Specification. The Contractor shall then subject the repair to further non-destructive testing until a passing test is achieved.

11.2.10 Destructive Seam Testing Requirements

i) Destructive Field Testing

The Contractor shall cut a 25mm wide field tab from the beginning and end of each completed field seam and shall subject it to qualitative destructive testing in peel and shear modes using a tensiometer or mole grips.

The seam will pass qualitative destructive testing if the failure occurs solely in the parent materials and does not enter the seam. The seam will fail qualitative destructive testing if any of the failure enters the seam. Conventional destructive sample test codes shall be used and the results should be confirmed and submitted to the Engineer.

If a field tab fails destructive testing, the installation Contractor shall either:

- reconstruct the seam between an up-weld tab and a down weld tab that have passed qualitative destructive testing
- cut further tabs from 3m to each side of the failed tab and subject these to field destructive testing. If these tabs pass field destructive testing the Contractor shall cut a laboratory sample from the passed area in accordance with this Specification and reconstruct the seam between the passed locations in accordance with this Specification. If either sample fails, the Contractor shall cut and test further field tabs until he can identify an area bounded by two passed locations. The Contractor shall then reconstruct the failed seam in accordance with this Specification

The Engineer reserves the right to request the cutting and destructive testing of further field tabs at any locations along the length of a seam.

ii) Destructive Laboratory Testing

The Contractor shall cut laboratory samples from the field seams when instructed by the Engineer and in any case at a frequency not exceeding 1 sample per 200m of seam performed by an individual fusion machine and 1 sample per 150m of seam performed by an individual extrusion machine.

It is likely that the majority of the welding within Cell 16 will be fusion welding. Extrusion welding is unlikely to exceed 150m. However, in order to examine the seam qualities of extrudate welds, a dummy sample shall be completed at the same time as patches and repairs are being undertaken and shall be subjected to field and laboratory destructive testing.

In accordance with LFE 5 the number of welds (and therefore repairs) shall be kept to a minimum. Destructive test locations shall be undertaken away from key areas including the base of slopes, sump areas, or complex panel intersection arrangements.

The Contractor shall divide the sample into 3 and release sub-sample C to the Engineer for archiving. Sub-sample A shall be kept by the installation Contractor. The Contractor shall without delay despatch sub-sample B to the Engineer or at the Engineers written instructions to the nominated geo-synthetic laboratory for destructive testing in shear and peel.

The dimension of each sample shall be a minimum of 300mm by 500mm. The Contractor should note that five tabs should be cut and taken for peel tests and five tabs for shear tests.

The laboratory shall report quantitative results and the mode of failure for the tests carried out. Mode of failure shall be described in accordance with industry convention. Copies of the test results certificates shall be issued to the Engineer within 24 hours of issue by the laboratory.

The seam will pass quantitative destructive testing if all of five of the tabs pass in the following modes:

- the failure occurs solely in the parent material and not seam.
- the peel strength exceeds 21.2 N/mm for fusion welds.
- the shear strength exceeds 28.0 N/mm for fusion welds.
- the peel strength exceeds 18.2 N/mm for extrusion welds
- the shear strength exceeds 28.0 N/mm for extrusion welds.

If a seam fails quantitative destructive testing the Contractor shall investigate the seam to each side of the failed sample as specified in this Specification. The Contractor shall cut further laboratory samples from each side of the failed section and perform laboratory tests upon them at their own expense until the failed seam is bounded by two pass locations.

The Contractor shall then reconstruct the failed seam in accordance with this Specification. The Engineer may at their discretion observe the destructive testing, in which event the Contractor shall arrange permission for access to the nominated laboratory.

The Contractor shall provide the Engineer with a copy of the formal report from the independent testing laboratory detailing the procedures used for testing and including a summary of all results. This report shall be provided to the Engineer within two weeks of the completion of the welding.

11.3 Use of Independent Laboratory

The laboratory used for conformance testing will be selected by the Engineer and the Client. The laboratory will be independent of the manufacturer's, suppliers, installers and contractors and payment to the laboratories will be made directly by the Client so that no undue commercial pressure can be applied by a supplier. The laboratory shall be UKAS accredited and shall be a recognised testing specialist for the chosen materials.

11.4 Out-of-Conformance Procedures

The Engineer will ensure that no part of the FML lining system is accepted until all of the non-destructive and destructive tests have met the Specification requirements. Where a test is seen to fail to meet the Specification, the entire seam back to the previous passing test will be considered suspect. The Contractor may attempt to narrow the bracket of non-conforming seam by taking further tests. The seams shall be re-constructed until the seam meets the Specification. Any non-conforming HDPE areas will be recorded on Forms CQA12 and 13, and ultimately then on CQA5.

The Engineer shall record the implementation of any out-of-conformance procedures and shall carefully monitor the seam reconstruction and re-testing. The CQA Inspector will also observe reconstruction works and verify that the Specification is met by the reconstructed works.

11.4.1 Defects and Repairs

All discontinuities in the geomembrane (whatever their cause) shall be identified, labelled (using a marker compatible with HDPE), photographed and surveyed.

All discontinuities in the geomembrane (whatever their cause) shall be repaired by the Contractor in accordance with Section 11.4.2 to 11.4.4.

11.4.2 Point Defects

All discontinuities in the geomembrane (whatever their cause) shall be identified, labelled (using a marker compatible with HDPE), photographed and surveyed.

The area shall be prepared by cleaning the surface, flattening any protrusions carefully and grinding a 3cm by 3cm area around the defect prior to applying a layer of extrudate.

11.4.3 Large Faults

All discontinuities in the geomembrane (whatever their cause) shall be identified, labelled (using a marker compatible with HDPE), photographed and surveyed.

Large damaged areas caused by trafficking, failed welds etc. shall be repaired using either fusion or extrusion welds. The method of repair shall be agreed on site between the installation Contractor and the Engineer.

The faulted area shall be cut back to remove all imperfections and shall be overlain with a single piece of compatible geomembrane to give a minimum overlap of 100 mm for extrusion welding and 125 mm for fusion welding.

If necessary an area will be required to be removed and re-welded (fusion) with a new FML section inserted.

11.4.4 Wrinkles

An inspection shall be made of the final as-laid FML to ensure that no large wrinkles are present, prior to placement of the overlying materials. A wrinkle that requires to be repaired is defined by the fact that it could be folded over onto itself. As it is known that thermal expansion causes wrinkles, any wrinkles identified for repair shall be identified on a cold day.

The repair of wrinkles shall be kept to a minimum by the placement and rapid covering over of the FML by the overlying materials as soon as is practicably possible. Each repair shall be logged and then tested in accordance with Section 11.2.10.

11.5 As Laid Panel Placement Survey

The Surveyor will carry out a topographic survey of each seam in the FML. The drawing produced will be carefully labelled with each panel number and each seam name. The location of all destructive and non-destructive tests will also be compiled onto the FML plan.

11.6 Provisional FML Acceptance

The liner shall be provisionally accepted on the basis of field destructive tests and field non-destructive tests. Upon provisional acceptance the Engineer shall issue an acceptance certificate allowing the lining contractor to overlay protective fabric. In the event that quantitative laboratory testing reveals a defect in the works the FML will be carefully uncovered and reconstruction works will take place. The CQA Inspector will examine the provisional acceptance certificates and will cross-reference these with the testing results to verify that the FML meets the Specification.

11.7 Final FML Acceptance

Upon receipt of the destructive laboratory tests the FML will be signed off piece-meal provided that the test results conform to the Specification. A final acceptance certificate will be issued and the certificate will identify those panels and seams that have been accepted. The CQA Inspector will verify the acceptance.

11.8 Determining Engineer Compliance

The actions taken by the Engineer will be checked by the CQA Inspector to ensure error free decision making. Those elements of the construction process subjected to testing will be considered to conform to the Specification if their properties are established to meet or

exceed the requirements of the Specification. The liner will only be considered to conform if sufficient numbers of test have been undertaken.

Those elements of the process checked by visual means and those processes concerned with recording procedures will be considered to comply where the CQA Inspector has independently verified the work of the Engineer.

12 PROTECTOR GEOTEXTILE

The geotextile used shall be a non-woven high density polyethylene containing 1% active carbon UV inhibitor fabric manufactured from 99% virgin materials. Geotextiles constructed from fibres of more than one polymer will not be permitted. The geotextile shall be manufactured under factory production control guidelines set out within EN 13257. The geotextile shall be constructed by needle punching staple fibres of high density polypropylene in accordance with BS EN 10320:1999 and have CE certification.

The protector geotextile shall be tested for the following properties: Limit Values indicated on this table are typical of a protector beneath the anticipated landfill load however the Specification will have to be confirmed by cylinder testing once the source of drainage aggregate is known. The suitability of the Protector Geotextile shall be determined from a cylinder test.

Table 12-1 Protector Geotextile Specification

Property	Standard	Unit	Typical Mean Value	Allowable tolerance to 95% confidence limits
Static CBR Puncture resistance	BS EN ISO 12236	kN	19	-10%
Plunger Displacement	BS EN ISO 12236	mm	65	n/a
Tensile strength (md)	BS EN ISO 10319	kN/m	100	-10%
Tensile strength (cmd)	BS EN ISO 10319	kN/m	100	-10%
Tensile Elongation (md)	BS EN ISO 10319	%	80	+/-30%
Tensile Elongation (cmd)	BS EN ISO 10319	%	80	+/-30%
Cone Drop	BS EN 13433	mm	0	+3mm
Thickness @ 2kPa	BS EN ISO 964-1	mm	9.5	n/a

* - not suitable for conformance testing – manufacturers CE declaration and test data to be used as acceptance criteria

12.1 Proposed Material Datasheet

The Contractor shall supply all the technical information from the geotextile manufacturer, for the geotextile he wishes to use. This information shall be forwarded to the Engineer for approval, prior to any material being purchased. The protector geotextile shall meet or exceed the Specification given in Table 12-1.

The Engineer will review the candidate material data from the manufacturer/supplier and also from any testing carried out in accordance with this Specification. Upon review, if the candidate material is found to meet the Specification in all respects, the Engineer may accept the material for delivery to the works.

Acceptance as a material in no way diminishes the manufacturers/suppliers requirement to supply materials of the same characteristics. Approval as a material does not confirm acceptance for the works – this has to be demonstrated by further conformance testing upon delivery. The Engineers review of the material data provided by the manufacturer/supplier will be recorded for review by the CQA Inspector.

12.2 Manufacturers Quality Control Data

When approved, but before or upon being brought to site, the manufacturer shall provide test results for all batches of materials that will or are being delivered to the site

demonstrating conformance with the Specification. This is the Manufacturer's Quality Control data. The MQC documentation shall include the following:

a) Copies of QC certificates issued to the manufacturer by the fibre supplier, providing information on the origin, identification and production date of the fibres used to manufacture the geotextile.
b) A Specification for the geotextile which concurs with the Specification in the document, having used the appropriate test methods.
c) A full listing of the materials, which comprise the geotextile, expressed as per cent by weight of base polymer, carbon black, any other additive.
d) Data demonstrating that the quality of the fibre used to produce the geotextile meets the manufacturer's Specification.
e) QC reports undertaken by the manufacture to ratify that the geotextile produced for the project meets the Specification.
f) Certification that the protector geotextiles delivered are free of metallic fragments and contain no needles.
g) As a minimum the QC certificates provided by the manufacturer are to include the following:

- Manufacturer name
- Product name
- Roll identification Number
- Sampling Interval
- Mass per unit area
- Thickness
- CBR Puncture Resistance
- Cone Drop
- Tensile properties

12.3 Geotextile Conformance Testing

When delivered, conformance samples of the geotextile shall be obtained at a rate of 1 per 2500 m^2 delivered. These samples shall then be forwarded to the nominated laboratory for testing at a frequency of 1 test per 2500m^2 for physical characteristics and 1 test per 5000m^2 for mechanical characteristics. A strip measuring 500 mm long shall be cut from the end of each selected roll, but not including the first 1m. From this main sample, a total of 3 No. sub samples of equal size shall be obtained; one is to be retained by the Contractor, one is to be retained by the Engineer and the third shall to be sent to the nominated testing laboratory for testing. The samples shall be stored in an opaque bag in a cool, dark place and shall be clearly labelled with the roll number.

Prior to installation, conformance testing in accordance with test methods shown in Table 12-1 shall be carried out by the nominated laboratory. The results shall be submitted to the Engineer, together with the roll number and the batch or consignment numbers to which they relate. Materials not conforming to the Specification shall be re-tested and, in the event of subsequent failure, will be rejected. In the event of a subsequent pass the Engineer will require a further test (as this indicates one pass and one fail). If this subsequent test passes then the material may be approved by the Engineer, but in the event of failure, the roll shall be rejected and shall not form part of the works. Under these circumstances the rolls numbers on either side of the failed roll shall both be tested to bracket the failure. If two or more rolls within a batch fail then the entire batch will be rejected by the Engineer unless testing demonstrates that a particular roll has passed its conformance testing. Retests or

bracketing tests shall not contribute toward the conformance testing frequency. Any re-testing shall be carried out at the expense of the Contractor.

Installation of the geotextile shall not take place until results of the conformance tests have been obtained from the independent testing laboratory and the material has been approved by the Engineer for use in the permanent works.

12.4 Cylinder Test

Cylinder load testing will be completed in accordance with the EA methodology for testing protector geotextiles for their performance in specific site conditions and the results provided to NRW for approval.

12.5 Deployment

Adjacent panels of protector geotextile should overlap by a minimum of 300mm and shall be fused together. This fusion process shall use a hand held wedge welder or hot air gun placed between the overlapped fabrics. As the wedge/gun is traversed along the overlap, pressure is applied via the use of a hand held roller to bond both surfaces of the fabrics together. The Contractor shall ensure that any equipment used in this process does not inadvertently damage the fabric.

The fabric is initially to be deployed such that the centreline of the roll is aligned with every second seam in the underlying HDPE membrane in accordance with manufacturer's recommendations. Thereafter the fabric shall be placed by unrolling over the completed liner. Fabric shall not be placed until the HDPE liner has been fully inspected and signed off.

The protector fabrics may be temporarily weighted down with spots of fines, sandbags or tyres to provide wind resistance until the drainage blanket and waste advances over them. The spots should be placed by machine from the side. Machinery shall not track directly over the fabric.

When placed, the fabrics should be smooth, without creases or bumps. Any slack in the fabric should be pulled out manually. Machinery is not to be used for pulling the fabric. The fabrics shall be cut using shielded knives only. Special care and attention should be applied during the cutting process to prevent damage of the underlying HDPE. Personnel involved in the deployment of the protector fabrics shall not smoke, use inappropriate footwear or engage in any other activity that could damage the textiles in any way.

The protector fabrics shall be placed in the FML anchor trench. They shall then be rolled down the slope, being continually in contact with the underlying HDPE.

During windy conditions an adequate number of sandbags or other materials are to be available to weigh down the geotextile and prevent lift-off. The sandbags should remain in place until adequate tailings material is applied on top.

The protector fabrics shall not be seamed during periods of precipitation. Seaming shall also take place immediately after deployment to ensure that the fabric is in a dry condition during the seaming process.

The Engineer shall, during the course of the fabric placement, undertake a full topographic survey prior to the placement of any overlying materials. During the course of this survey

the Engineer shall undertake a visual examination of the textile to ensure that all identified areas have been repaired, welded down to ensure no gaps exist and that no other defects are noted.

12.6 Damage Repair

If remedial works are required which results in the textile being cut, the cut area shall be covered on reinstatement by a patch of fabric, which measures 300mm over the defect in all directions.

12.7 Protection Layer Acceptance

Once placed, a final visual inspection of the protector textiles shall be carried out and any potentially damaging objects removed. Any needles encountered during this inspection shall be reported to the CQA Inspector.

The geotextile shall be signed off by the Contractor and the Engineer.

12.8 Damage Inspection Upon Unrolling

Geotextile delivered to site will have been subjected to inspection for damage prior to storage. A more rigorous inspection for defects will be made upon unrolling on site. The installer/supplier will be required to certify the material is free of defects or damage and part of this duty is a full inspection of the sheet by the installation crew.

The Engineer will also inspect the unrolled sheet, sometimes before and sometimes after fixing in-situ. The CQA Inspector will carry out spot checks to ensure that the materials are free of damage and defects. Any anomalies will be recorded initially on Form CQA11 and then in detail on Form CQA5.

12.9 Determining Compliance

The actions of the contractors in laying the geotextile and that of the Engineer in accepting or rejecting the materials and the finished geotextile layer will be examined by the CQA Inspector to determine whether the actions leading to the decisions to incorporate materials into the works have been carried out in accordance with the Specification. The delivery and sampling of the Protector Geotextile will be recorded on Form CQA2 whilst defects or problems with regard to the placement of the Protector Geotextile will be recorded on Form CQA11 and ultimately on Form CQA5.

13 LEACHATE DRAINAGE PIPEWORK

The leachate drainage pipe will be 150mm and 225mm OD high density polyethylene pipes with a Standard Dimensional Ratio of 11. The pipes are to be perforated with a series of 12mm diameter holes which in total amount to 5% of the pipe surface area (Pattern C).

The pipe will be delivered in 6m or 12m lengths and will be jointed with either butt fusion joints or electrofusion couplers. The pipe is to be assembled on the ground surface before feeding into position within a trench cut into the drainage blanket. All joints must be completed by a suitably qualified operative, in possession of an appropriate Pipe Welders Accreditation Certificate. Whichever method is used to form the joints the welding machine will be automatic and will print a record of each weld. The records will show that the joint has been properly formed.

a) Main Spine Drain - external diameter 225mm
b) Cross Fall (Spur) Drains – external diameter 150mm

In order to evaluate the crushing risk a calculation using the ATV method has been undertaken. A static load of 318 kN/m^2 has been calculated, but the pipe crushing calculations, which are included in Appendix 3, have used an imposed load of 594kN/m^2, considerably larger than the calculated 3180kN/m^2. Even under these loads the pipe crushing calculations reveal that the pipe deflection under the load is acceptable.

13.1 Determining Conformance

The supplier should provide manufacturers certification for the physical properties of the pipework used at the site. The Engineer shall examine the certificates to determine conformance with the Specification. The supplier should provide source characterisation data on the pipe bedding and the Engineer shall review the data to determine conformance with the Specification. Delivered pipework to the project shall be recorded on Form CQA3.

13.2 Out of Conformance Procedures

Where the conformance data does not meet the requirements of the Specification, it shall be removed from site. This action shall be recorded by the Engineer. Out of conformance materials will be recorded on Form CQA5.

13.3 Determining Compliance

The Engineer shall supervise the laying of the drainage pipework and shall ensure that the joints are properly formed and that the installation process does not result in mechanical damage to the pipework.

13.4 Out-of-Compliance Procedures

In the event that the Engineer observes improper jointing or any form of mechanical damage that particular section of pipework shall be removed and the joints reconstructed. The fact shall be recorded and the records made available to the CQA Inspector for inspection. Out of compliance procedures will be recorded in Form CQA5.

14 LEACHATE DRAINAGE LAYER

The leachate drainage blinding aggregate shall be placed in a single 100mm thick layer directly onto the protector geotextile.

The grading limits are as shown in the following table:

Table 14-1 Blinding Aggregate Specification

British Standard Sieve Size (mm)	Percentage Passing (%)
63	-
40	100
31.5	98 to 100
20	80 to 99
14	20 to 70 (+/- 15)
10	0 to 20
4	0 to 5

The blinding aggregate shall be a clean granular material, possessing no more than 5% fines (silt and clay fraction). The leachate drainage aggregate material shall not include any metals, wood or fragments that could puncture or damage the liner beneath.

The leachate drainage aggregate shall be placed in a single 300mm thick layer directly onto the blinding aggregate described in Table 14-1. No leachate drainage aggregate shall be directly placed onto the protector geotextile unless 100mm of the blinding aggregate is in-situ.

The grading limits for the drainage aggregate are as shown in the following table:

Table 14-2 Drainage Aggregate Specification

British Standard Sieve Size (mm)	Percentage Passing (%)
63	98-100
40	80 to 99
31.5	20 to 70 (+/- 15)
20	0 to 20
14	-
10	0 to 5
4	-

The leachate drainage aggregate shall be a clean granular material, possessing no more than 5% fines (silt and clay fraction). The leachate drainage aggregate material shall not include any metals, wood or any other un-identified fragments.

14.1 Conformance Testing

The grading envelope of the leachate drainage aggregate to be used shall be demonstrated by at least 3 particle distribution curves per layer in accordance with BS EN 933-1 1997. At

the same frequency, the drainage aggregate shall also be tested to ensure that the aggregate has a minimum soaked ten per-cent fines value of 100 kN.

A further maximum 2% additional fine content will be considered acceptable from that shown above in order to reflect site handling.

14.2 Determining Compliance

The Engineer is to ensure that the placement method of the aggregate blinding and leachate drainage layer complies with the Specification. Delivery of the drainage aggregates is to be recorded on Forms CQA3 and CQA4 with Form CQA4 totaling quantities of aggregate delivered to the project. The conformance of the leachate drainage aggregate records shall be recorded on Form CQA14.

14.3 Out-of-Compliance Procedures

In the event that the Engineer observes improper placement or any form of mechanical damage, the underlying protector geotextile will be carefully cut using a shielded knife and pulled back to allow inspection of the underlying FML. In the event that damage to the underlying FML is noted this shall be repaired in accordance with the Specification. The fabric shall be re-laid or replaced and re-welded using filler pieces. The works will be supervised and recorded by the Engineer and the CQA Inspector will be invited to observe the works.

