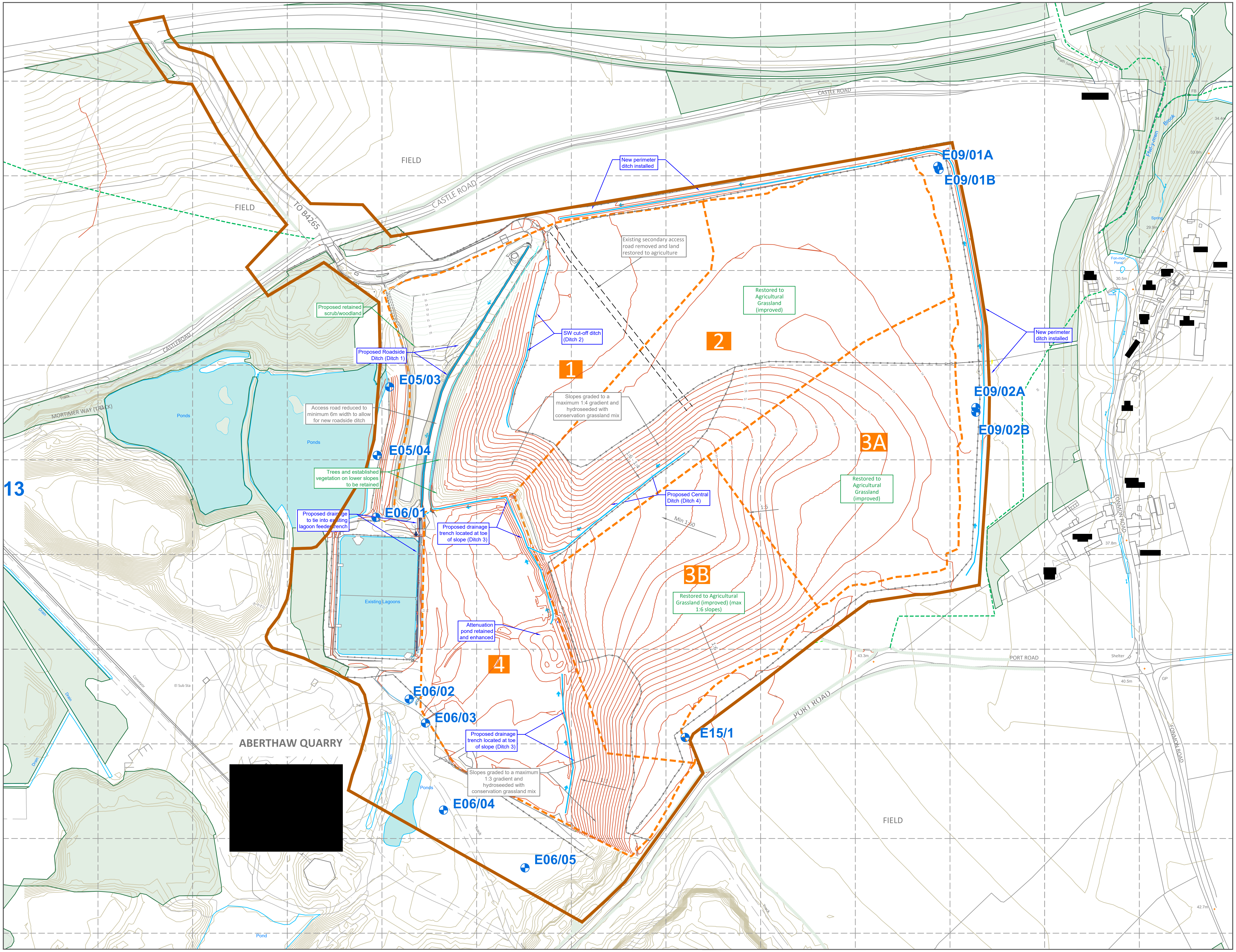
Appendix B
Restoration Scheme And Associated Drainage Plans