Out of compliance procedures will be recorded initially on Form CQA14 and then on Form CQA5.

15 LEACHATE EXTRACTION & MONITORING POINTS

The concrete pad for the leachate abstraction well will be constructed to provide an overall slab dimension of 6 metres by 3 metres to provide a target pad for retro drilling of a replacement leachate extraction well should this be required.

The well/concrete base will be surrounded with a drainage filter material , typically 20/40mm graded stone up to the top level of the drainage layer.

Two Remote Monitoring Points will be constructed to an approximate height of 2000mm during the Works and will subsequently and progressively be extended with the infilling of waste. The location and construction detail of the Monitoring Points is shown on Drawing 1575/5.

The CQA Inspector will ensure construction of the leachate control measures are undertaken in accordance with the detail shown on Drawing 1575/5 which shall include:

- Details of the over dig areas and thickening of the mineral liner
- Installation of steel reinforcing
- Dimensions of the concrete pads

15.1 Determining Conformance

The supplier should provide manufacturers certification for the physical properties of the pipework used at the site. The engineer shall examine the certificates to determine conformance with the Specification. The supplier should provide source characterisation data on the pipe bedding and the Engineer shall review the data to determine conformance with the Specification. Delivered pipework to the project shall be recorded on Form CQA3.

15.2 Out of Conformance Procedures

Where the conformance data does not meet the requirements of the Specification, it shall be removed from site. This action shall be recorded by the Engineer. Out of conformance materials will be recorded on Form CQA5.

15.3 Determining Compliance

The Engineer shall supervise the construction of the extraction and monitoring points and shall ensure that the installation process does not result in mechanical damage to the pipework or underlying lining system.

15.4 Out-of-Compliance Procedures

In the event that the Engineer observes improper jointing or any form of mechanical damage that particular section of pipework shall be removed and the joints reconstructed. The fact shall be recorded and the records made available to the CQA Inspector for inspection. Out of compliance procedures will be recorded in Form CQA5.

16 GENERAL DUTIES

16.1 Photographic Records

The Engineer shall maintain a dated photographic record of all aspects of the construction of the cell. Wherever an out-of-compliance or out-of-conformance procedure has to be invoked, photographs shall accompany that event. Photographs of specific elements of the work shall be properly labelled for future ease of identification.

16.2 Data Collation

The Engineer is responsible for collating all of the data submitted by suppliers and contractors and reported by independent laboratories. The Engineer will maintain summary databases of the information. The surveyor will be responsible for ensuring that the topographic survey company (Stafsurv) maintains a survey record of the project. The collated data will be held on file at the site offices and will be available at all times for inspection by the CQA Consultant and the Environmental Regulator.

16.3 Contractual Matters

Cory assumes all of the duties relating to contractual matters for the construction of the works.

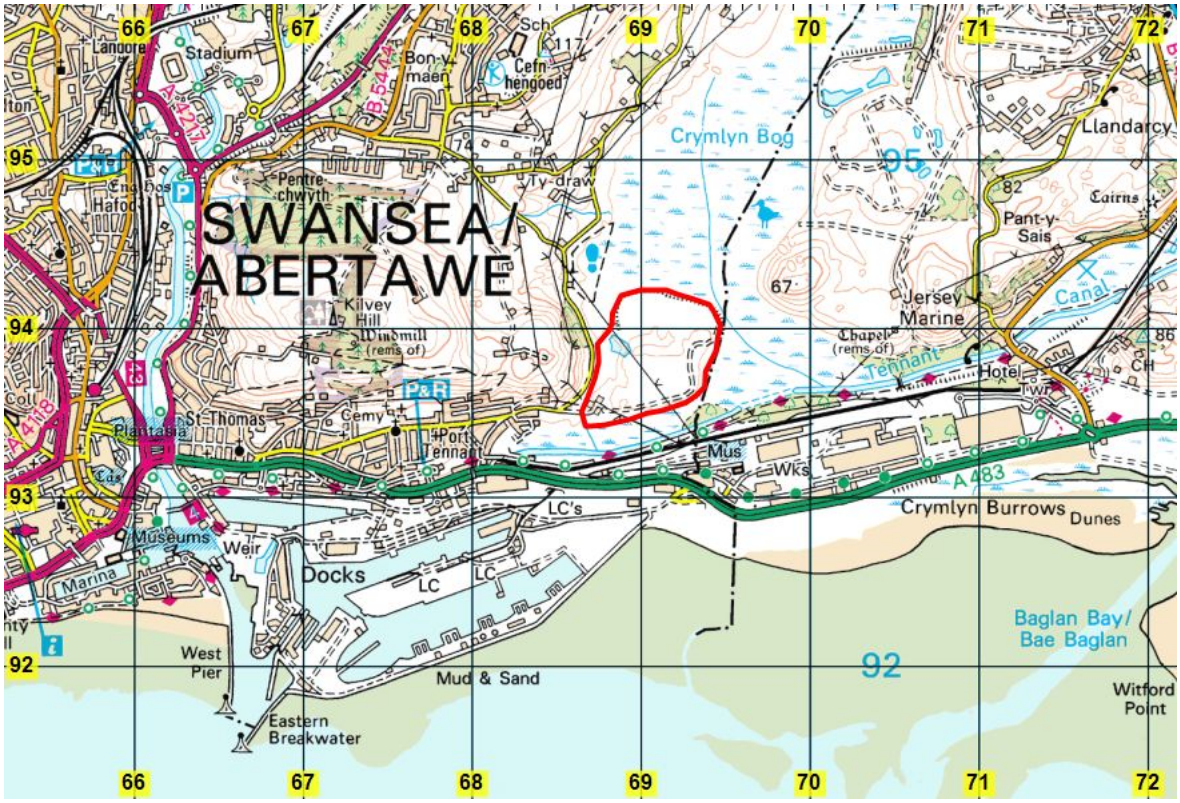
16.4 Geophysical Leak Location Survey

The client will procure a geophysical leak location survey from a suitable and competent contractor and the Engineer will ensure it is carried out in accordance with the specification. The Engineer and CQA Inspector will be present if remedial works are required to investigate any anomalies revealed by the GLLS.

16.5 Validation Report

The CQA Consultant is responsible for compiling a CQA Validation report for submission to the environmental regulator. The report shall include all construction monitoring records kept during the works together with the completed CQA forms. As built surveys to OS datum and the results of all laboratory testing will be included. The CQA Consultant will have to verify that the Engineer and Contractor have carried out the construction works in accordance with the Specification.

Drawing 1575/1 Site Location Plan



Drawing Number 1575/2

Legend

Notes

Rev	Date	Status/Ammendments

CLIENT

Cory Environmental Ltd

PROJECT

Proposed Cell 16
Tir John Landfill, Swansea

TITLE

SITE SETTING

DRAWING NUMBER			REVISION
1575/2			0
DATE	DRAWN	CHECKED	SCALE AT A3
06.16	KT		1:2500

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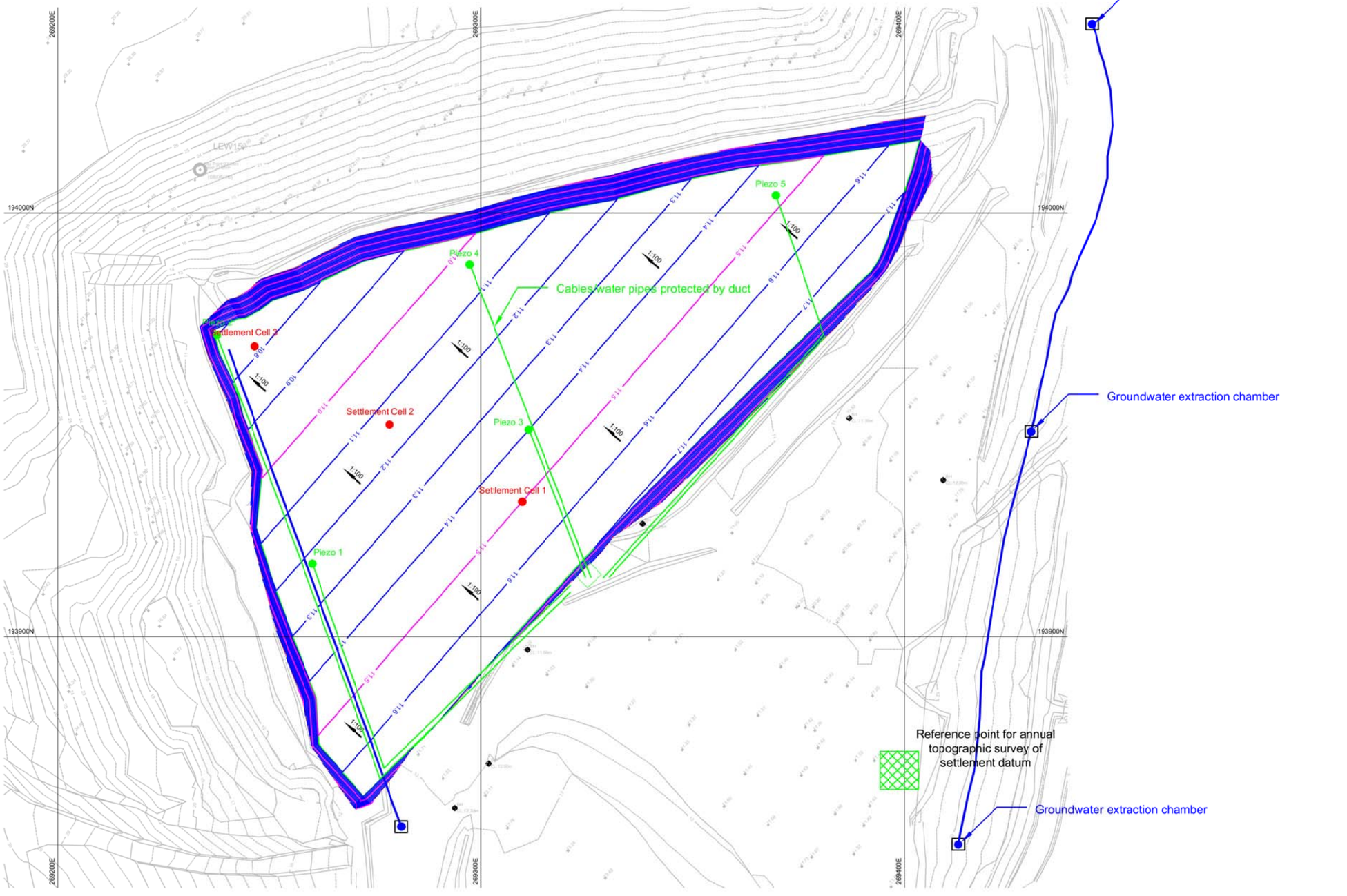
GEO TECHNOLOGY



FORMATION LEVELS

Drawing Number 1575/3

Legend

Notes

Rev	Date	Status/Ammendments

CLIENT

Cory Environmental Ltd

PROJECT

Proposed Cell 16
Tir John Landfill, Swansea

TITLE

CELL16 FORMATION LEVELS

DRAWING NUMBER	REVISION
1575/3	0

DATE	DRAWN	CHECKED	SCALE AT A3
06.17	KT		1:1000

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TOP OF CLAY LEVELS & LEACHATE CONTROL SYSTEM

Drawing Number 1575/4

Legend

Notes

Rev	Date	Status/Ammendments

CLIENT

Cory Environmental Ltd

PROJECT

Proposed Cell 16
Tir John Landfill, Swansea

TITLE

CELL16 MINERAL LINER AND LEACHATE CONTROL SYSTEM

DRAWING NUMBER			REVISION
1575/4			0
DATE	DRAWN	CHECKED	SCALE AT A3
06.17	KT		1:1000

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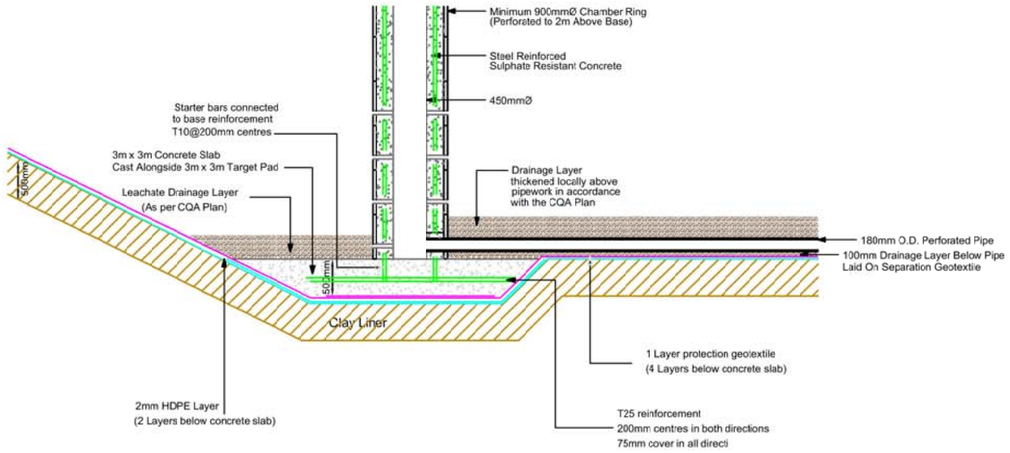
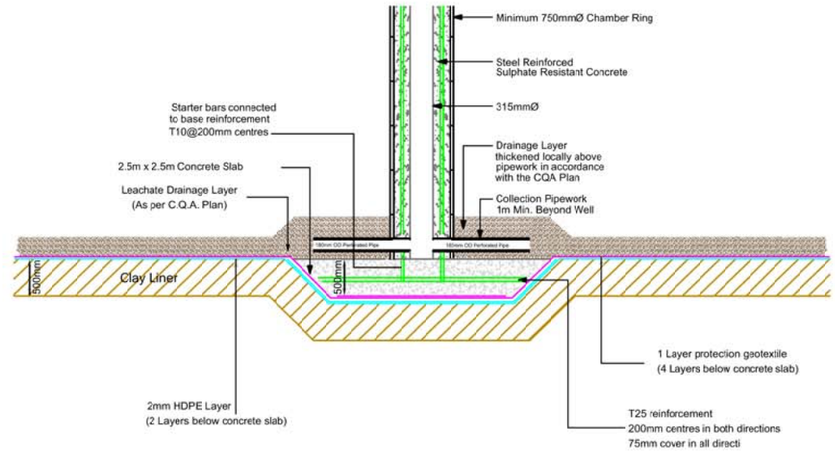
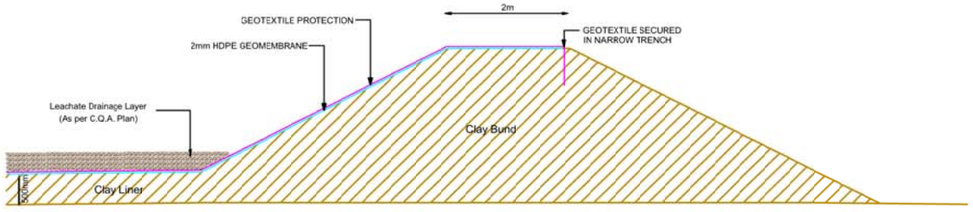


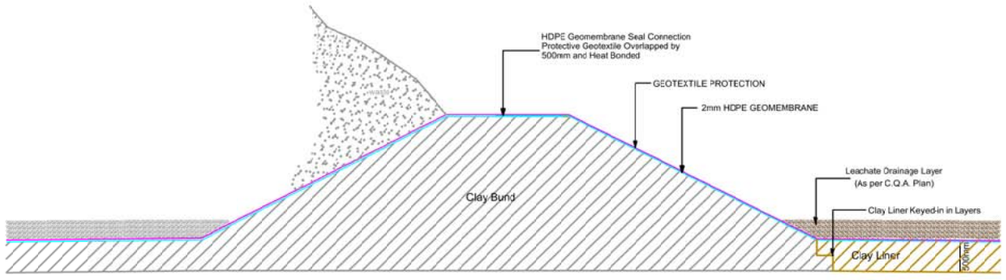
SECTION THROUGH LEACHATE EXTRACTION POINT



SECTION THROUGH LEACHATE MONITORING POINT



SECTION B-B THROUGH INTERCELL BUND



SECTION A-A THROUGH EXISTING INTERCELL BUND

Drawing Number 1575/5

Legend

Notes

Rev	Date	Status/Ammendments

CLIENT

Cory Environmental Ltd

PROJECT

Proposed Cell 16
Tir John Landfill, Swansea

TITLE

CELL16 DESIGN DETAILS

DRAWING NUMBER			REVISION
1575/5			0
DATE	DRAWN	CHECKED	SCALE AT A3
06.17	KT		NTS

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GEO TECHNOLOGY

Drawing Number 1575/6

Legend

Prominent Contour (5m)

Normal Contour (1m)

Notes

Rev	Date	Status/Ammendments
1	07.16	New PCS position

CLIENT

Cory Environmental Ltd

PROJECT

Proposed Cell 16
Tir John Landfill, Swansea

TITLE

CELL16 PROPOSED FINAL LEVELS

DRAWING NUMBER	REVISION
1575/6	0

DATE	DRAWN	CHECKED	SCALE AT A3
06.17	ET		1:700

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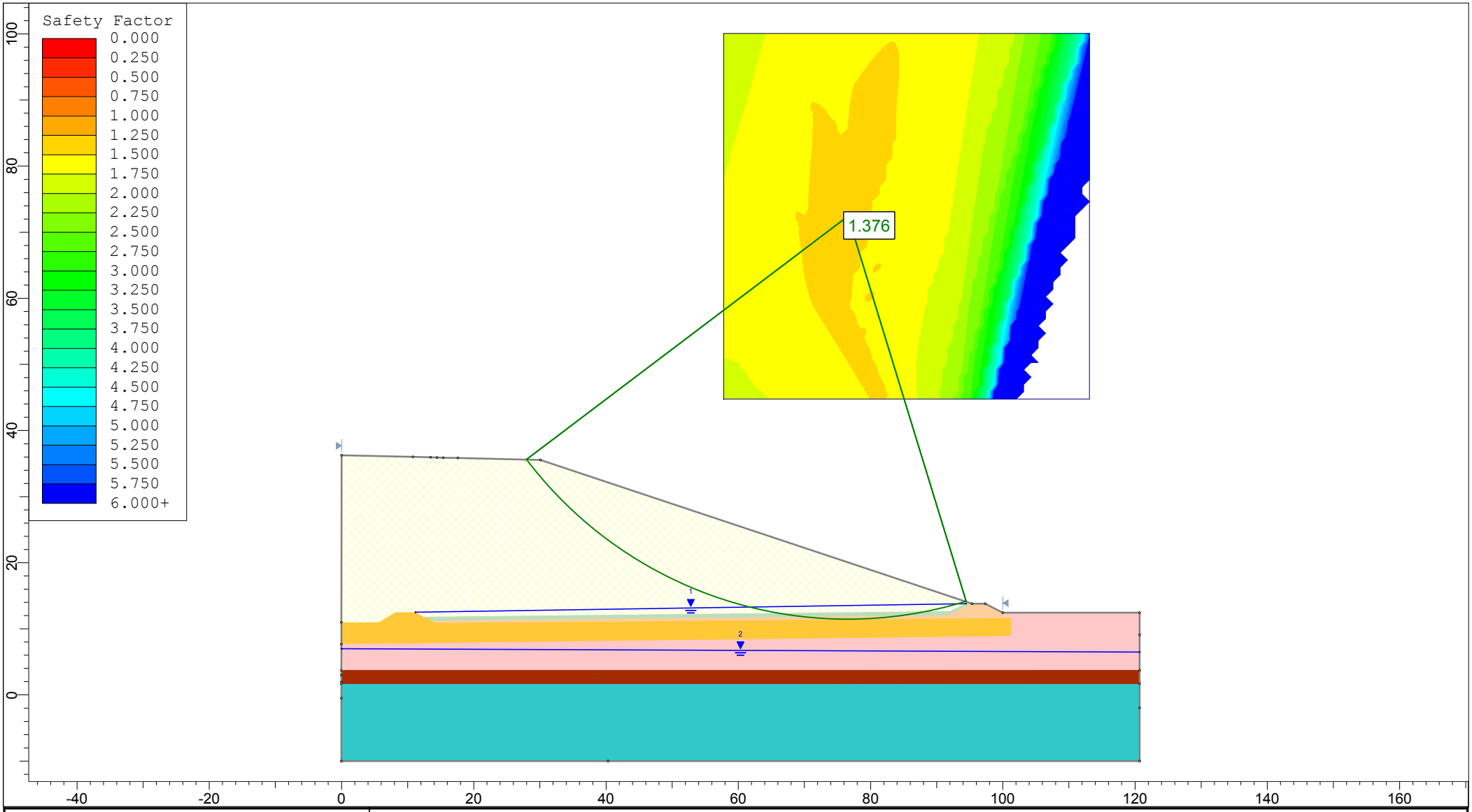
GEO TECHNOLOGY