13
FIELD
FIELD
CASTLE ROAD
TO B4265
CASTLE ROAD
MORTIMER WAY (TRACK)
Ponds
Ponds
Existing Lagoons
ABERTHAW QUARRY
[redacted]
Proposed retained scrub/woodland
Proposed Roadside Ditch (Ditch 1)
Access road reduced to minimum 6m width to allow for new roadside ditch
Trees and established vegetation on lower slopes to be retained
Proposed drainage to tie into existing lagoon feeder trench
Proposed drainage trench located at toe of slope (Ditch 3)
Attenuation pond retained and enhanced
Proposed drainage trench located at toe of slope (Ditch 3)
Slopes graded to a maximum 1:3 gradient and hydroseeded with conservation grassland mix
SW cut-off ditch (Ditch 2)
Slopes graded to a maximum 1:4 gradient and hydroseeded with conservation grassland mix
Existing secondary access road removed and land restored to agriculture
New perimeter ditch installed
New perimeter ditch installed
Proposed Central Ditch (Ditch 4)
Restored to Agricultural Grassland (improved)
Restored to Agricultural Grassland (improved)
Restored to Agricultural Grassland (improved) (max 1:6 slopes)
Min 1:50
1:6
1
2
3A
3B
4
E05/03
E05/04
E06/01
E06/02
E06/03
E06/04
E06/05
E09/01A
E09/01B
E09/02A
E09/02B
E15/1
PORT ROAD
PORT ROAD
FIELD
Pond
FONMON ROAD
Shelter

ABERTHAW QUARRY, RHOOSE, WALES

Technical Note:
Proposed Surface Water Drainage and Attenuation Proposals, Post Restoration of Phases 3a, 3b and 4

AAC5891
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Contents

Appendices

1 INTRODUCTION

RPS have been appointed by RWE to review the proposed restoration works at Aberthaw Quarry, Rhoose, Barry and provide surface water drainage advice for the scheme. The site is located at ordnance reference coordinates 304161,167641.

Aberthaw North Quarry benefits from an existing planning consent as the long-term disposal site for pulverised fuel ash (PFA) generated by Aberthaw power station. The PFA was being used as an infill material to create a restoration landform that was suitable for agriculture. With the closure of the power station this source of PFA ceased in 2019.

Now that the deposition of PFA has ceased a new restoration scheme is required for the Aberthaw North Quarry. There is now a considerable shortfall in material volumes to achieve the approved landform. It is considered that the importation of materials to achieve the approved landform is neither practical nor desirable. On this basis a new restoration scheme has been developed based on utilising the existing materials already available on site.

This report has been prepared to support the submission of a new planning application for the amendments to the consented restoration of Aberthaw North Quarry. It will facilitate/support discussions with the landowner prior to handing back the site and will also feed into the future surrender of the existing Environmental Permit that controls the PFA infilling and restoration works.

Several consultants have been retained by RWE to prepare the technical information required to support the new planning application, provide any technical justification in relation to amendments to the environmental permit and to address likely landowner concerns. This report should be read in conjunction with separate reports and details describing a Hydrogeological Risk Assessment (HRA) and topsoil investigation works being undertaken by RPS for this scheme.

Details of the proposed revised scheme are shown on David Jarvis Associates (DJA) drawing Restoration Plan with Slope Analysis ref 2873-4-1-1-DR-0002 S4-P1, a copy of which is included at Appendix A. This plan indicates the restoration area, which is split into a number of phases, from 1-4. The restoration of Phases 1 and 2 is largely complete, whilst Phase 3a and 3b is partially complete. The majority of Phase 4 is no longer intended to receive PFA infilling material and therefore will not need to receive a topsoil restoration layer as part of the RWE works.

This drainage strategy will assess and propose a surface water drainage system that will provide for the adequate, safe and appropriate management of surface water flows on site following the restoration works. It will include an assessment of the baseline conditions, review of likely attenuation requirements and commensurate flow control measures, design of a suitable conveyance network and suggested maintenance information for the resulting drainage features.

2 SURFACE WATER RUNOFF

2.1 Discussion

In order to ascertain whether and to what extent the proposed PFA infilling works would generate a requirement for surface water attenuation, an assessment of greenfield runoff rates was made pre and post infilling works. Although in both the pre and post infilling scenarios the area will be, in essence, greenfield, it is anticipated that the different hydraulic properties of the PFA mass and compacted PFA cap/restoration soils will alter the proportion of rainfall falling on the site which will appear as runoff. The following sections assess the nature and likely magnitude of the anticipated change to the site runoff characteristics.

It is important to note that for the purposes of this drainage assessment, the component of surface water run off that is of interest is the “quick flow” element, i.e.: that proportion of rainfall falling over the site which will appear in the local watercourses within minutes and hours of the rainfall event starting.

Given the different hydraulic properties of the PFA infilling material, it is likely that there will also be a “slow flow” component to the runoff that will be initially held in the restoration layer before migrating laterally through the soil mass after encountering the impermeable compacted PFA cap. This slow flow component is anticipated to appear in the new ditch courses installed on site but is likely to present as small flows within the watercourses long after the rainfall event that produces the peak flows has passed. On that basis, this drainage strategy will only consider the “quick flow” component of the surface water runoff as this is likely to generate the peak surface water flows to be considered within the drainage design.

3 GREENFIELD FLOW RATES

3.1 PFA Characteristics

As stated above, it is envisaged that the introduction of a PFA mass infill and associated cap and restoration soils within the quarry will increase the proportion of rainfall appearing as run off. Laboratory tests have been undertaken on disturbed samples of PFA and other soils recovered from site, as detailed in the RPS produced report 220608RJFR2782 Aberthaw Quarry Ground Investigation Factual Report.

The report states that *"all samples analysed typically have low permeabilities'* and quotes permeability results of:

Uncompacted PFA:

- 1.1x 10^{-9} m/s
- 2.1 x 10^{-7} m/s

Compacted PFA:

- 7.9 x 10^{-8} m/s
- 6.5 x 10^{-8} m/s

Secondary data was also collated from journal sources (Galupino and Dungca, 2015, found in Appendix F) that showed the permeability of uncompacted PFA to be in the range of:

Uncompacted PFA:

- Minimum - 4.53 x 10^{-7} m/s
- Maximum - 5.52 x 10^{-7} m/s

Both the RPS lab tests and the secondary source data are comparable, and from a drainage perspective, these values are effectively impermeable.

3.2 Method of Analysis

The assessment of greenfield runoff has been undertaken using the Rural Runoff Calculator within the Source Control Module of MicroDrainage version 2020. This system allows the hydrological characteristics of a specific location to be selected from a database of information which is generated from a map location that is pinpointed using the first three digits of the Ordnance Survey easting and northing coordinates.

There are various recognised methods for calculating greenfield rural run off and in this instance, the IH 124 method was selected. This method of calculation is usually used for catchment areas of 50 ha and above, so for the purposes of obtaining an accurate result the assessment area is input as 50ha and then the result is proportionally reduced down to the actual site area contributing (where site areas are less than 50ha).

The MicroDrainage calculations for the pre and post-development scenario greenfield rural runoff calcs are contained at Appendix B. The common input information is listed below:

From AAC5891_RPS_XX_XX_DR_C_112-01_Surface_Water_Drainage_Areas the catchment area contributing to the proposed drainage system is **29ha**.

From MicroDrainage hydrological maps with location coordinates for the centroid of the site, x=*302, y=168,* the worst-case scenario SAAR (Standard Annual Average Rainfall) = **972mm**.

3.3 Greenfield Runoff QBar (Pre-Development Scenario)

The input SPR (Standard Percentage Runoff) variable for the pre-development assessment of QBar is SPR = **0.15**. This value is automatically generated from the location grid coordinates and MicroDrainage database.

To use IH124 Method, initial area input as 50ha and output QBar is adjusted down to the site area of 29ha.

QBar for 50ha = 29.7 l/s

Adjusted for site area of 29ha = **17.23 l/s**

3.4 Greenfield Runoff QBar (Post-Development Scenario)

To calculate QBar values for the Post-Development scenario, the revised hydrological characteristics of the PFA infill as input into the Rural Runoff Calculator need to be ascertained.

The location of the site, the site area and the standard average annual rainfall values do not change from the values used in the Pre-Development Assessment. Thus, the only variable that changes as a result of the PFA infilling works is the SPR value, which is also the same as the Soil Index value.

The Soil Index of the catchment can be found from Flood Studies Report (FSR) figure I.4.18 or Wallingford Procedure Volume 3. Soil classes 1 to 5 have Soil Index values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively. The lower figures represent soils which generate lower surface water runoff rates, and the higher figures generate greater surface water runoff rates. It can be seen from the details at 3.3 above that the “natural” Soil Index value for this location is 0.15, i.e.: relatively free draining with the least proportion of rainfall appearing as runoff.