TIR JOHN LANDFILL CELL 16 DETAILED DESIGN & CQA PLAN

Appendix 1
Stability Analysis

Report Number 1575r1v2d0617



rocscience	*Project*	Tir John Landfill		
	Analysis Description	Circular Mineral Liner Failure		
	Drawn By	Ewan Thomas	*Scale* 1:800	*Company* Geotechnology Ltd
	Date	04/11/2016, 14:36:27		*File Name* Tir John Cell 16 v4.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

Tir John Landfill

Project Summary

File Name: Tir John Cell 16 v4
Slide Modeler Version: 6.039
Project Title: Tir John Landfill
Analysis: Circular Mineral Liner Failure
Author: Ewan Thomas
Company: Geotechnology Ltd
Date Created: 04/11/2016, 14:36:27
Comments:

> A simulation using previously accepted design parameters for all strata except for the mineral liner. A new source of mineral has been proposed and this simulation has been run to determine whether this revised liner destabilises the waste mass in any way

General Settings

Units of Measurement: Metric Units
Time Units: days
Permeability Units: meters/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20

Maximum Support Properties: 20

Design Standard

Selected Type: Eurocode 7 - Design Approach 1, Combination 2

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1.3
Variable Actions: Favourable	0
Effective cohesion	1.25
Coefficient of shearing resistance	1.25
Undrained strength	1.4
Weight density	1
Shear strength (other models)	1.25
Earth resistance	1
Tensile and plate strength	1.1
Shear strength	1.1
Compressive strength	1.1
Bond strength	1.1
Seismic Coefficient	1

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 9.81 kN/m3
Advanced Groundwater Method: Excess Pore Pressure

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Waste	Drainage Stone	Mineral Liner	Compacted Fill	Historic Fill	Peat	Alluvium
Color							
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	9	20	15	20	14	15	20
Cohesion [kPa]	5	1	5	2	1	1	1
Friction Angle [deg]	25	30	19.6	25	27	25	30
Water Surface	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 2	Piezometric Line 2	Piezometric Line 2
Hu Value	1	1	1	1	1	1	1
Material Weight Causes Excess Pore Pressure	Yes						
B_bar value		0	0.1	0	0	0	0

Global Minimums

Method: bishop simplified

FS: 1.376160
Center: 76.589, 72.409
Radius: 60.990
Left Slip Surface Endpoint: 27.961, 35.597
Right Slip Surface Endpoint: 94.466, 14.097
Resisting Moment=114809 kN-m
Driving Moment=83427.5 kN-m
Total Slice Area=543.167 m2

Method: janbu simplified

FS: 1.284390
Center: 76.589, 72.409
Radius: 60.990
Left Slip Surface Endpoint: 27.961, 35.597
Right Slip Surface Endpoint: 94.466, 14.097
Resisting Horizontal Force=1702.57 kN
Driving Horizontal Force=1325.58 kN
Total Slice Area=543.167 m2

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces: 18212
Number of Invalid Surfaces: 10399

Error Codes:

Error Code -106 reported for 120 surfaces
Error Code -108 reported for 3 surfaces
Error Code -110 reported for 10276 surfaces

Method: janbu simplified

Number of Valid Surfaces: 18114
Number of Invalid Surfaces: 10497

Error Codes:

Error Code -106 reported for 120 surfaces
Error Code -108 reported for 101 surfaces
Error Code -110 reported for 10276 surfaces

Error Codes

The following errors were encountered during the computation:

-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-110 = The water table or a piezoline does not span the slip region for a given slip surface, when Water Surfaces is specified as the method of pore pressure calculation. If this error occurs, check that the water table or piezoline(s) span the appropriate soil cells.

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.37616

Slice Number	Width [m]	Weight [kN]	Base Material	Base Cohesion [kPa]	Base Friction Angle [degrees]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]
1	2.54037	34.9344	Waste	4	20.4579	4.97255	6.84302	7.6211	0	7.6211
2	2.54037	89.2564	Waste	4	20.4579	9.60858	13.223	24.7233	0	24.7233
3	2.54037	129.35	Waste	4	20.4579	13.2541	18.2398	38.1717	0	38.1717
4	2.54037	162.905	Waste	4	20.4579	16.4589	22.6501	49.994	0	49.994
5	2.54037	190.869	Waste	4	20.4579	19.2578	26.5018	60.3192	0	60.3192
6	2.54037	213.939	Waste	4	20.4579	21.6792	29.834	69.2515	0	69.2515
7	2.54037	232.644	Waste	4	20.4579	23.7462	32.6786	76.8771	0	76.8771
8	2.54037	247.393	Waste	4	20.4579	25.4779	35.0617	83.2649	0	83.2649
9	2.54037	258.513	Waste	4	20.4579	26.8895	37.0042	88.4723	0	88.4723
10	2.54037	266.264	Waste	4	20.4579	27.9933	38.5232	92.544	0	92.544
11	2.54037	270.857	Waste	4	20.4579	28.799	39.632	95.5163	0	95.5163
12	2.54037	272.465	Waste	4	20.4579	29.3143	40.3411	97.4173	0	97.4173
13	2.54037	271.228	Waste	4	20.4579	29.5445	40.658	98.2668	0	98.2668

14	2.54037	267.26	Waste	4	20.4579	29.1036	40.0512	98.1731	1.53307	96.6401
15	2.54037	260.654	Waste	4	20.4579	27.2613	37.5159	97.2355	7.39184	89.8437
16	3.16395	320.111	Drainage Stone	0.8	24.7913	28.8787	39.7417	96.897	12.5856	84.3114
17	2.662	264.531	Mineral Liner	4	15.9005	17.8636	24.5832	97.6002	25.3447	72.2555
18	2.662	251.933	Mineral Liner	4	15.9005	16.7278	23.0201	93.7166	26.9483	66.7683
19	2.662	234.668	Mineral Liner	4	15.9005	15.445	21.2548	87.9766	27.4056	60.571
20	2.662	212.757	Mineral Liner	4	15.9005	14.0128	19.2838	80.3741	26.7214	53.6527
21	2.662	186.195	Mineral Liner	4	15.9005	12.4276	17.1024	70.8893	24.8944	45.9949
22	2.662	154.947	Mineral Liner	4	15.9005	10.6847	14.7039	59.4912	21.9162	37.575
23	3.14491	132.178	Drainage Stone	0.8	24.7913	10.7413	14.7818	43.8478	13.5764	30.2714
24	3.05944	74.9585	Waste	4	20.4579	7.8297	10.7749	26.2477	8.08658	18.1611
25	3.05944	25.7585	Waste	4	20.4579	5.31071	7.30839	9.8961	1.02753	8.86857

Global Minimum Query (janbu simplified) - Safety Factor: 1.28439

Slice Number	Width [m]	Weight [kN]	Base Material	Base Cohesion [kPa]	Base Friction Angle [degrees]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]
1	2.54037	34.9344	Waste	4	20.4579	5.23406	6.72257	7.29823	0	7.29823
2	2.54037	89.2564	Waste	4	20.4579	10.1306	13.0116	24.1569	0	24.1569
3	2.54037	129.35	Waste	4	20.4579	13.9941	17.9739	37.459	0	37.459
4	2.54037	162.905	Waste	4	20.4579	17.3999	22.3483	49.185	0	49.185
5	2.54037	190.869	Waste	4	20.4579	20.3822	26.1787	59.453	0	59.453
6	2.54037	213.939	Waste	4	20.4579	22.9692	29.5014	68.3599	0	68.3599
7	2.54037	232.644	Waste	4	20.4579	25.184	32.3461	75.9857	0	75.9857
8	2.54037	247.393	Waste	4	20.4579	27.0457	34.7372	82.395	0	82.395
9	2.54037	258.513	Waste	4	20.4579	28.5693	36.6941	87.6411	0	87.6411
10	2.54037	266.264	Waste	4	20.4579	29.7673	38.2328	91.7657	0	91.7657
11	2.54037	270.857	Waste	4	20.4579	30.6493	39.3656	94.802	0	94.802
12	2.54037	272.465	Waste	4	20.4579	31.2225	40.1019	96.7758	0	96.7758

13	2.54037	271.228	Waste	4	20.4579	31.4925	40.4487	97.7054	0	97.7054
14	2.54037	267.26	Waste	4	20.4579	31.0465	39.8758	97.7029	1.53307	96.1698
15	2.54037	260.654	Waste	4	20.4579	29.1036	37.3804	96.8725	7.39184	89.4806
16	3.16395	320.111	Drainage Stone	0.8	24.7913	30.8377	39.6076	96.6063	12.5856	84.0207
17	2.662	264.531	Mineral Liner	4	15.9005	19.1125	24.5479	97.4761	25.3447	72.1314
18	2.662	251.933	Mineral Liner	4	15.9005	17.9085	23.0015	93.6513	26.9483	66.703
19	2.662	234.668	Mineral Liner	4	15.9005	16.5457	21.2511	87.9642	27.4056	60.5586
20	2.662	212.757	Mineral Liner	4	15.9005	15.0212	19.2931	80.4064	26.7214	53.685
21	2.662	186.195	Mineral Liner	4	15.9005	13.3308	17.122	70.9578	24.8944	46.0634
22	2.662	154.947	Mineral Liner	4	15.9005	11.4691	14.7308	59.5856	21.9162	37.6694
23	3.14491	132.178	Drainage Stone	0.8	24.7913	11.5586	14.8457	43.9864	13.5764	30.41
24	3.05944	74.9585	Waste	4	20.4579	8.42795	10.8248	26.3813	8.08658	18.2947
25	3.05944	25.7585	Waste	4	20.4579	5.72354	7.35126	10.011	1.02753	8.98351

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.37616

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Interslice Normal Force [kN]	Interslice Shear Force [kN]	Interslice Force Angle [degrees]
1	27.961	35.597	0	0	0
2	30.5014	32.4623	11.2685	0	0
3	33.0417	29.7072	54.9962	0	0
4	35.5821	27.2621	114.689	0	0
5	38.1225	25.0789	182.059	0	0
6	40.6628	23.1228	251.166	0	0
7	43.2032	21.3678	317.68	0	0
8	45.7436	19.7936	378.424	0	0

9	48.2839	18.3846	431.084	0	0
10	50.8243	17.1279	474.012	0	0
11	53.3647	16.0135	506.09	0	0
12	55.905	15.0331	526.639	0	0
13	58.4454	14.1799	535.353	0	0
14	60.9858	13.4483	532.251	0	0
15	63.5261	12.834	518.694	0	0
16	66.0665	12.3332	498.191	0	0
17	69.2304	11.8642	452.347	0	0
18	71.8924	11.5997	430.645	0	0
19	74.5544	11.4526	399.945	0	0
20	77.2164	11.4219	361.568	0	0
21	79.8784	11.5074	317.423	0	0
22	82.5404	11.7097	270.029	0	0
23	85.2024	12.0299	222.561	0	0
24	88.3473	12.5628	165.443	0	0
25	91.4068	13.246	123.577	0	0
26	94.4662	14.0975	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 1.28439

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Interslice Normal Force [kN]	Interslice Shear Force [kN]	Interslice Force Angle [degrees]
1	27.961	35.597	0	0	0
2	30.5014	32.4623	9.59169	0	0
3	33.0417	29.7072	50.4319	0	0
4	35.5821	27.2621	106.501	0	0
5	38.1225	25.0789	169.713	0	0
6	40.6628	23.1228	234.269	0	0

7	43.2032	21.3678	295.939	0	0
8	45.7436	19.7936	351.626	0	0
9	48.2839	18.3846	399.077	0	0
10	50.8243	17.1279	436.691	0	0
11	53.3647	16.0135	463.393	0	0
12	55.905	15.0331	478.54	0	0
13	58.4454	14.1799	481.858	0	0
14	60.9858	13.4483	473.395	0	0
15	63.5261	12.834	454.612	0	0
16	66.0665	12.3332	429.246	0	0
17	69.2304	11.8642	377.066	0	0
18	71.8924	11.5997	352.006	0	0
19	74.5544	11.4526	318.152	0	0
20	77.2164	11.4219	276.845	0	0
21	79.8784	11.5074	230.012	0	0
22	82.5404	11.7097	180.199	0	0
23	85.2024	12.0299	130.612	0	0
24	88.3473	12.5628	70.85	0	0
25	91.4068	13.246	27.0616	0	0
26	94.4662	14.0975	0	0	0

List Of Coordinates

Piezoline

X	Y
11.187	12.5
94.442	13.8

Piezoline

X	Y
0	7
120.665	6.5

External Boundary

X	Y
-0.0119143	-10
40.3098	-10
120.665	-10
120.665	-1.942
120.665	1.719
120.665	3.719
120.665	9.08
120.665	12.4451
100	12.4451
97.36	13.8
95.359	13.8
30.093	35.548
17.605	35.835
15.373	35.886
14.437	35.9305
13.447	35.935
10.81	36
9.4369e-016	36.266
-0.0105266	10.991

-0.0119143	7.659
-0.0119143	3.719
-0.0119143	2.991
-0.0119143	1.932
-0.0119143	1.719
-0.0119143	-0.5

Material Boundary

X	Y
14.1865	10.8649
14.187	9.948

Material Boundary

X	Y
14.187	7.814
14.187	9.948

Material Boundary

X	Y
14.1865	10.8649
14.599	10.814
101.222	11.581

Material Boundary

X	Y
13.402	11.2849
91.958	12.1
95.359	13.8

Material Boundary

X	Y
13.402	11.2849
12.4836	11.7811
91.958	12.6
94.442	13.8
95.359	13.8

Material Boundary

X	Y
14.187	7.814
101.222	8.84883

Material Boundary

X	Y
-0.0119143	1.719
120.665	1.719

Material Boundary

X	Y

-0.0119143	3.719
120.665	3.719

Material Boundary

X	Y
101.222	11.581
101.222	8.84883
120.665	9.08

Material Boundary

X	Y
100	12.4451
101.222	11.581

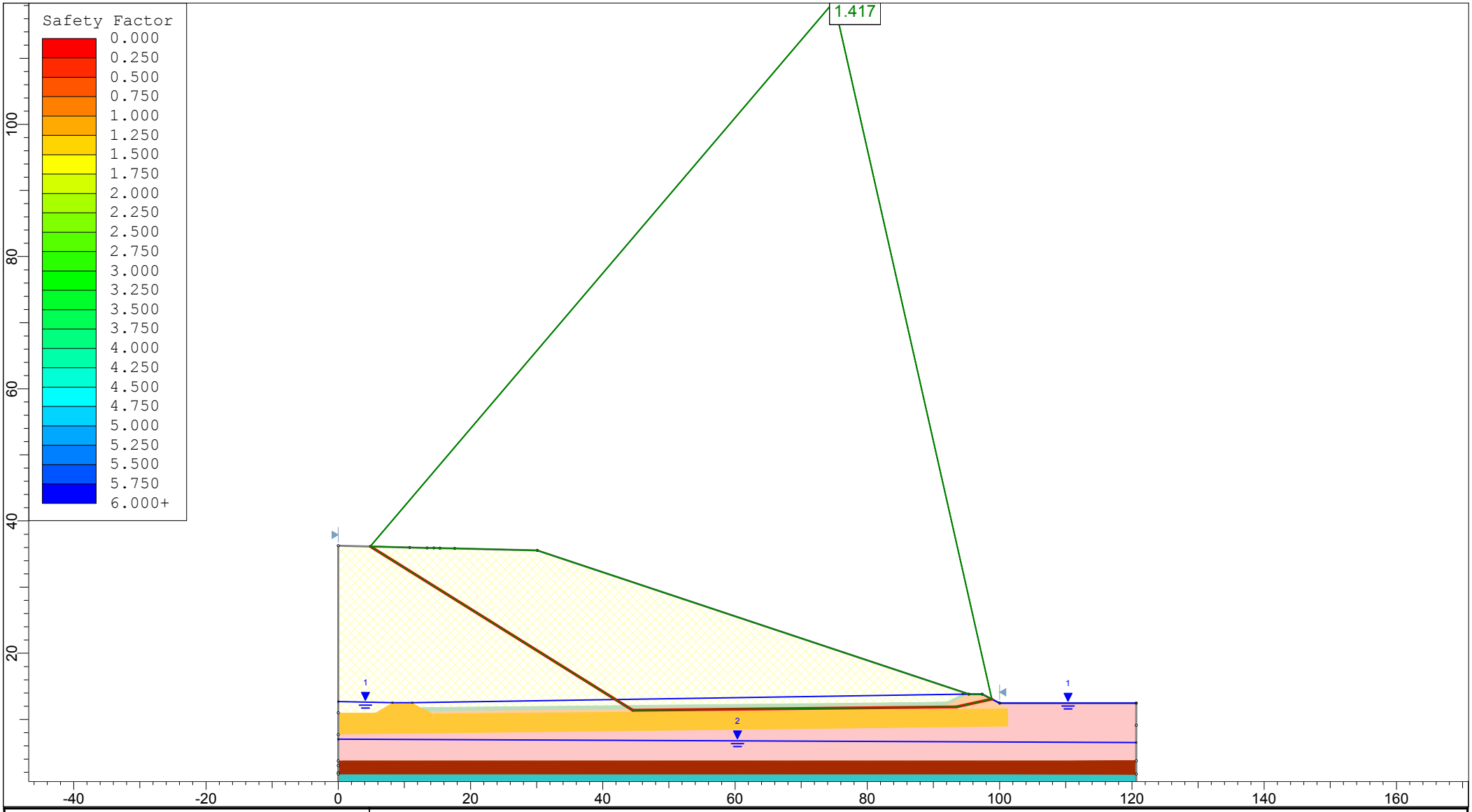
Material Boundary

X	Y
-0.0105266	10.991
5.619	10.991
8.187	12.5
11.187	12.5
12.4836	11.7811
12.72	11.65
13.402	11.2849
14.1865	10.8649

Material Boundary

X	Y
-0.0119143	7.659
14.187	7.814
14.1865	10.8649

SLIDEINTERPRET 6.039	*Project*	Tir John Landfill	
	Analysis Description	Circular Mineral Liner Failure	
	Drawn By Ewan Thomas	*Scale*	*Company* Geotechnology Ltd
	Date 04/11/2016, 14:36:27		*File Name* Tir John Cell 16 v4.slim



SLIDEINTERPRET 6.039	*Project*	Tir John Landfill Site		
	Analysis Description	Non Circular Mineral Liner Failure		
	Drawn By	Ewan Thomas	*Scale* 1:800	*Company* Geotechnology Ltd
	Date	04/11/2016, 14:36:27		*File Name* Tir John Cell 16 v4 NC.slim

Slide Analysis Information

Tir John Landfill Site

Project Summary

File Name: Tir John Cell 16 v4 NC
Slide Modeler Version: 6.039
Project Title: Tir John Landfill Site
Analysis: Non Circular Mineral Liner Failure
Author: Ewan Thomas
Company: Geotechnology Ltd
Date Created: 04/11/2016, 14:36:27
Comments:

A simulation using previously accepted design parameters for all strata except for the mineral liner. A new source of mineral has been proposed and this simulation has been run to determine whether this revised liner destabilises the waste mass in any way

General Settings

Units of Measurement: Metric Units
Time Units: days
Permeability Units: meters/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20

Maximum Support Properties: 20

Design Standard

Selected Type: Eurocode 7 - Design Approach 1, Combination 2

Type	Partial Factor
Permanent Actions: Unfavourable	1
Permanent Actions: Favourable	1
Variable Actions: Unfavourable	1.3
Variable Actions: Favourable	0
Effective cohesion	1.25
Coefficient of shearing resistance	1.25
Undrained strength	1.4
Weight density	1
Shear strength (other models)	1.25
Earth resistance	1
Tensile and plate strength	1.1
Shear strength	1.1
Compressive strength	1.1
Bond strength	1.1
Seismic Coefficient	1

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 9.81 kN/m3
Advanced Groundwater Method: Excess Pore Pressure

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 135
Left Projection Angle (End Angle): 135
Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Waste	Drainage Stone	Mineral Liner	Compacted Fill	Historic Fill	Peat	Alluvium
Color							
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [kN/m3]	9	20	15	20	14	15	20
Cohesion [kPa]	5	1	5	2	1	1	1
Friction Angle [deg]	25	30	19.6	25	27	25	30
Water Surface	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 2	Piezometric Line 2	Piezometric Line 2
Hu Value	1	1	1	1	1	1	1
Material Weight Causes Excess Pore Pressure	Yes						
B_bar value		0	0.1	0	0	0	0

Global Minimums

Method: bishop simplified

FS: 1.416790
Axis Location: 74.935, 118.582
Left Slip Surface Endpoint: 4.842, 36.147
Right Slip Surface Endpoint: 98.828, 13.047
Resisting Moment=319723 kN-m
Driving Moment=225667 kN-m
Total Slice Area=983.82 m2

Method: janbu simplified

FS: 1.364030
Axis Location: 74.935, 118.582
Left Slip Surface Endpoint: 4.842, 36.147
Right Slip Surface Endpoint: 98.828, 13.047
Resisting Horizontal Force=2729.13 kN
Driving Horizontal Force=2000.79 kN
Total Slice Area=983.82 m2

Global Minimum Coordinates

Method: bishop simplified

X	Y
4.84204	36.1469
44.515	11.374
93.415	11.89
98.8276	13.0468

Method: janbu simplified

X	Y
4.84204	36.1469
44.515	11.374
93.415	11.89
98.8276	13.0468

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces: 1
Number of Invalid Surfaces: 0

Method: janbu simplified

Number of Valid Surfaces: 1
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.41679

Slice Number	Width [m]	Weight [kN]	Base Material	Base Cohesion [kPa]	Base Friction Angle [degrees]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]
1	3.85116	40.0329	Waste	4	20.4579	4.77536	6.76568	7.41378	0	7.41378
2	3.85116	120.098	Waste	4	20.4579	9.47662	13.4264	25.2686	0	25.2686
3	3.85116	200.32	Waste	4	20.4579	14.1871	20.1001	43.1586	0	43.1586
4	3.85116	280.346	Waste	4	20.4579	18.8861	26.7576	61.0047	0	61.0047
5	3.85116	360.629	Waste	4	20.4579	23.6001	33.4364	78.9082	0	78.9082
6	3.85116	440.912	Waste	4	20.4579	28.3141	40.1152	96.8116	0	96.8116
7	3.85116	517.126	Waste	4	20.4579	32.7893	46.4555	113.808	0	113.808
8	3.85116	562.414	Waste	4	20.4579	35.4485	50.2231	123.907	0	123.907
9	3.85116	601.285	Waste	4	20.4579	37.7309	53.4568	132.576	0	132.576
10	3.85116	640.156	Waste	4	20.4579	40.0134	56.6906	141.244	0	141.244
11	0.793167	138.867	Drainage Stone	0.8	24.7913	44.8196	63.4999	147.099	11.3494	135.749

12	0.368183	66.2991	Mineral Liner	4	15.9005	28.9922	41.0758	161.971	31.8203	130.151
13	4.075	712.908	Mineral Liner	4	15.9005	31.5533	44.7044	175.28	32.3905	142.889
14	4.075	661.501	Mineral Liner	4	15.9005	29.2245	41.405	162.64	31.333	131.307
15	4.075	610.093	Mineral Liner	4	15.9005	26.8957	38.1055	150	30.2755	119.724
16	4.075	558.685	Mineral Liner	4	15.9005	24.5668	34.806	137.36	29.218	108.142
17	4.075	507.277	Mineral Liner	4	15.9005	22.238	31.5066	124.72	28.1605	96.5592
18	4.075	455.869	Mineral Liner	4	15.9005	19.9092	28.2071	112.08	27.103	84.9769
19	4.075	404.462	Mineral Liner	4	15.9005	17.5803	24.9076	99.4399	26.0455	73.3944
20	4.075	353.054	Mineral Liner	4	15.9005	15.2515	21.6082	86.7998	24.988	61.8118
21	4.075	301.646	Mineral Liner	4	15.9005	12.9227	18.3087	74.1598	23.9305	50.2293
22	4.075	250.238	Mineral Liner	4	15.9005	10.5938	15.0092	61.5198	22.873	38.6468
23	4.075	198.83	Mineral Liner	4	15.9005	8.26499	11.7098	48.88	21.8155	27.0645
24	4.075	150.345	Mineral Liner	4	15.9005	6.10299	8.64665	36.9589	20.6472	16.3117
25	5.41262	107.409	Mineral Liner	4	15.9005	4.34376	6.15419	20.7722	13.2102	7.56199

Global Minimum Query (janbu simplified) - Safety Factor: 1.36403

Slice Number	Width [m]	Weight [kN]	Base Material	Base Cohesion [kPa]	Base Friction Angle [degrees]	Shear Stress [kPa]	Shear Strength [kPa]	Base Normal Stress [kPa]	Pore Pressure [kPa]	Effective Normal Stress [kPa]
1	3.85116	40.0329	Waste	4	20.4579	4.93387	6.72995	7.31799	0	7.31799
2	3.85116	120.098	Waste	4	20.4579	9.79118	13.3555	25.0785	0	25.0785
3	3.85116	200.32	Waste	4	20.4579	14.658	19.9939	42.874	0	42.874
4	3.85116	280.346	Waste	4	20.4579	19.5129	26.6162	60.6259	0	60.6259
5	3.85116	360.629	Waste	4	20.4579	24.3835	33.2598	78.4349	0	78.4349
6	3.85116	440.912	Waste	4	20.4579	29.254	39.9033	96.2438	0	96.2438
7	3.85116	517.126	Waste	4	20.4579	33.8777	46.2102	113.15	0	113.15
8	3.85116	562.414	Waste	4	20.4579	36.6251	49.9578	123.196	0	123.196
9	3.85116	601.285	Waste	4	20.4579	38.9834	53.1745	131.819	0	131.819
10	3.85116	640.156	Waste	4	20.4579	41.3415	56.3911	140.441	0	140.441

11	0.793167	138.867	Drainage Stone	0.8	24.7913	46.2589	63.0985	146.229	11.3494	134.88
12	0.368183	66.2991	Mineral Liner	4	15.9005	29.9878	40.9042	161.369	31.8203	129.549
13	4.075	712.908	Mineral Liner	4	15.9005	32.7764	44.708	175.292	32.3905	142.902
14	4.075	661.501	Mineral Liner	4	15.9005	30.3573	41.4083	162.651	31.333	131.318
15	4.075	610.093	Mineral Liner	4	15.9005	27.9382	38.1086	150.011	30.2755	119.735
16	4.075	558.685	Mineral Liner	4	15.9005	25.5191	34.8088	137.37	29.218	108.152
17	4.075	507.277	Mineral Liner	4	15.9005	23.1	31.5091	124.729	28.1605	96.5683
18	4.075	455.869	Mineral Liner	4	15.9005	20.6809	28.2094	112.088	27.103	84.9847
19	4.075	404.462	Mineral Liner	4	15.9005	18.2618	24.9096	99.4467	26.0455	73.4012
20	4.075	353.054	Mineral Liner	4	15.9005	15.8427	21.6099	86.806	24.988	61.818
21	4.075	301.646	Mineral Liner	4	15.9005	13.4236	18.3102	74.165	23.9305	50.2345
22	4.075	250.238	Mineral Liner	4	15.9005	11.0045	15.0104	61.5242	22.873	38.6512
23	4.075	198.83	Mineral Liner	4	15.9005	8.58536	11.7107	48.8832	21.8155	27.0677
24	4.075	150.345	Mineral Liner	4	15.9005	6.33955	8.64734	36.9614	20.6472	16.3142
25	5.41262	107.409	Mineral Liner	4	15.9005	4.5194	6.1646	20.8089	13.2102	7.59867

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.41679

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Interslice Normal Force [kN]	Interslice Shear Force [kN]	Interslice Force Angle [degrees]
1	4.84204	36.1469	0	0	0
2	8.6932	33.7421	-0.558374	0	0
3	12.5444	31.3373	23.7186	0	0
4	16.3955	28.9326	72.8796	0	0
5	20.2467	26.5278	146.864	0	0
6	24.0978	24.123	245.751	0	0

7	27.949	21.7182	369.542	0	0
8	31.8002	19.3135	516.973	0	0
9	35.6513	16.9087	678.452	0	0
10	39.5025	14.5039	851.988	0	0
11	43.3537	12.0992	1037.58	0	0
12	44.1468	11.6039	1074.89	0	0
13	44.515	11.374	1101.46	0	0
14	48.59	11.417	965.37	0	0
15	52.665	11.46	839.312	0	0
16	56.74	11.503	723.285	0	0
17	60.815	11.546	617.29	0	0
18	64.89	11.589	521.326	0	0
19	68.965	11.632	435.394	0	0
20	73.04	11.675	359.494	0	0
21	77.115	11.718	293.625	0	0
22	81.19	11.761	237.787	0	0
23	85.265	11.804	191.981	0	0
24	89.34	11.847	156.206	0	0
25	93.415	11.89	129.753	0	0
26	98.8276	13.0468	0	0	0

Global Minimum Query (janbu simplified) - Safety Factor: 1.36403

Slice Number	X coordinate [m]	Y coordinate - Bottom [m]	Interslice Normal Force [kN]	Interslice Shear Force [kN]	Interslice Force Angle [degrees]
1	4.84204	36.1469	0	0	0
2	8.6932	33.7421	-1.37954	0	0
3	12.5444	31.3373	21.2679	0	0
4	16.3955	28.9326	67.9893	0	0

5	20.2467	26.5278	138.726	0	0
6	24.0978	24.123	233.555	0	0
7	27.949	21.7182	352.477	0	0
8	31.8002	19.3135	494.269	0	0
9	35.6513	16.9087	649.652	0	0
10	39.5025	14.5039	816.701	0	0
11	43.3537	12.0992	995.414	0	0
12	44.1468	11.6039	1031.19	0	0
13	44.515	11.374	1057.26	0	0
14	48.59	11.417	916.328	0	0
15	52.665	11.46	785.781	0	0
16	56.74	11.503	665.623	0	0
17	60.815	11.546	555.855	0	0
18	64.89	11.589	456.476	0	0
19	68.965	11.632	367.486	0	0
20	73.04	11.675	288.885	0	0
21	77.115	11.718	220.673	0	0
22	81.19	11.761	162.851	0	0
23	85.265	11.804	115.418	0	0
24	89.34	11.847	78.3738	0	0
25	93.415	11.89	50.9827	0	0
26	98.8276	13.0468	0	0	0

List Of Coordinates

Piezoline

X	Y

0	7
120.665	6.5

Piezoline

X	Y
-0.00982319	12.6798
8.187	12.5
11.187	12.5
94.442	13.8
95.359	13.8
97.36	13.8
98.8276	13.0468
100	12.4451
120.665	12.4451

Non-Circular Failure Surface

X	Y
4.84204	36.1469
44.515	11.374
93.415	11.89
98.8276	13.0468

External Boundary

X	Y
-0.0119143	-10
40.3098	-10

120.665	-10
120.665	-1.942
120.665	1.719
120.665	3.719
120.665	9.08
120.665	12.4451
100	12.4451
97.36	13.8
95.359	13.8
30.093	35.548
17.605	35.835
15.373	35.886
14.437	35.9305
13.447	35.935
10.81	36
9.4369e-016	36.266
-0.0105266	10.991
-0.0119143	7.659
-0.0119143	3.719
-0.0119143	2.991
-0.0119143	1.932
-0.0119143	1.719
-0.0119143	-0.5

Material Boundary

X	Y
14.1865	10.8649

14.187	9.948

Material Boundary

X	Y
14.187	7.814
14.187	9.948

Material Boundary

X	Y
14.1865	10.8649
14.599	10.814
101.222	11.581

Material Boundary

X	Y
13.402	11.2849
91.958	12.1
95.359	13.8

Material Boundary

X	Y
13.402	11.2849
12.4836	11.7811
91.958	12.6
94.442	13.8

95.359	13.8

Material Boundary

X	Y
14.187	7.814
101.222	8.84883

Material Boundary

X	Y
-0.0119143	1.719
120.665	1.719

Material Boundary

X	Y
-0.0119143	3.719
120.665	3.719

Material Boundary

X	Y
101.222	11.581
101.222	8.84883
120.665	9.08

Material Boundary

X	Y
100	12.4451
101.222	11.581

Material Boundary

X	Y
-0.0105266	10.991
5.619	10.991
8.187	12.5
11.187	12.5
12.4836	11.7811
12.72	11.65
13.402	11.2849
14.1865	10.8649

Material Boundary

X	Y
-0.0119143	7.659
14.187	7.814
14.1865	10.8649

TIR JOHN LANDFILL
CELL 16 DETAILED DESIGN & CQA PLAN

Appendix 2
Source Material Laboratory Test Results

Report Number 1575r1v2d0617

Site:- Tir John **Job Manager:** **SUMMARY OF TEST RESULTS**

Contract: Dyfan Road Source Clay **CLAY FILL**

Receipt Number	Site Sample Ref	Date	Grid Reference (chainage)	Location	Organic Content	M.C. %	Dry Density mg/m3	Air Voids %	Atterberg Limits PL	Atterberg Limits LL	Atterberg Limits PI	Particle Density %	Clay Content %	Compaction 2.5kg O.M.C %	Compaction 2.5kg M.D.D mg/m3	Permeability m/s	Shear Strength Vane kPa	Shear Strength Triaxial kPa
S58645	TP1/S1	31/05/2016		TP1/S1		35.8			28	77	49	2.68						
"	TP1/S2	"		TP1/S2									66.7					
"	TP1/S3	"		TP1/S3	1.1													
"	TP1/S4	"		TP1/S4										30	1.37			
"	TP1/S5	"		TP1/S5													28%mc	
"	"	"		"													30%mc	
"	"	"		"													32%mc	
"	TP1/S6	"		TP1/S6												1.1x10-10		
"	TP1/S7	"		TP1/S7	1.1													
"	TP2/S1	"		TP2/S1		35.5			28	74	46	2.67						
"	TP2/S2	"		TP2/S2									53.8					
"	TP2/S3	"		TP2/S3	2.0													
"	TP2/S4	"		TP2/S4														CUT
"	TP2/S5	"		TP2/S5												1.3x10-10		
"	TP2/S6	"		TP2/S6												1.0x10-10		
"	TP3/S1	"		TP3/S1		33.8			27	68	41	2.68						
"	TP3/S2	"		TP3/S2									56.2					
"	TP3/S3	"		TP3/S3	1.3													
"	TP3/S4	"		TP3/S4													28%mc	
"	"	"		"													30%mc	
"	"	"		"													32%mc	
"	TP3/S5	"		TP3/S5												5.8x10-11		
"	TP3/S6	"		TP3/S6												9.2x10-11		
"	TP3/S7	"		TP3/S7	2.2													
"	TP4/S1	"		TP4/S1		35.1			29	73	44	2.70						
"	TP4/S2	"		TP4/S2									62.7					
"	TP4/S3	"		TP4/S3	1.2													
"	TP4/S4	"		TP4/S4														CUT
"	TP4/S5	"		TP4/S5												1.1x10-10		
"	TP4/S6	"		TP4/S6												1.5x10-10		
"	TP5/S1	"		TP5/S1		35.1			28	74	46	2.69						
"	TP5/S2	"		TP5/S2									58.8					
"	TP5/S3	"		TP5/S3	1.4													
"	TP5/S4	"		TP5/S4													28%mc	
"	"	"		"													30%mc	
"	"	"		"													32%mc	
"	TP5/S5	"		TP5/S5												8.3x10-11		
"	TP5/S6	"		TP5/S6												6.8x10-11		

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467413

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Dry Density and Moisture Content Relationship of soil passing 20mm sieve **2.5kg Rammer Method in accordance with BS 1377: 4: 1990 Clause 3.3** and the in-situ vane strength of weak intact cohesive soils in accordance with **BS 1377: Part 9: 1990: clause 4.4**

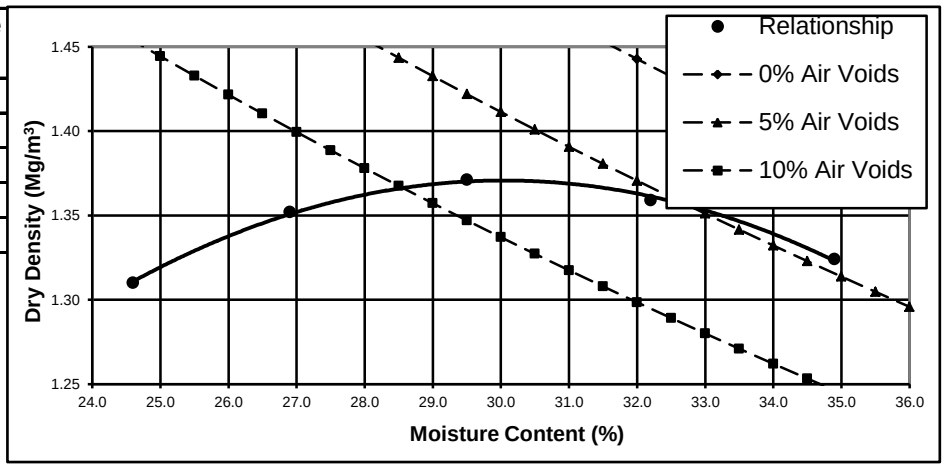
SAMPLE DETAILS:

Certificate of sampling received	**No**	Name of Source:	**Dyfan Road, Barry**
Laboratory Ref. No:	**S58645**	Method of Sampling:	**Disturbed Bulk Sample**
Client Ref. :	**TP1/S4**	Sampled By:	**Client**
Date and Time of Sampling:	**31/05/2016**		
Date of Receipt at Lab:	**01/06/2016**		
Date of Start of Test:	**10/06/2016**		
Sampling Location:	**TP1/S4**		
Soil Description:	**Brown silty CLAY**		

RESULTS:

Were any unrepresentative lumps present?	**No**
Sample Preparation Procedure:	**3.2.4.1**
Sample Preparation Method:	**Single**
Particle Density:	**2.68Mg/m3 (Found)**
Amount of sample retained on 37.5mm test sieve:	**0 %**
Amount of sample retained on 20mm test sieve:	**0 %**

Moisture Content (%)	Dry Density Mg/m^3	Shear Vane (kPa)
24.6	1.31	
26.9	1.35	
29.5	1.37	
32.2	1.36	
34.9	1.32	
Optimum Moisture Content (%)	**Maximum Dry Density Mg/m^3**	
30	1.37	



Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by:
Eric Goulden
Technical Manager

CQA International Ltd
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 26th July 2016
Test Report No: STR 469695

Contract: Tir John Landfill – Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine Consolidated Undrained Triaxial Test with Pore Pressure Measurement in accordance with BS1377: Part 8 : Clause 7 : 1990

SAMPLE DETAILS:

Certificate of Sampling Received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S4**
Date and Time of Sampling:	**31/05/2015**
Date of Receipt at Lab:	**01/06/2015**
Sampling Location:	**TP2/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Type of Sample:	**Disturbed**
Were any unrepresentative lumps present?	**None**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.

E. N. Jones – Soils Laboratory Manager

Effective Stress Triaxial Compression

Consolidated Undrained

Summary Report

Sample Details

sketch showing specimen location in original sample

Depth	-		
Description	Brown CLAY.		
Type	Remoulded using 2.5kg effort at 30% moisture content.		
Initial Length	L_0	(mm)	205.0
Initial Diameter	D_0	(mm)	101.0
Initial Weight	W_0	(gr)	2995.0
Initial Bulk Density	ρ_0	(Mg/m3)	1.82
Particle Density	ρ_s	(Mg/m3)	2.65

Initial Conditions			Stage 1	2	3	4
Initial Cell Pressure	σ_{3i}	(kPa)	649	750	850	
Initial Back Pressure	U_{bi}	(kPa)	550	550	550	
Membrane Thickness	m_b	(mm)	0.400			
Displacement Input	L_{IP}	(mm)	CH 2			
Load Input	N_{IP}	(N)	CH 4			
Pore Water Pressure Input	u_{pwp}	(kPa)	CH 3			
Sample Volume	V	(cm3)	CH 2			
Initial Moisture	ω_i%	(%)	29			
Initial Dry Density	ρ_{di}	(Mg/m3)	1.42			
Initial Voids Ratio	e_i	.	0.870			
Initial Degree of Saturation	S_i	(%)	87			
B Value	B	.	0.96			

Final Conditions						
Final Moisture	ω_f%	(%)	29			
Final Dry Density	ρ_{df}	(Mg/m3)	1.50			
Final Voids Ratio	e_f	.	0.770			
Final Degree of Saturation	S_f	(%)	98.6			
			Stage 1	2	3	4
Failure Criteria		.	Max. Dev. Stress	Max. Dev. Stress	Max. Dev. Stress	
Strain At Failure	ε%	(%)	6.59	9.46	12.94	
Stress At Failure	$(\sigma_1 - \sigma_3)$	(kPa)	89.4	140.7	199.7	
Minor Stress At Failure	σ_3'	(kPa)	42.0	82.0	149.0	
Major Stress At Failure	σ_1'	(kPa)	131.4	222.7	348.7	
Principal Stress At Failure	σ_1'/σ_3'		3.128	2.716	2.340	