In selecting an appropriate Post-Development SPR value, permeability characteristics of the PFA were of vital importance. As discussed at 3.1, the RPS derived laboratory tests show the compacted PFA cap to be installed above the PFA mass infill to have a very low permeability. Defining the PFA by permeability allows for the Soil Index value to be more accurately identified. The PFA permeability was considered to be similar in value to a clay soil, which would normally return a Soil Index value of 0.45 – see table below, replicated from the MicroDrainage software:

Soil Index	General Description	Soil Type
0.150	i) Well drained permeable sandy or loamy soils and shallower analogues over highly permeable limestone, chalk, sandstone or related drifts. ii) Earthy peat soil drained by dikes and pumps. iii) Less permeable soils in valleys.	1
0.300	i) Very permeable soils with shallow groundwater. ii) Permeable soils over rock or frangipani, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils. iii) Moderately permeable soils, some with slowly permeable subsoils.	2

Soil Index	General Description	Soil Type
0.400	i) Relatively impermeable soils in boulder and sedimentary clays and in alluvium, especially in eastern England. ii) Permeable soils with shallow groundwater in low lying areas. iii) Mixed areas of permeable and impermeable soils in approximately equal proportions.	3
0.450	i) Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.	4
0.500	Soils of the wet upland i) With peaty or humose surface horizons and impermeable layers at shallow depth. ii) Deep raw peat associated with gentle upland slopes or basin sites. iii) Bare rock cliffs and screes. iv) Shallow, permeable rocky soil on steep slopes.	5

However, for the most robust assessment the maximum value of 0.500 was input into the calculations which will lead to a greater run off rate calculated. These calculations are included in Appendix B.

From table above, new SPR = **0.5**

SAAR is still equal to 972mm as site location hasn't changed

QBar for 50ha = 405.4 l/s

QBar when adjusted for site area of 29ha = **235.132 l/s**

Due to the increased surface water runoff in the post-development scenario (235l/s versus 17l/s), surface water attenuation will be necessary. Subject to confirmation of capacity, it is proposed that the existing lagoons situated to the west of the quarry infill works can be re-used for attenuation purposes.

4 EQUIVALENT IMPERMEABLE AREA

4.1 Discussion

The assessment of pre and post greenfield flow rates has identified that an increase in surface water runoff is expected following the PFA infilling works and installation of compacted PFA cap. The design and review of the proposed drainage system under different storm conditions will be carried out using the Network module of MicroDrainage version 2020. This will allow the sizing and simulation of both the conveyance network and the attenuation system under different storm conditions to ensure satisfactory performance.

As discussed in Section 2.1 above, the design of the drainage conveyance and attenuation features will consider the likely peak flow rates in the system, which will be generated by the “quick flow” component of the surface water runoff. By designing for this peak flow, the conveyance systems will, by definition, also be able to accommodate the lower “slow flow” component of surface water runoff expected in the system when the design storm has passed.

In order to use the MicroDrainage Network module, one of the variables required to be input into the software is that impermeable area which contributes to each drainage element to be designed. In a standard development model, the introduction of hardstanding areas and buildings would reduce the overall permeability and increase the impermeable areas of the site, thus increasing the rate of surface water runoff. However, in the case of Aberthaw Quarry, there are no new impermeable areas proposed to be installed. Rather, it is the altered hydrological properties of the PFA material that is increasing the rate of runoff, as evidenced by the difference in the pre and post-development greenfield runoff rates. It was therefore necessary to somehow represent to the design software the extent of the increased surface water runoff created by the introduction of the PFA material as an impermeable area.

This has been achieved by the introduction of an “Equivalent Impermeable Area”, which is derived as described below. It is important to note that this “Equivalent Impermeable Area” is simply a device to allow the MicroDrainage system to understand and design for the increased proportion of surface water runoff generated post PFA infilling works and placement of PFA cap.

4.2 Derivation

The Equivalent Impermeable Area represents an impermeable area that would generate the same surface water runoff rate as that occurring from the changed hydrological properties of the PFA. We can therefore use the greenfield run off calculations already undertaken as a basis to establish the proportional increase in surface water runoff.