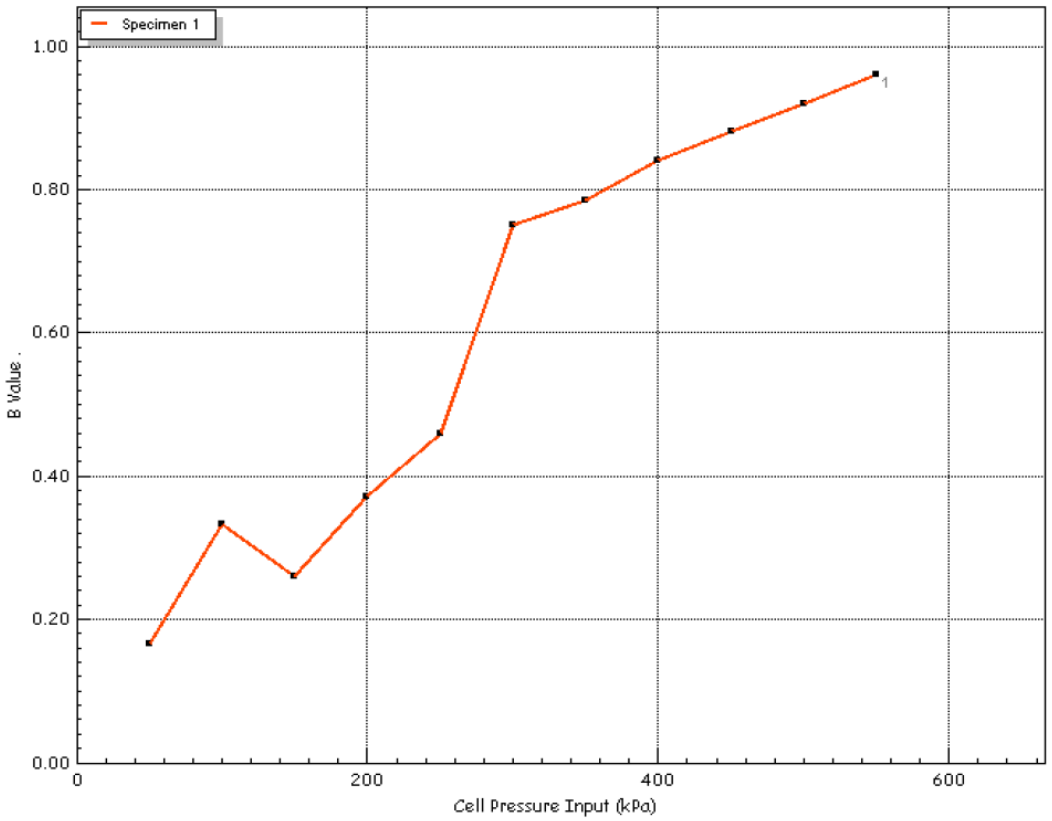
Notes

Effective Stress Triaxial Compression

Consolidated Undrained

Saturation Plots

			1
Saturation Method			Stepped
Cell Pressure Input	σ	(kPa)	550
Pore Water Pressure Input	u pwp	(kPa)	507
B Value	B	.	0.96



Effective Stress Triaxial Compression

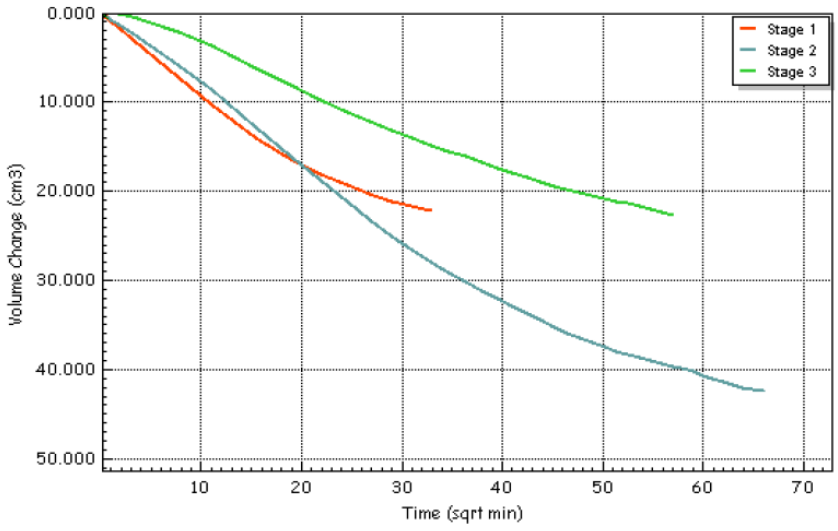
Consolidated Undrained

Consolidation Plots

Initial Conditions			Stage 1	2	3
Initial Cell Pressure	σ_3	(kPa)	650	750	850
Initial Back Pressure	u_{bi}	(kPa)	550	550	550
Pore Water Pressure Input	u_{pwp}	(kPa)	603	669	704
Drainage Method			Radial+One End		

Final Conditions			Stage 1	2	3
PWP Dissipation %	U%	(%)	96.23	95.80	95.45
Volumetric Strain	ε_v%	(%)	1.35	3.93	5.31
Corrected Length	L_C	(mm)	204.1	188.1	167.0
Corrected Area	A_C	79.40	79.40	82.73	89.41
Corrected Volume	V_C	(cm3)	1620.273	1577.863	1555.151
T100 Time to Failure	t_{100}	(min)	553.81	980.09	1090.45
Consolidation	c_V	(m2/year)	0.380	0.215	0.193
Compressibility	m_V	(m2/MN)	0.264	0.345	0.361
Test Time	t_F	(h:m:s)	16:36:51	29:24:09	32:42:48
Estimated Strain to Failure	ε%	(%)	5.0	5.0	5.0
Shear Machine Speed	d_r	(mm/min)	0.01024	0.00533	0.00425

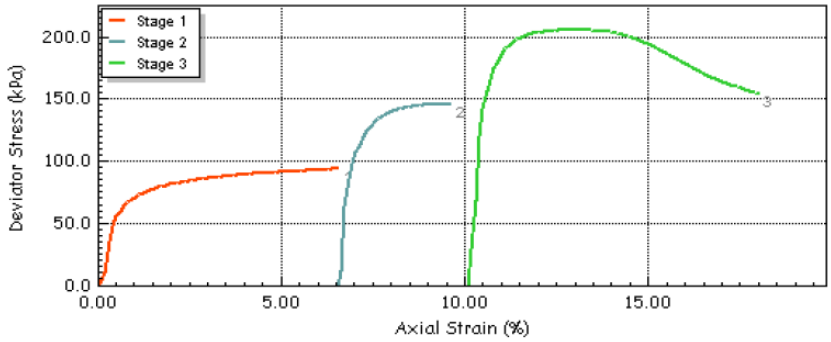
Notes

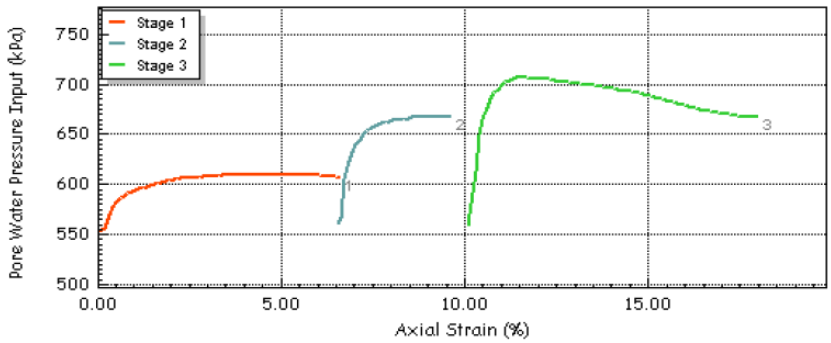


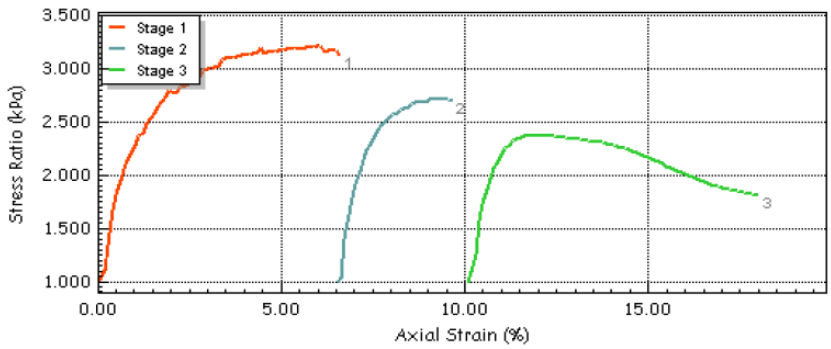
Effective Stress Triaxial Compression

Consolidated Undrained

Shear Stage Plots





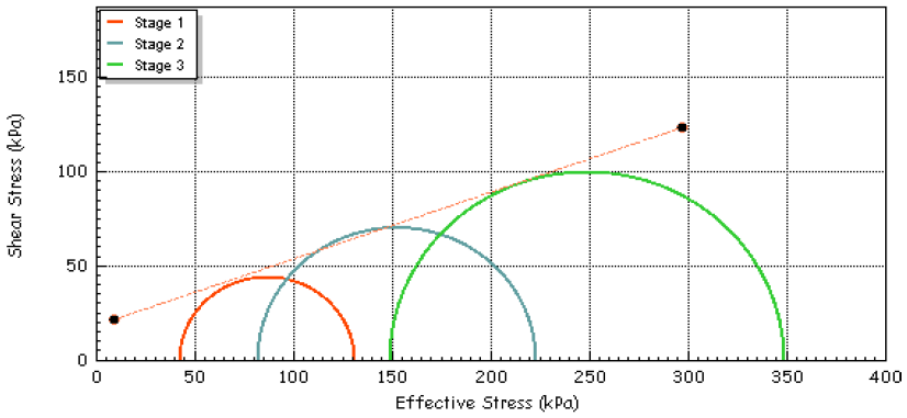


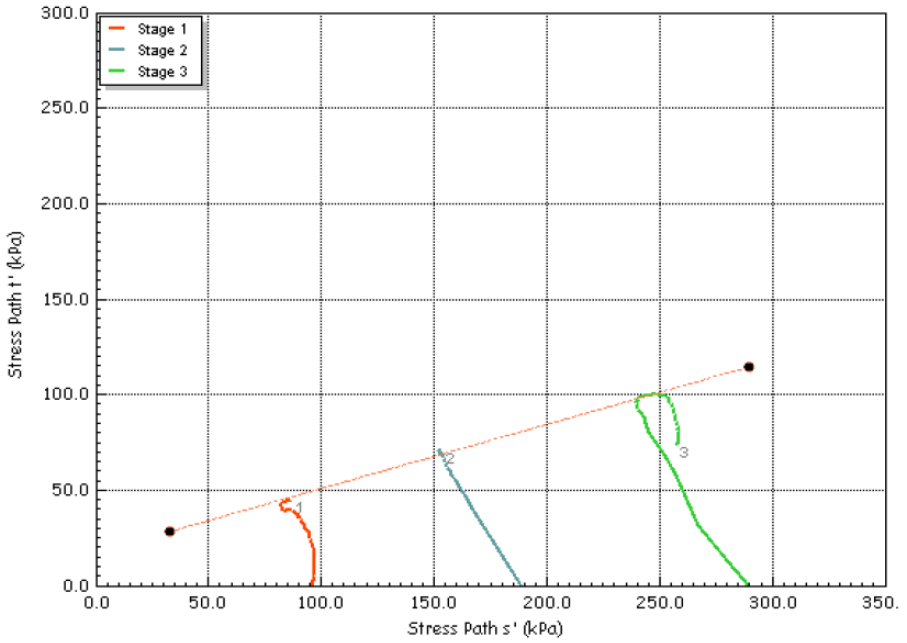
Effective Stress Triaxial Compression

Consolidated Undrained

Shear Stage Plots

Effective	c'	(kPa)	17.82	Effective Cohesion	c'	(kPa)	17.82
Effective Friction	ϕ'	(deg)	19.6	Effective Friction	ϕ'	(deg)	19.6





CQA International Ltd
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 26th July 2016
Test Report No: STR 469696

Contract: Tir John Landfill – Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine Consolidated Undrained Triaxial Test with Pore Pressure Measurement in accordance with BS1377: Part 8 : Clause 7 : 1990

SAMPLE DETAILS:

Certificate of Sampling Received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S4**
Date and Time of Sampling:	**31/05/2015**
Date of Receipt at Lab:	**01/06/2015**
Sampling Location:	**TP4/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Type of Sample:	**Disturbed**
Were any unrepresentative lumps present?	**None**

RESULTS:

See Attached

COMMENTS/ DEPARTURE FROM SPECIFIED PROCEDURE

The work was carried out by our accredited, competent, sub contracted laboratory.

E. N. Jones – Soils Laboratory Manager

Effective Stress Triaxial Compression

Consolidated Undrained

Summary Report

Sample Details				
 *sketch showing specimen location in original sample*	Depth			-
	Description			Brown CLAY.
	Type			Remoulded using 2.5kg effort at 30% moisture content.
	Initial Length	L_0	(mm)	205.0
	Initial Diameter	D_0	(mm)	101.0
	Initial Weight	W_0	(gr)	2980.0
	Initial Bulk Density	ρ_0	(Mg/m3)	1.81
	Particle Density	ρ_s	(Mg/m3)	2.65

Initial Conditions			Stage 1	2	3	4
Initial Cell Pressure	σ_{3i}	(kPa)	799	899	999	
Initial Back Pressure	U_{bi}	(kPa)	700	699	700	
Membrane Thickness	m_b	(mm)	0.400			
Displacement Input	L_{IP}	(mm)	CH 2			
Load Input	N_{IP}	(N)	CH 1			
Pore Water Pressure Input	u_{pwp}	(kPa)	CH 3			
Sample Volume	V	(cm3)	CH 2			
Initial Moisture	ω_i%	(%)	29			
Initial Dry Density	ρ_{di}	(Mg/m3)	1.40			
Initial Voids Ratio	e_i	.	0.891			
Initial Degree of Saturation	S_i	(%)	88			
B Value	B	.	0.96			

Final Conditions						
Final Moisture	ω_f%	(%)	33			
Final Dry Density	ρ_{df}	(Mg/m3)	1.57			
Final Voids Ratio	e_f	.	0.690			
Final Degree of Saturation	S_f	(%)	100.0			
			Stage 1	2	3	4
Failure Criteria		.	Max. Dev. Stress	Max. Dev. Stress	Max. Dev. Stress	
Strain At Failure	ε%	(%)	10.00	15.00	19.95	
Stress At Failure	$(\sigma_1 - \sigma_3)$	(kPa)	78.2	128.3	167.2	
Minor Stress At Failure	σ_3'	(kPa)	52.0	94.0	153.0	
Major Stress At Failure	σ_1'	(kPa)	130.2	222.3	320.2	
Principal Stress At Failure	σ_1'/σ_3'		2.505	2.365	2.093	

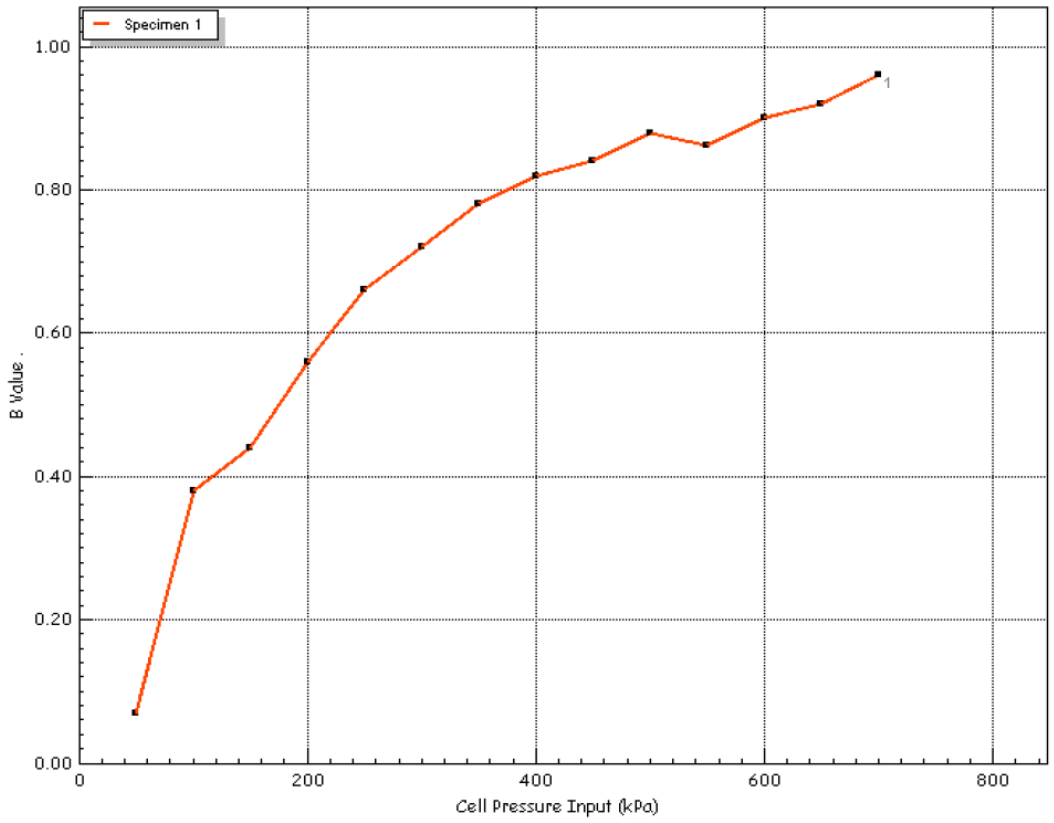
Notes

Effective Stress Triaxial Compression

Consolidated Undrained

Saturation Plots

			1
Saturation Method			Stepped
Cell Pressure Input	σ	(kPa)	700
Pore Water Pressure Input	u pwp	(kPa)	685
B Value	B	.	0.96



Effective Stress Triaxial Compression

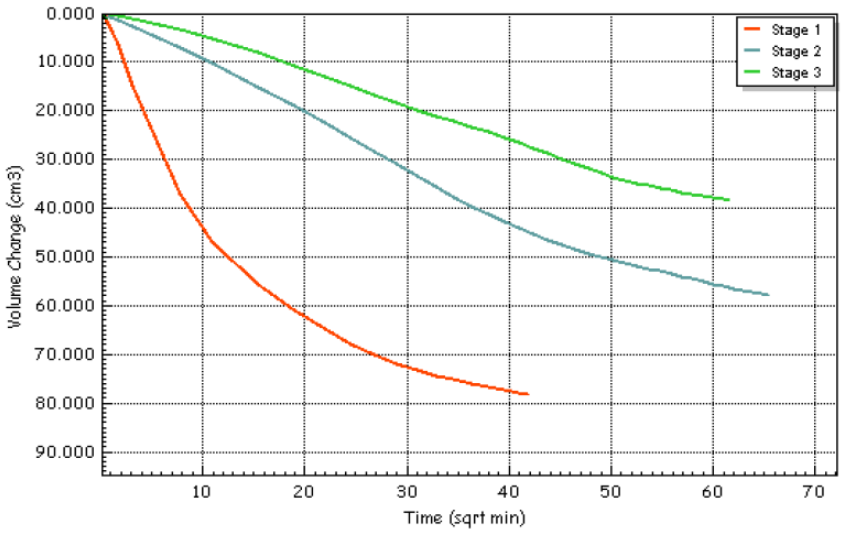
Consolidated Undrained

Consolidation Plots

Initial Conditions			Stage 1	2	3
Initial Cell Pressure	σ_3	(kPa)	800	900	1000
Initial Back Pressure	u_{bi}	(kPa)	700	700	700
Pore Water Pressure Input	u_{pwp}	(kPa)	782	829	849
Drainage Method			Radial+One End		

Final Conditions			Stage 1	2	3
PWP Dissipation %	U%	(%)	95.12	95.35	95.30
Volumetric Strain	ε_v%	(%)	4.76	8.28	10.61
Corrected Length	L_C	(mm)	201.7	176.6	144.8
Corrected Area	A_C	77.57	77.57	81.16	92.64
Corrected Volume	V_C	(cm3)	1564.174	1506.432	1468.139
T100 Time to Failure	t_{100}	(min)	255.77	1355.79	1846.20
Consolidation	c_V	(m2/year)	0.824	0.155	0.114
Compressibility	m_V	(m2/MN)	0.611	0.673	0.747
Test Time	t_F	(h:m:s)	07:40:23	40:40:25	55:23:09
Estimated Strain to Failure	ε%	(%)	5.0	5.0	5.0
Shear Machine Speed	d_r	(mm/min)	0.02191	0.00362	0.00218

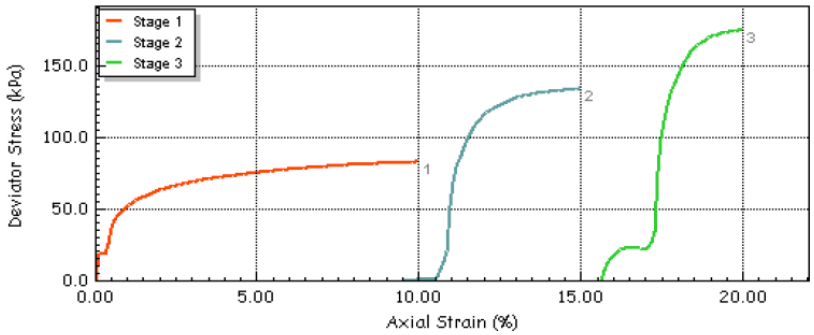
Notes

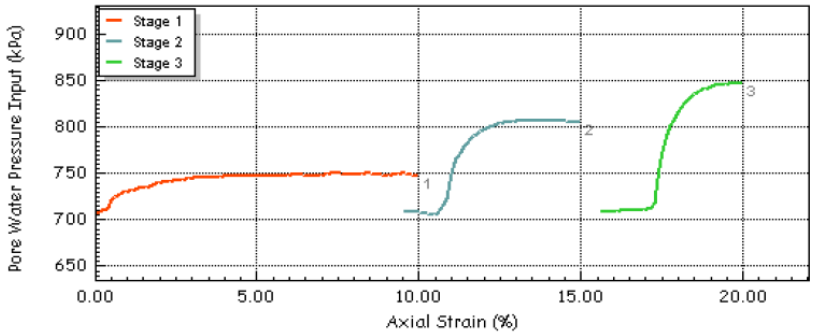


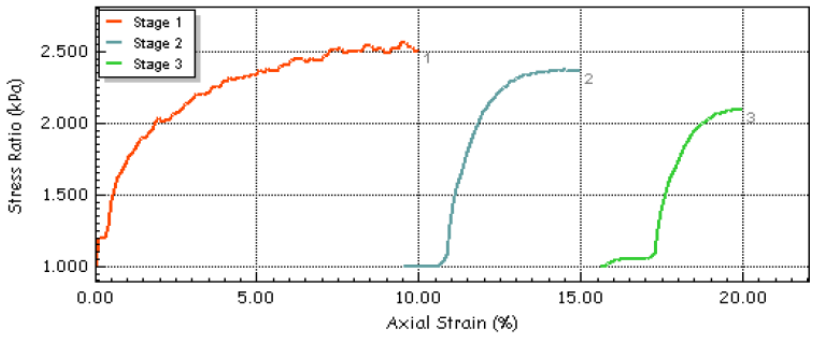
Effective Stress Triaxial Compression

Consolidated Undrained

Shear Stage Plots





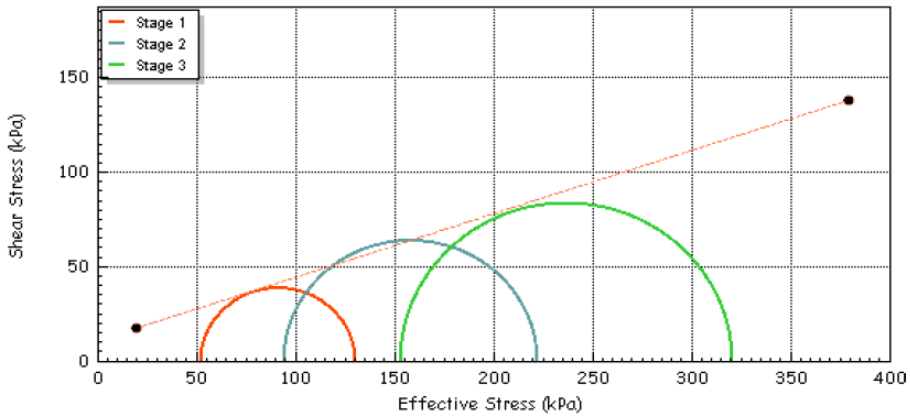


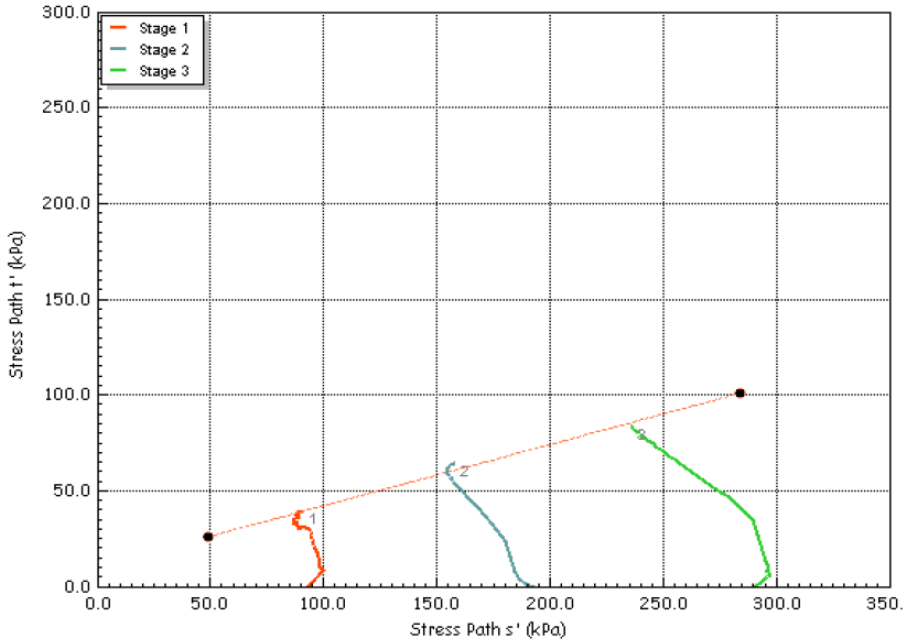
Effective Stress Triaxial Compression

Consolidated Undrained

Shear Stage Plots

Effective	c'	(kPa)	10.77	Effective Cohesion	c'	(kPa)	10.77
Effective Friction	ϕ'	(deg)	18.5	Effective Friction	ϕ'	(deg)	18.5





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Date: 11 July 2016
Test Report Ref: STR 467431

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Moisture Content of a soil sample (definitive oven-drying method) in accordance with **BS 1377 : Part 2 : 1990 : clause 3.2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP4/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Moisture Content (%) = **35.1**

Comments
None

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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The Keele Centre
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Date: 11 July 2016
Test Report Ref: STR 467442

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Moisture Content of a soil sample (definitive oven-drying method) in accordance with **BS 1377 : Part 2 : 1990 : clause 3.2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP5/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Moisture Content (%) = **35.1**

Comments
None

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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Date: 11 July 2016
Test Report Ref: STR 467408

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Moisture Content of a soil sample (definitive oven-drying method) in accordance with **BS 1377 : Part 2 : 1990 : clause 3.2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP1/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Moisture Content (%) = 35.8

Comments
None

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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Date: 11 July 2016
Test Report Ref: STR 467416

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Moisture Content of a soil sample (definitive oven-drying method) in accordance with **BS 1377 : Part 2 : 1990 : clause 3.2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP2/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Moisture Content (%) = **35.5**

Comments
None

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467423

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Moisture Content of a soil sample (definitive oven-drying method) in accordance with **BS 1377 : Part 2 : 1990 : clause 3.2**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP3/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Moisture Content (%) = **33.8**

Comments
None

Certificate Prepared by:-
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Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467430

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S7**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP3/S7**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 2.2
*95% Confidence limit** *1.98% - 2.42%*

Comments
*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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Date: 11 July 2016
Test Report Ref: STR 467436

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S3**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP4/S3**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 1.2
*95% Confidence limit** *1.08% - 1.32%*

Comments

*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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Date: 11 July 2016
Test Report Ref: STR 467449

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S3**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP5/S3**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 1.4
*95% Confidence limit** *1.26% - 1.54%*

Comments
*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:- Meical Owen, Assistant Laboratory Manager

Approved by: - Eric Goulden, Technical Manager

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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467412

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S3**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP1/S3**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 1.1
*95% Confidence limit** *0.99% - 1.21%*

Comments
*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:- Meical Owen, Assistant Laboratory Manager

Approved by: - Eric Goulden, Technical Manager

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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467415

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S7**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP1/S7**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 1.1
*95% Confidence limit** *0.99% - 1.21%*

Comments

*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467420

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S3**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP2/S3**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 2.0
*95% Confidence limit** *1.8% - 2.2%*

Comments

*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

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Date: 11 July 2016
Test Report Ref: STR 467427

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Organic Content of Soil in accordance with **BS 1377: Part 3: 1990 clause 3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S3**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**13/06/2016**
Sampling Location:	**TP3/S3**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

Percentage of soil passing 2mm sieve (%) = 100

Mean Organic Content (%) = 1.3
*95% Confidence limit** *1.17% - 1.43%*

Comments
*95% Confidence limit is the expanded uncertainty which is the combined uncertainty standard multiplied by a factor (k) of 2

Certificate Prepared by:- Meical Owen, Assistant Laboratory Manager

Approved by: - Eric Goulden, Technical Manager

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Date: 11 July 2016
Test Report Ref: STR 467425

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Density of Soil - Small pyknometer method, in accordance with **BS 1377 : Part 2 : 1990 : Clause 8.3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**10/06/2016**
Sampling Location:	**TP3/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification	**N/A**

RESULTS:

Particle Density = 2.68 Mg/m^3

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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The Keele Centre
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Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467433

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Density of Soil - Small pyknometer method, in accordance with **BS 1377 : Part 2 : 1990 : Clause 8.3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**10/06/2016**
Sampling Location:	**TP4/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification	**N/A**

RESULTS:

Particle Density = 2.70 Mg/m^3

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467444

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Density of Soil - Small pyknometer method, in accordance with **BS 1377 : Part 2 : 1990 : Clause 8.3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**10/06/2016**
Sampling Location:	**TP5/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification	**N/A**

RESULTS:

Particle Density = 2.69 Mg/m^3

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467410

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Density of Soil - Small pyknometer method, in accordance with **BS 1377 : Part 2 : 1990 : Clause 8.3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**10/06/2016**
Sampling Location:	**TP1/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification	**N/A**

RESULTS:

Particle Density = 2.68 Mg/m^3

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

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The Keele Centre
Three Mile Lane
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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467418

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Density of Soil - Small pyknometer method, in accordance with **BS 1377 : Part 2 : 1990 : Clause 8.3.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**10/06/2016**
Sampling Location:	**TP2/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification	**N/A**

RESULTS:

Particle Density = 2.67 Mg/m^3

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467437

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**22/06/2016**
Sampling Location:	**TP4/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 28% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.6 mm	N/A
Height:	98.9 mm	N/A
Moisture Content:	28.3 %	33.0 %
Bulk density:	1.778 Mg/m^3	1.863 Mg/m^3
Dry density:	1.386 Mg/m^3	1.401 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B:	0.24
Final pore pressure coefficient,B:	1.00
Duration of stage:	8 days

Consolidation stage:

Effective pressure:	50 kPa
Duration of stage:	2 days

Permeability stage:

Pressure difference across specimen:	10 kPa
Mean effective stress:	45 kPa
Duration of stage	2 days

Coefficient of Permeability (k_v) at 20°C = 1.1×10^{-10} m/s

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Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467439

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S6**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**22/06/2016**
Sampling Location:	**TP4/S6**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 30% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.6 mm	N/A
Height:	99.0 mm	N/A
Moisture Content:	30.0 %	34.5 %
Bulk density:	1.806 Mg/m^3	1.900 Mg/m^3
Dry density:	1.389 Mg/m^3	1.412 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B:	0.34
Final pore pressure coefficient,B:	0.96
Duration of stage:	6 days

Consolidation stage:

Effective pressure:	50 kPa
Duration of stage:	2 days

Permeability stage:

Pressure difference across specimen:	10 kPa
Mean effective stress:	45 kPa
Duration of stage	2 days

Coefficient of Permeability (k_v) at 20°C = 1.5×10^{-10} m/s

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Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467450

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**22/06/2016**
Sampling Location:	**TP5/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 28% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.6 mm	N/A
Height:	98.3 mm	N/A
Moisture Content:	28.4 %	31.9 %
Bulk density:	1.767 Mg/m^3	1.845 Mg/m^3
Dry density:	1.376 Mg/m^3	1.399 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B:	0.30
Final pore pressure coefficient,B:	1.00
Duration of stage:	7 days

Consolidation stage:

Effective pressure:	50 kPa
Duration of stage:	2 days

Permeability stage:

Pressure difference across specimen:	10 kPa
Mean effective stress:	45 kPa
Duration of stage	2 days

Coefficient of Permeability (k_v) at 20°C = 8.3×10^{-11} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467451

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S6**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**22/06/2016**
Sampling Location:	**TP5/S6**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 32% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.5 mm	N/A
Height:	98.6 mm	N/A
Moisture Content:	32.0 %	34.2 %
Bulk density:	1.807 Mg/m^3	1.859 Mg/m^3
Dry density:	1.369 Mg/m^3	1.385 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B:	0.46
Final pore pressure coefficient,B:	0.96
Duration of stage:	6 days

Consolidation stage:

Effective pressure:	50 kPa
Duration of stage:	2 days

Permeability stage:

Pressure difference across specimen:	10 kPa
Mean effective stress:	45 kPa
Duration of stage	2 days

Coefficient of Permeability (k_v) at 20°C = 6.8×10^{-11} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467414

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S6**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**21/06/2016**
Sampling Location:	**TP1/S6**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 32% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.6 mm	N/A
Height:	98.9 mm	N/A
Moisture Content:	32.0 %	34.4 %
Bulk density:	1.804 Mg/m^3	1.863 Mg/m^3
Dry density:	1.367 Mg/m^3	1.386 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B: **0.40**

Final pore pressure coefficient,B: **0.96**

Duration of stage: **7 days**

Consolidation stage:

Effective pressure: **50 kPa**

Duration of stage: **2 days**

Permeability stage:

Pressure difference across specimen: **10 kPa**

Mean effective stress: **45 kPa**

Duration of stage **2 days**

Coefficient of Permeability (k_v) at 20°C = 1.0×10^{-10} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467421

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**21/06/2016**
Sampling Location:	**TP2/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 32% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.3 mm	N/A
Height:	98.9 mm	N/A
Moisture Content:	32.3 %	33.9 %
Bulk density:	1.801 Mg/m^3	1.853 Mg/m^3
Dry density:	1.361 Mg/m^3	1.384 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B: **0.44**

Final pore pressure coefficient,B: **1.00**

Duration of stage: **7 days**

Consolidation stage:

Effective pressure: **50 kPa**

Duration of stage: **2 days**

Permeability stage:

Pressure difference across specimen: **10 kPa**

Mean effective stress: **45 kPa**

Duration of stage **2 days**

Coefficient of Permeability (k_v) at 20°C = 1.3×10^{-10} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467422

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S6**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**21/06/2016**
Sampling Location:	**TP2/S6**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 28% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.3 mm	N/A
Height:	98.9 mm	N/A
Moisture Content:	28.4 %	32.1 %
Bulk density:	1.777 Mg/m^3	1.865 Mg/m^3
Dry density:	1.384 Mg/m^3	1.412 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B:	0.28
Final pore pressure coefficient,B:	0.98
Duration of stage:	8 days

Consolidation stage:

Effective pressure:	50 kPa
Duration of stage:	2 days

Permeability stage:

Pressure difference across specimen:	10 kPa
Mean effective stress:	45 kPa
Duration of stage	2 days

Coefficient of Permeability (k_v) at 20°C = 1.0×10^{-10} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467428

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**21/06/2016**
Sampling Location:	**TP3/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 30% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.6 mm	N/A
Height:	98.8 mm	N/A
Moisture Content:	30.0 %	33.4 %
Bulk density:	1.802 Mg/m^3	1.870 Mg/m^3
Dry density:	1.386 Mg/m^3	1.402 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B:	0.36
Final pore pressure coefficient,B:	0.98
Duration of stage:	7 days

Consolidation stage:

Effective pressure:	50 kPa
Duration of stage:	2 days

Permeability stage:

Pressure difference across specimen:	10 kPa
Mean effective stress:	45 kPa
Duration of stage	2 days

Coefficient of Permeability (k_v) at 20°C = 5.8×10^{-11} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467429

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Coefficient of Permeability under constant head conditions in a Triaxial Cell in accordance with **BS 1377: Part 6 : 1990 : Clause 6.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S6**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**22/06/2016**
Sampling Location:	**TP3/S6**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments
Remoulded at 32% moisture content

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

TEST RESULTS

Sample condition: **Remoulded**

Method of Remoulding (If applicable): **2.5kg rammer**

Specimen Details:	Initial:	Final:
Diameter:	101.6 mm	N/A
Height:	98.9 mm	N/A
Moisture Content:	32.1 %	33.9 %
Bulk density:	1.812 Mg/m^3	1.869 Mg/m^3
Dry density:	1.372 Mg/m^3	1.396 Mg/m^3

Saturation stage: **Performed in accordance with clause 5.4.3 - Saturation by increments of cell pressure and back pressure.**

Initial pore pressure coefficient,B: **0.50**

Final pore pressure coefficient,B: **0.96**

Duration of stage: **7 days**

Consolidation stage:

Effective pressure: **50 kPa**

Duration of stage: **2 days**

Permeability stage:

Pressure difference across specimen: **10 kPa**

Mean effective stress: **45 kPa**

Duration of stage **2 days**

Coefficient of Permeability (k_v) at 20°C = 9.2×10^{-11} m/s

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467424

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Plastic Limit, Liquid Limit, and Plasticity Index of sample in accordance with **BS 1377:Part 2:1990 Clause 5.3, Clause 4.3, and Clause 5.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. :	**TP3/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP3/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

History of sample:	**:**	**Natural state**
% Materials passing 425µm	**=**	**99**
Plastic Limit	**=**	**27**
Liquid Limit	**=**	**68**
Plasticity Index	**=**	**41**

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by:
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467432

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Plastic Limit, Liquid Limit, and Plasticity Index of sample in accordance with **BS 1377:Part 2:1990 Clause 5.3, Clause 4.3, and Clause 5.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. :	**TP4/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP4/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

History of sample:	**:**	**Natural state**
% Materials passing 425µm	**=**	**99**
Plastic Limit	**=**	**29**
Liquid Limit	**=**	**73**
Plasticity Index	**=**	**44**

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by:
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467443

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Plastic Limit, Liquid Limit, and Plasticity Index of sample in accordance with **BS 1377:Part 2:1990 Clause 5.3, Clause 4.3, and Clause 5.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. :	**TP5/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP5/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

History of sample:	**:**	**Natural state**
% Materials passing 425µm	**=**	**99**
Plastic Limit	**=**	**28**
Liquid Limit	**=**	**74**
Plasticity Index	**=**	**46**

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by:
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467409

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Plastic Limit, Liquid Limit, and Plasticity Index of sample in accordance with **BS 1377:Part 2:1990 Clause 5.3, Clause 4.3, and Clause 5.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. :	**TP1/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP1/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

History of sample:	**:**	**Natural state**
% Materials passing 425µm	**=**	**99**
Plastic Limit	**=**	**28**
Liquid Limit	**=**	**77**
Plasticity Index	**=**	**49**

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by:
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467417

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Plastic Limit, Liquid Limit, and Plasticity Index of sample in accordance with **BS 1377:Part 2:1990 Clause 5.3, Clause 4.3, and Clause 5.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. :	**TP2/S1**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**06/06/2016**
Sampling Location:	**TP2/S1**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Soil Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

History of sample:	**:**	**Natural state**
% Materials passing 425µm	**=**	**99**
Plastic Limit	**=**	**28**
Liquid Limit	**=**	**74**
Plasticity Index	**=**	**46**

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by:
Eric Goulden
Technical Manager

CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467426

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Size Distribution (PSD) of a soil sample- washing and sieving method in accordance with **BS1377-Part2-1990 Clause 9.2** Sedimentation by pipette method to **BS 1377: Part 2: 1990: clause 9.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S2**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**08/06/2016**
Sampling Location:	**TP3/S2**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

SEE ATTACHED

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

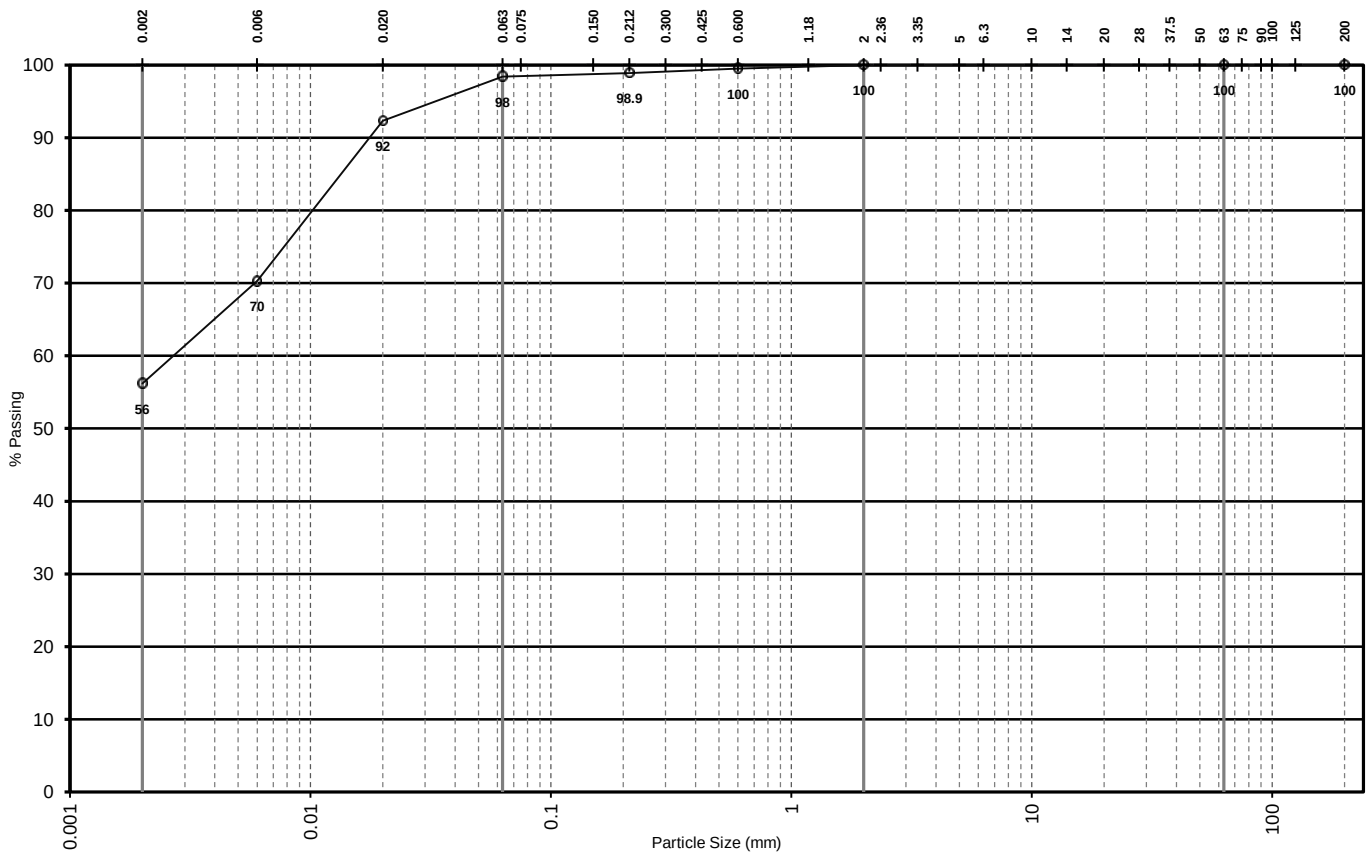
MATERIAL DESCRIPTION

Brown silty CLAY

Method of pre-treatment: N/A

Sieve Size mm	% Passing	Sieve Size mm	% Passing
200	100.0	3.35	
125		2.36	
100		2.0	100.0
90		1.18	
75		0.600	99.5
63	100.0	0.425	
50		0.300	
37.5		0.212	98.9
28		0.150	
20		0.075	
14		0.063	98.4
10		0.020	92.3
6.3		0.006	70.3
5.0		0.002	56.2

Cobbles	0.0
Gravel	0.0
Sand	1.6
Silt	42.2
Clay	56.2



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	0.002 0.006		0.02	0.063		0.63	2.0 6.3		20	63 200
	SILT			0.2 SAND			GRAVEL			

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Keele
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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467435

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Size Distribution (PSD) of a soil sample- washing and sieving method in accordance with **BS1377-Part2-1990 Clause 9.2** Sedimentation by pipette method to **BS 1377: Part 2: 1990: clause 9.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP4/S2**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**08/06/2016**
Sampling Location:	**TP4/S2**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

SEE ATTACHED

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

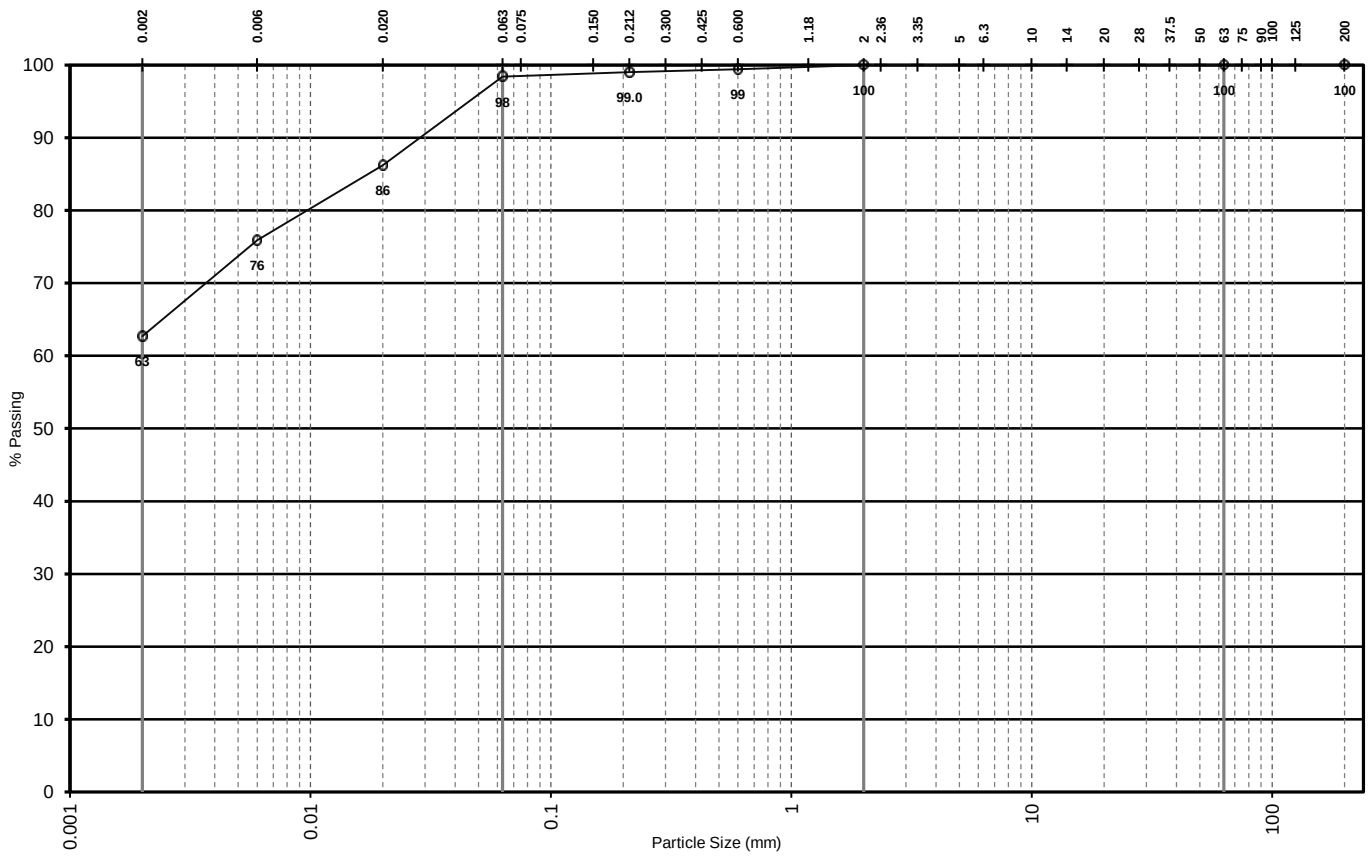
MATERIAL DESCRIPTION

Brown silty CLAY

Method of pre-treatment: N/A

Sieve Size mm	% Passing	Sieve Size mm	% Passing
200	100.0	3.35	
125		2.36	
100		2.0	100.0
90		1.18	
75		0.600	99.4
63	100.0	0.425	
50		0.300	
37.5		0.212	99.0
28		0.150	
20		0.075	
14		0.063	98.4
10		0.020	86.2
6.3		0.006	75.9
5.0		0.002	62.7

Cobbles	0.0
Gravel	0.0
Sand	1.6
Silt	35.7
Clay	62.7



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	0.002	0.006	0.02	0.063		0.63	2.0	6.3	20	63 200
	SILT			0.2 SAND			GRAVEL			

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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467447

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Size Distribution (PSD) of a soil sample- washing and sieving method in accordance with **BS1377-Part2-1990 Clause 9.2** Sedimentation by pipette method to **BS 1377: Part 2: 1990: clause 9.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S2**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**08/06/2016**
Sampling Location:	**TP5/S2**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

SEE ATTACHED

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

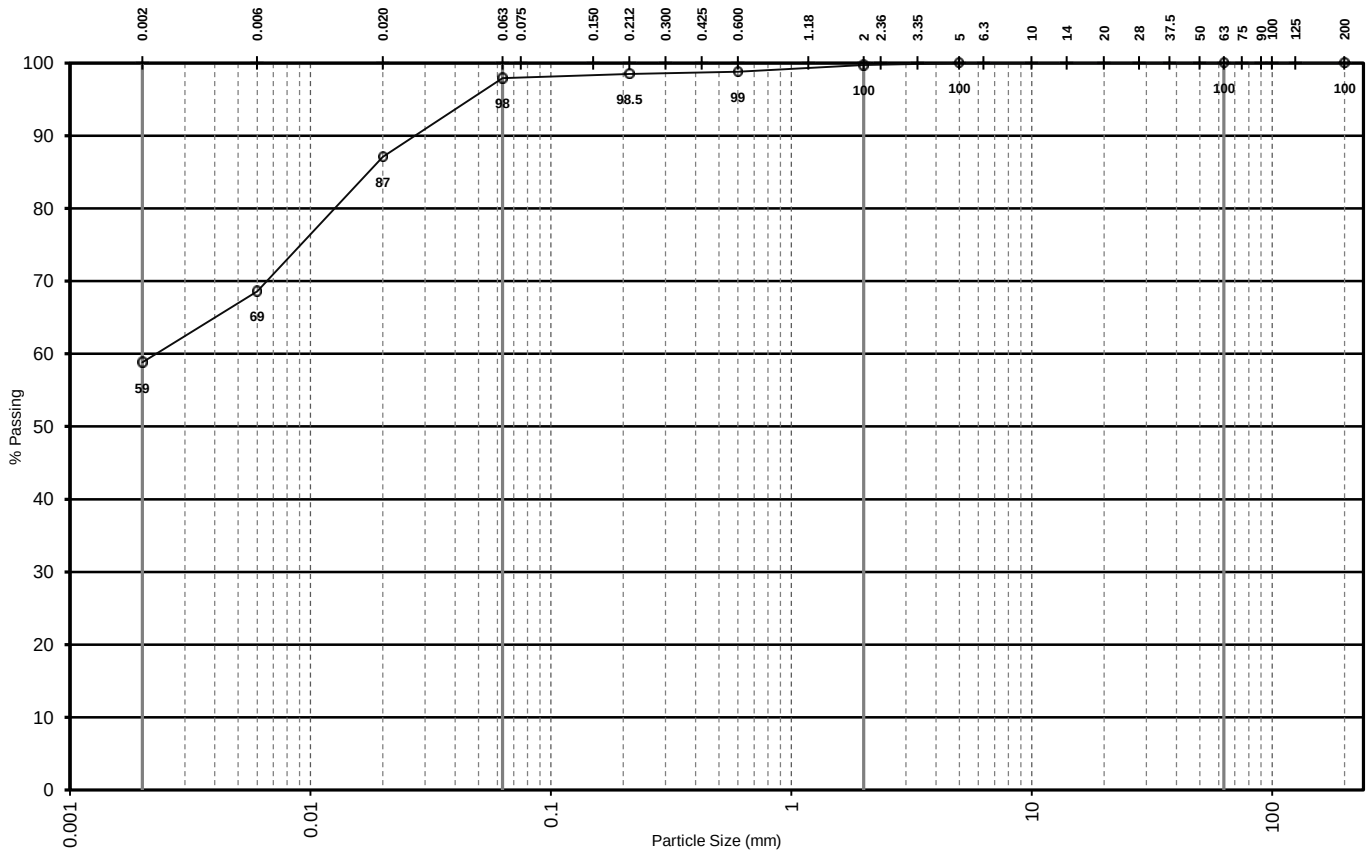
MATERIAL DESCRIPTION

Brown silty CLAY

Method of pre-treatment: N/A

Sieve Size mm	% Passing	Sieve Size mm	% Passing
200	100.0	3.35	
125		2.36	
100		2.0	99.7
90		1.18	
75		0.600	98.8
63	100.0	0.425	
50		0.300	
37.5		0.212	98.5
28		0.150	
20		0.075	
14		0.063	97.9
10		0.020	87.1
6.3		0.006	68.6
5.0	100.0	0.002	58.8

Cobbles	0.0
Gravel	0.3
Sand	1.8
Silt	39.1
Clay	58.8



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	0.002 0.006 0.02			0.063 0.2 0.63			2.0 6.3 20			63 200
	SILT			SAND			GRAVEL			

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Staffordshire
ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467411

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Size Distribution (PSD) of a soil sample- washing and sieving method in accordance with **BS1377-Part2-1990 Clause 9.2** Sedimentation by pipette method to **BS 1377: Part 2: 1990: clause 9.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S2**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**08/06/2016**
Sampling Location:	**TP1/S2**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

SEE ATTACHED

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

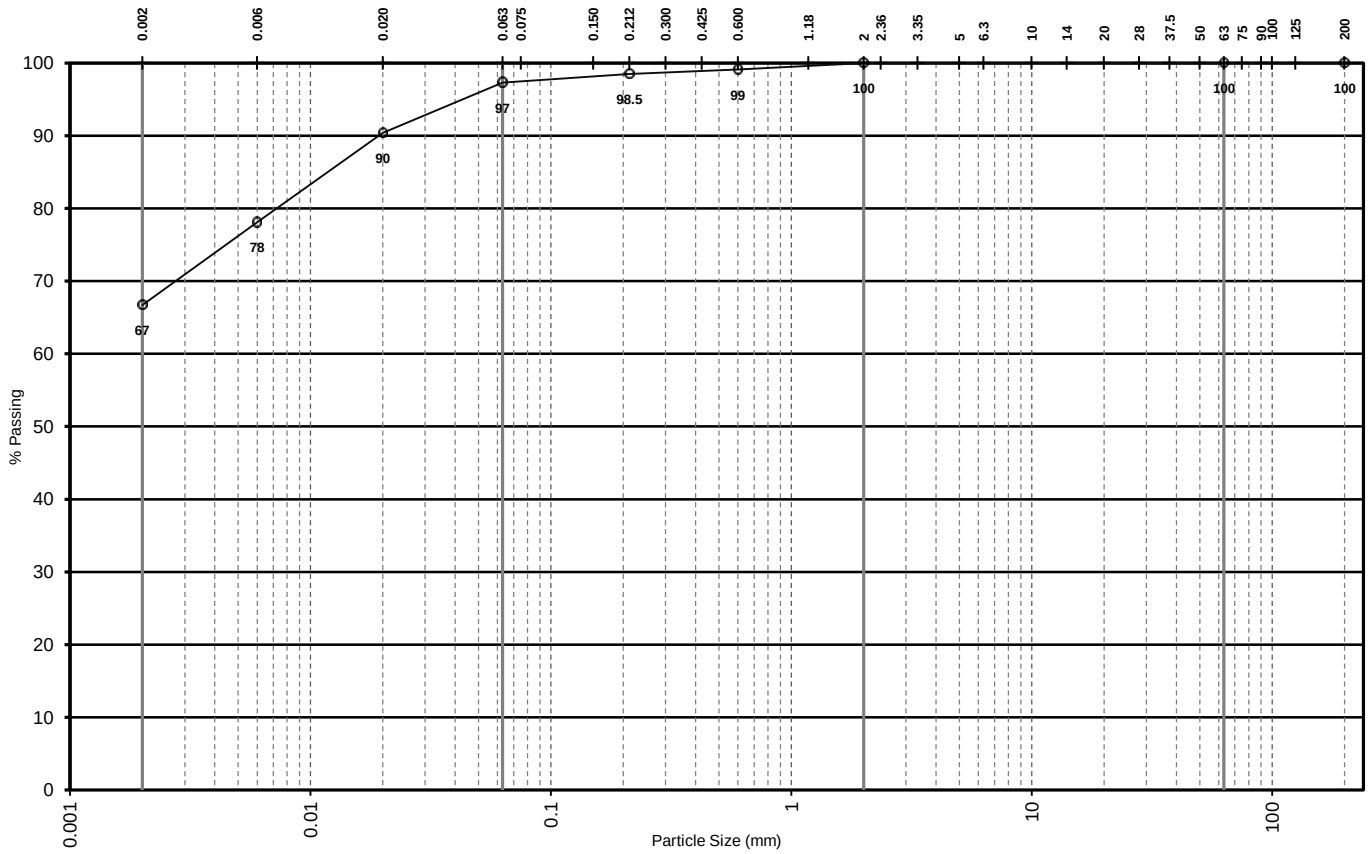
MATERIAL DESCRIPTION

Brown silty CLAY

Method of pre-treatment: N/A

Sieve Size mm	% Passing	Sieve Size mm	% Passing
200	100.0	3.35	
125		2.36	
100		2.0	100.0
90		1.18	
75		0.600	99.1
63	100.0	0.425	
50		0.300	
37.5		0.212	98.5
28		0.150	
20		0.075	
14		0.063	97.3
10		0.020	90.4
6.3		0.006	78.1
5.0		0.002	66.7

Cobbles	0.0
Gravel	0.0
Sand	2.7
Silt	30.6
Clay	66.7



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	0.002 0.006		0.02	0.063		0.63	2.0 6.3		20	63 200
	SILT			0.2 SAND			GRAVEL			

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ST5 5HH

Date: 11 July 2016
Test Report Ref: STR 467419

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Particle Size Distribution (PSD) of a soil sample- washing and sieving method in accordance with **BS1377-Part2-1990 Clause 9.2** Sedimentation by pipette method to **BS 1377: Part 2: 1990: clause 9.4.**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP2/S2**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**08/06/2016**
Sampling Location:	**TP2/S2**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

SEE ATTACHED

Comments
None

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

Test Report Ref: STR 467419: Page 2 of 2

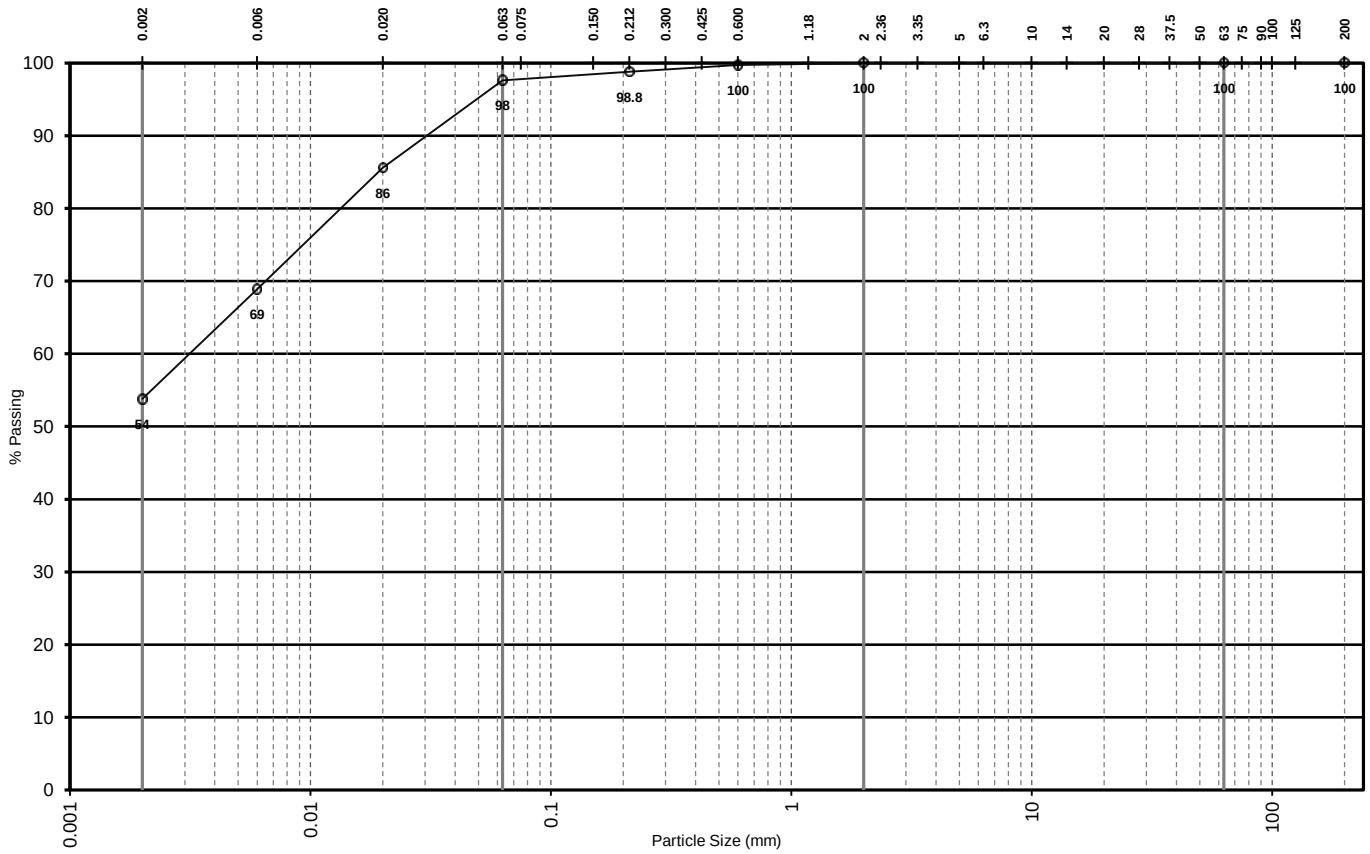
MATERIAL DESCRIPTION

Brown silty CLAY

Method of pre-treatment: N/A

Sieve Size mm	% Passing	Sieve Size mm	% Passing
200	100.0	3.35	
125		2.36	
100		2.0	100.0
90		1.18	
75		0.600	99.7
63	100.0	0.425	
50		0.300	
37.5		0.212	98.8
28		0.150	
20		0.075	
14		0.063	97.6
10		0.020	85.6
6.3		0.006	68.9
5.0		0.002	53.8

Cobbles	0.0
Gravel	0.0
Sand	2.4
Silt	43.8
Clay	53.8



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	0.002	0.006	0.02	0.063		0.63	2.0	6.3	20	63 200
	SILT			0.2 SAND			GRAVEL			

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Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469160

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S4**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**04/07/2016**
Sampling Location:	**TP3/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

Comments

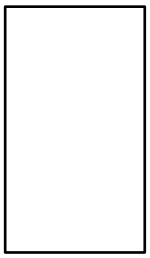
Remoulded to target of 32% moisture.

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

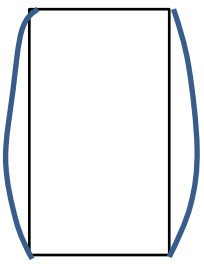
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	32.1 %
Bulk Density	1.863 Mg/m³
Dry Density	1.410 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	110 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**55 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



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Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469161

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S4**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**04/07/2016**
Sampling Location:	**TP5/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

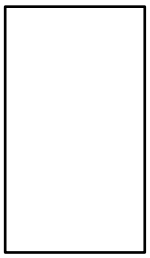
Comments
Remoulded to target of 28% moisture.

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

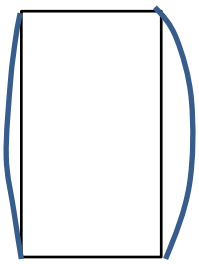
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	28.2 %
Bulk Density	1.869 Mg/m³
Dry Density	1.458 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	254 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**127 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



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The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469162

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S4**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**11/07/2016**
Sampling Location:	**TP5/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

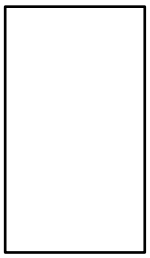
Comments
Remoulded to target of 30% moisture.

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

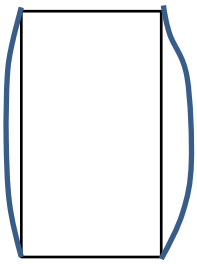
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	30.4 %
Bulk Density	1.857 Mg/m³
Dry Density	1.424 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	189 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**95 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



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Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469163

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP5/S4**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**11/07/2016**
Sampling Location:	**TP5/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

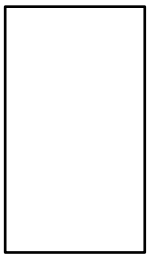
Comments
Remoulded to target of 32% moisture.

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

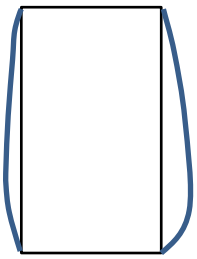
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	32.3 %
Bulk Density	1.852 Mg/m³
Dry Density	1.400 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	116 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**58 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



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Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469155

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**04/07/2016**
Sampling Location:	**TP1/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

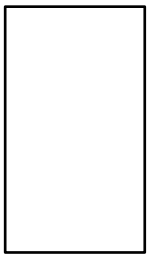
Comments
Remoulded to target of 28% moisture

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

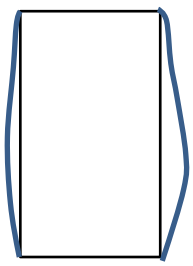
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	28.2 %
Bulk Density	1.847 Mg/m³
Dry Density	1.441 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	271 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**136 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469156

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**11/07/2016**
Sampling Location:	**TP1/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

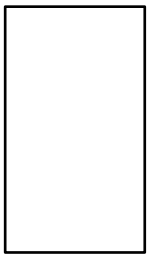
Comments
Remoulded to target of 30% moisture.

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

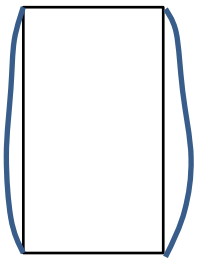
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	30.4 %
Bulk Density	1.892 Mg/m³
Dry Density	1.451 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	196 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**98 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



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ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469157

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP1/S5**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**04/07/2016**
Sampling Location:	**TP1/S5**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

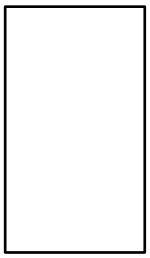
Comments
Remoulded to target of 32% moisture.

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

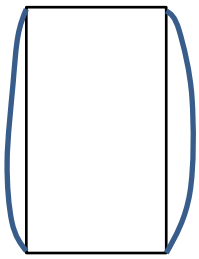
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	32.2 %
Bulk Density	1.838 Mg/m³
Dry Density	1.390 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	128 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**64 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469158

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S4**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**04/07/2016**
Sampling Location:	**TP3/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

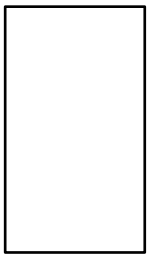
Comments
Remoulded to target of 28% moisture.

Certificate Prepared by:- Meical Owen
Assistant Laboratory Manager

Approved by: - Eric Goulden
Technical Manager

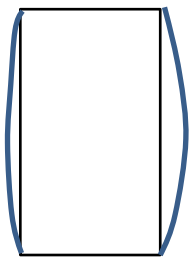
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	27.8 %
Bulk Density	1.881 Mg/m³
Dry Density	1.472 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	241 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**121 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



CQA International Ltd.
The Keele Centre
Three Mile Lane
Keele
Staffordshire
ST5 5HH

Date: 13 July 2016
Test Report Ref: STR 469159

Contract: Tir John Landfill - Dyfan Road Source Evaluation

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Undrained Shear Strength in Triaxial Compression Without Measurement of Pore Pressure in accordance with **BS 1377-7: 1990 Clause 8**

SAMPLE DETAILS:

Certificate of sampling received:	**No**
Laboratory Ref. No:	**S58645**
Client Ref. No:	**TP3/S4**
Date and Time of Sampling:	**31/05/2016**
Date of Receipt at Lab:	**01/06/2016**
Date of Start of Test:	**11/07/2016**
Sampling Location:	**TP3/S4**
Name of Source:	**Dyfan Road, Barry**
Method of Sampling:	**Disturbed Bulk Sample**
Sampled By:	**Client**
Material Description:	**Brown silty CLAY**
Target Specification:	**N/A**

RESULTS:

See attached

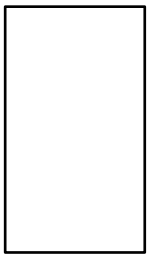
Comments
Remoulded to target of 30% moisture.

Certificate Prepared by:-
Meical Owen
Assistant Laboratory Manager

Approved by: -
Eric Goulden
Technical Manager

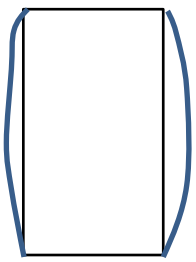
Sample Condition: REMOULDED
If remoulded state method of compaction: 2.5kg rammer

ORIENTATION AND POSITION OF UNDISTURBED SAMPLE WITHIN SAMPLING CONTAINER



Initial Specimen Length	201 mm
Initial Specimen Diameter	101 mm
Initial Moisture Content	30.2 %
Bulk Density	1.868 Mg/m³
Dry Density	1.435 Mg/m³
Rate of Strain	1.5 %/min
Latex Membrane Thickness	0.6 mm
Membrane Correction	2.2 kPa
Cell Pressure	200 kPa
Corrected Maximum Deviator Stress at failure	178 kPa
Strain at Failure	20.0 %
Shear Strength C_u	**89 kPa**

Mode of Failure: Plastic Failure-(Barrelling) *
~~Brittle Failure (Shear Plane)~~ *
~~Intermediate Type~~ *
* Delete as appropriate.



TIR JOHN LANDFILL CELL 16 DETAILED DESIGN & CQA PLAN

Appendix 3
Pipe Crushing Calculations

Report Number 1575r1v2d0617

FRANK GmbH
Starkenburgstr. 1
64546 Mörfelden-Walldorf
Telefon 06105/926-0
Telefax 06105/926-49

Calculations to ATV-DVWK-A 127, third edition, August 2000

Project: TIR JON LANDFILL SITE-CORY

Client: GEO TECHNOLOGY/CORY ENVIRONMENTAL

Date: 09/06/2016

Contact: EWAN THOMAS

225MM OD SDR11 DURODRIAN FULLY PERFORATED 12MM HOLES OVER THE FULLY CIRCUMFERENCE OF THE PIPE X6M PLAIN ENDED PIPE GIVING A 5% OPEN AREA

Input:

Safety factors

Safety class:	A (normal case)		
Allowable deflection:	6% (normal case)		
A type predeformation:	$\delta_{v,TypeA}$	1.00	%
Local predeformation:	$\delta_{v,local}$	0.00	%

Pipe

Description:	Solid wall		
Inside diameter:	d_i	184.0	mm
Wall thickness:	s	20.50	mm
Perforationsart:	Fully perforated		
Perforation geometry:	Perforated		
Number of holes per 1 m:	n_W	162.00	[1]
Distance between holes:	l_1	60.00	mm
Hole diameter:	b_W	12.00	mm

Pipe material

Material class:	Thermoplastic		
Description:	PE-HD (ATV-A 127)		
Density of pipe material	γ_P	9.40	kN/m³
Transv. contr. coeff.	ν	0.38	[1]
E-Modulus, short	E_{st}	800.00	N/mm²
E-Modulus, long	E_{lt0}	160.00	N/mm²
Ultimate flexural tensile stress, short-term	$\sigma_{BT,st}$	21.00	N/mm²
Ultimate flexural compressive stress, short-term	$\sigma_{BC,st}$	21.00	N/mm²
Ultimate flexural tensile stress, long-term	$\sigma_{BT,lt}$	14.00	N/mm²
Ultimate flexural compressive stress, long-term	$\sigma_{BC,lt}$	14.00	N/mm²

Soil

E1: Backfilling:	Soil group: G1		
Value from Table 8 in ATV A127:	D_{PR1}	95.0	%
E20: Pipe zone:	Soil group: G1		
Value from Table 8 in ATV A127:	D_{PR2}	95.0	%
E3: Native soil:	Soil group: G1		
Proctor density:	D_{PR3}	97.0	%
E4: Below trench	E4 = 10 * E1		

Installation

Trench width:	b	1,000	mm
Slope angle:	β	90.00	°
Cover condition:	A1		
Bedding condition:	B1		
Type of bedding:	loose		
Relative projection:	a	1.00	[1]
Bedding angle:	180°		

Load case combination 1

Description:	Area with maximum cover		
Cover depth:	h	33,000	mm
Soil density:	γ	18.00	kN/m³
Additional surface load:	P_0	0.00	N/mm²
Maximum groundwater level above pipe bed:	$h_{W,max}$	1,000	mm
Minimum groundwater level above pipe bed:	$h_{W,min}$	500	mm
Internal pressure:	P_I	0.00	bar
Water fill (e.g. damming channel)	Yes		
Density of medium:	γ_F	10.00	kN/m³
Traffic load:	No traffic		

Proof for load case combination 1, Short term

Stress proof (with minimum groundwater):

Calculated ultimate flexural tensile stress, soil/traffic load:	$\sigma_{,calc,BZ}$	21.0	N/mm²
Calculated ultimate flexural compr. stress, soil/traffic load:	$\sigma_{,calc,BD}$	21.0	N/mm²
Ultimate flexural tensile stress due to other loads:	$\sigma_{all,BZ}$	21.0	N/mm²
Ultimate flexural compressive stress due to other loads:	$\sigma_{all,BD}$	21.0	N/mm²

Internal:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	0.394	-0.721	0.394	N/mm²
Stress due to other loads:	$\sigma_{other,i}$	-0.003	-0.075	0.016	N/mm²
Safety coefficient:	γ_{BTi}	53.67	---	51.26	[1]
Safety coefficient:	γ_{BCi}	---	26.39	---	[1]

External:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-0.65	0.17	-0.65	N/mm²
Stress due to other loads:	$\sigma_{other,a}$	-0.06	0.00	-0.06	N/mm²
Safety coefficient:	γ_{BTe}	---	120.18	---	[1]
Safety coefficient:	γ_{BCe}	29.86	---	29.57	[1]

Required flexural tensile safety coefficient:	req γ_{BT}	2.50	[1]
Required flexural compressive safety coefficient:	req γ_{BC}	2.50	[1]

The stress safety coefficients determined are sufficient.

Stress proof (with maximum groundwater):

Calculated ultimate flexural tensile stress, soil/traffic load:	$\sigma_{,calc,BZ}$	21.0	N/mm²
Calculated ultimate flexural compr. stress, soil/traffic load:	$\sigma_{,calc,BD}$	21.0	N/mm²
Ultimate flexural tensile stress due to other loads:	$\sigma_{all,BZ}$	21.0	N/mm²
Ultimate flexural compressive stress due to other loads:	$\sigma_{all,BD}$	21.0	N/mm²

Internal:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	0.392	-0.716	0.392	N/mm²
Stress due to other loads:	$\sigma_{other,i}$	-0.040	-0.113	-0.022	N/mm²
Safety coefficient:	γ_{BTi}	59.78	---	56.81	[1]
Safety coefficient:	γ_{BCi}	---	25.33	---	[1]

External:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-0.64	0.17	-0.64	N/mm²
Stress due to other loads:	$\sigma_{other,a}$	-0.09	-0.03	-0.10	N/mm²
Safety coefficient:	γ_{BTe}	---	147.63	---	[1]
Safety coefficient:	γ_{BCe}	28.74	---	28.47	[1]

Required flexural tensile safety coefficient:	req γ_{BT}	2.50	[1]
Required flexural compressive safety coefficient:	req γ_{BC}	2.50	[1]

The stress safety coefficients determined are sufficient.

Deflection proof (with minimum groundwater):

Calculation method:		linear	
Ratio:	$I/(A_{rad} \cdot r_m^2)$	0.00335	[1]
Ratio:	$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0.00402	[1]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments:	c_v	-0.0833	0.0833	0.0640	[1]
Deflection coefficient for axial forces:	cN_v	-0.648	-0.681	-0.247	[1]
Deflection coefficient for lateral forces:	cQ_v	-0.335	0.335	0.243	[1]
Resultant deflection coefficient:	c'_v	-0.0892	0.0847	0.0659	[1]

Vertical diameter change:	Δd_v	0.4	mm
Horizontal diameter change:	Δd_h	0.3	mm
Relative vertical deformation:	δ_v	0.20	%
Allowable deflection:	all d_v	6.00	%

The deflection determined is less than the allowable deflection.

Deflection proof (with maximum groundwater):

Calculation method:		linear		
Ratio:		$I/(A_{rad} \cdot r_m^2)$	0.00335	[1]
Ratio:		$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0.00402	[1]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments:	c_v	-0.0833	0.0833	0.0640	[1]
Deflection coefficient for axial forces:	cN_v	-0.648	-0.681	-0.247	[1]
Deflection coefficient for lateral forces:	cQ_v	-0.335	0.335	0.243	[1]
Resultant deflection coefficient:	c'_v	-0.0892	0.0847	0.0659	[1]

Vertical diameter change:	Δd_v	0.4	mm
Horizontal diameter change:	Δd_h	0.3	mm
Relative vertical deformation:	δ_v	0.20	%
Allowable deflection:	all d_v	6.00	%

The deflection determined is less than the allowable deflection.

Stability proof (linear) (with maximum groundwater):

Total vertical load	q_v	38.8	kN/m²
Reduction factor for soil/traffic load:	κ_{v2}	0.86	[1]
Critical buckling load (soil/traffic load):	crit q_v	3,828.0	kN/m²
Partial buckling safety coefficient (soil/traffic load):	$\gamma_{buckl,qv}$	98.69	[1]
External water pressure:	p_e	10.0	kN/m²
Plus vacuum in the pipe:	p_i	0.0	kN/m²
Sytem stiffness without traffic load correction:	V_{RB}	0.0544	[1]
Input value δ_{v2} for determining κ_{a2}:	δ_{v2}	1.20	%
Predeformation reduction factor for water pressure:	κ_{r2}	0.90	[1]
Local predeformation reduction factor for water pressure:	κ_{r1}	1.00	[1]
Parameter k* (substitute for r_m/s) for determining α_D:	k*	5.000	[1]
Perforation coefficient:	α_P	5.467	[1]
Critical buckling load (external water pressure):	crit p_e	2,569.2	kN/m²
Partial buckling safety coefficient (ext. water pressure):	$\gamma_{buckl,pe}$	256.92	[1]
Buckling safety coefficient:	γ_{buckl}	71.30	[1]
Required buckling safety coefficient:	req γ_{buckl}	2.00	[1]

The buckling safety coefficients determined are sufficient.

Non linear stability proof (with maximum groundwater):

- n/a -

Proof for load case combination 1, Long term

Stress proof (with minimum groundwater):

Calculated ultimate flexural tensile stress, soil/traffic load:	$\sigma_{,calc,BZ}$	14.0	N/mm²
Calculated ultimate flexural compr. stress, soil/traffic load:	$\sigma_{,calc,BD}$	14.0	N/mm²
Ultimate flexural tensile stress due to other loads:	$\sigma_{all,BZ}$	14.0	N/mm²
Ultimate flexural compressive stress due to other loads:	$\sigma_{all,BD}$	14.0	N/mm²

Internal:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	-0.038	-0.232	-0.038	N/mm²
Stress due to other loads:	$\sigma_{other,i}$	-0.012	-0.065	0.006	N/mm²
Safety coefficient:	γ_{BTi}	---	---	---	[1]
Safety coefficient:	γ_{BCi}	282.68	47.09	449.32	[1]

External:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-0.23	-0.10	-0.23	N/mm²
Stress due to other loads:	$\sigma_{other,a}$	-0.05	-0.01	-0.06	N/mm²
Safety coefficient:	γ_{BTe}	---	---	---	[1]
Safety coefficient:	γ_{BCe}	49.38	132.96	48.21	[1]

Required flexural tensile safety coefficient:	req γ_{BT}	2.50	[1]
Required flexural compressive safety coefficient:	req γ_{BC}	2.50	[1]

The stress safety coefficients determined are sufficient.

Stress proof (with maximum groundwater):

Calculated ultimate flexural tensile stress, soil/traffic load:	$\sigma_{,calc,BZ}$	14.0	N/mm²
Calculated ultimate flexural compr. stress, soil/traffic load:	$\sigma_{,calc,BD}$	14.0	N/mm²
Ultimate flexural tensile stress due to other loads:	$\sigma_{all,BZ}$	14.0	N/mm²
Ultimate flexural compressive stress due to other loads:	$\sigma_{all,BD}$	14.0	N/mm²

Internal:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	-0.037	-0.231	-0.037	N/mm²
Stress due to other loads:	$\sigma_{other,i}$	-0.050	-0.103	-0.031	N/mm²
Safety coefficient:	γ_{BTi}	---	---	---	[1]
Safety coefficient:	γ_{BCi}	161.02	41.97	204.15	[1]

External:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-0.23	-0.10	-0.23	N/mm²
Stress due to other loads:	$\sigma_{other,a}$	-0.08	-0.04	-0.09	N/mm²
Safety coefficient:	γ_{BTe}	---	---	---	[1]
Safety coefficient:	γ_{BCe}	44.65	102.84	43.70	[1]

Required flexural tensile safety coefficient:	req γ_{BT}	2.50	[1]
Required flexural compressive safety coefficient:	req γ_{BC}	2.50	[1]

The stress safety coefficients determined are sufficient.

Deflection proof (with minimum groundwater):

Calculation method:		linear	
Ratio:	$I/(A_{rad} \cdot r_m^2)$	0.00335	[1]
Ratio:	$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0.00402	[1]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments:	c_v	-0.0833	0.0833	0.0640	[1]
Deflection coefficient for axial forces:	cN_v	-0.648	-0.681	-0.247	[1]
Deflection coefficient for lateral forces:	cQ_v	-0.335	0.335	0.243	[1]
Resultant deflection coefficient:	c'_v	-0.0892	0.0847	0.0659	[1]

Vertical diameter change:	Δd_v	0.5	mm
Horizontal diameter change:	Δd_h	0.1	mm
Relative vertical deformation:	δ_v	0.25	%
Allowable deflection:	all d_v	6.00	%

The deflection determined is less than the allowable deflection.

Deflection proof (with maximum groundwater):

Calculation method:		linear		
Ratio:		$I/(A_{rad} \cdot r_m^2)$	0.00335	[1]
Ratio:		$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0.00402	[1]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments:	c_v	-0.0833	0.0833	0.0640	[1]
Deflection coefficient for axial forces:	cN_v	-0.648	-0.681	-0.247	[1]
Deflection coefficient for lateral forces:	cQ_v	-0.335	0.335	0.243	[1]
Resultant deflection coefficient:	c'_v	-0.0892	0.0847	0.0659	[1]

Vertical diameter change:	Δd_v	0.5	mm
Horizontal diameter change:	Δd_h	0.1	mm
Relative vertical deformation:	δ_v	0.25	%
Allowable deflection:	all d_v	6.00	%

The deflection determined is less than the allowable deflection.

Stability proof (linear) (with maximum groundwater):

Total vertical load	q_v	25.5	kN/m²
Reduction factor for soil/traffic load:	κ_{v2}	0.87	[1]
Critical buckling load (soil/traffic load):	crit q_v	1,740.3	kN/m²
Partial buckling safety coefficient (soil/traffic load):	$\gamma_{buckl,qv}$	68.19	[1]
External water pressure:	p_e	10.0	kN/m²
Plus vacuum in the pipe:	p_i-	0.0	kN/m²
Sytem stiffness without traffic load correction:	V_{RB}	0.0109	[1]
Input value δ_{v2} for determining κ_{a2}:	δ_{v2}	1.25	%
Predeformation reduction factor for water pressure:	κ_{r2}	0.94	[1]
Local predeformation reduction factor for water pressure:	κ_{r1}	1.00	[1]
Parameter k* (substitute for r_m/s) for determining α_D:	k*	5.000	[1]
Perforation coefficient:	α_P	7.875	[1]
Critical buckling load (external water pressure):	crit p_e	769.4	kN/m²
Partial buckling safety coefficient (ext. water pressure):	$\gamma_{buckl,pe}$	76.94	[1]
Buckling safety coefficient:	γ_{buckl}	36.15	[1]
Required buckling safety coefficient:	req γ_{buckl}	2.00	[1]

The buckling safety coefficients determined are sufficient.

Non linear stability proof (with maximum groundwater):

- n/a -

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