The base QBar calculation that the Rural Runoff Calculator within the Source Control module of MicroDrainage version 2020 uses is as follows:

$$QBAR = 0.00108 \times (0.01 \times AREA)^{0.89} \times SAAR^{1.17} \times SPR^{2.17}$$

$$QBAR = m^3/s$$

$$AREA = ha$$

$$SAAR = mm$$

$$SPR = Unitless$$

To work out an equivalent impermeable area, use the greenfield flow rates already established and re-arrange the equation with the SPR (Standard Percentage Runoff) equal to 1.0. This replicates an impermeable surface where 100% of the water is shown as surface runoff.

4.2.1 Greenfield (Pre-Development Scenario)

SAAR will be the same as the site location has not changed so = **972mm**

QBar is the greenfield QBar rate for the 29ha site = 17.23 l/s (as per section 2.2.3 above) **= 0.01723** m^3/s (Units to use within equation)

SPR = 1.0

From rearranging the QBar equation **AREA^{equiv} = 0.2654 ha**.

This expressed as a percentage of the whole 29ha site = 0.92% = **1% Impermeable Area**

4.2.2 Post-Development

SAAR will be the same as the site location has not changed so = **972mm**

QBar is the post-development QBar rate for the 29ha site = 235.132 l/s (as per section 2.2.4 above) **= 0.235132** m^3/s (Units to use within equation)

SPR = 1.0

From rearranging the equation **AREA^{equiv} = 5.00 ha**.

This expressed as a percentage of the whole 29ha site = **17 % Impermeable Area**

From the result above in 4.2.2, it can be shown that the increase in surface water runoff generated by the introduction of the less permeable PFA infill material is equivalent to introducing a 17% impermeable area onto the site.

This means that a standard drainage design can now be undertaken to size the proposed individual drainage components (ditches, pipes and storage areas) and allow the system to be checked for performance against different storm events.

5 DRAINAGE STRATEGY

A Drainage Area Plan has been prepared with respect to the revised restoration levels. The restoration levels have been designed by David Jarvis Associates (DJA) to achieve a materials balance utilising the available material volumes currently present on site. A copy of DJA drawing "Restoration Plan with Slope Analysis ref 2873-4-1-1-DR-0002 S4-P1" describing those levels is included at Appendix A.

The proposed topography of the site was assessed, and the total site area split up into individual drainage areas that would each feed into a particular length of the drainage conveyance network. The total area for each drainage region was then converted into an equivalent impermeable area as per the methods outlined in Section 4. This is displayed within the RPS drawing 'AAC5891_RPS_XX_XX_DR_C_112-01_Surface_ Water_Drainage_Areas', a copy of which is included at Appendix C.

5.1 Ditches

A series of ditches and pipes have been designed to manage post-development surface water flows with a preference for ditches over pipes for the following reasons:

- Ditches are more appropriate in form to farming use and future maintenance.
- Ditches are better in terms of mimicking natural drainage.
- Ditches are better for biodiversity.
- Ditches typically have more hydraulic capacity than a pipe of a similar diameter to the ditch depth.

A drawing showing the proposed drainage network, RPS drawing 'AAC5891_RPS_XX_XX_DR_C_101-01_Drainage_Layout' is included at Appendix C.

The ditches will perform both cut-off/intercept and conveyance functions. They are proposed to be situated at the toe of embankments, top of embankments where levels are falling towards the embankment and at the edge of the site to manage and control quick flow component of surface runoff producing peak flow conditions and the slow flow component appearing through the 600mm deep restoration soils.

Where necessary for crossing beneath the access roads, short sections of ditch will be culverted with appropriately sized pipes to allow access to be maintained.

The minimum geometry of the ditches is shown on drawing AAC5891_RPS_XX_XX_DR_C_104-01_Construction_Details. Typically, the minimum depth of a ditch where situated on PFA infill is equal to 600mm, which matches the depth of the restoration soils layer. This is to ensure that both surface water runoff (quick flow) and the slower runoff through the restoration soils matrix is all captured and routed through the attenuation lagoons.

A perimeter ditch drain has been largely installed at the edge of the quarry infill to the eastern and northern boundaries of the site, in accordance with approved Bingham Hall Partnership Ltd drawing 5764A/066 – Final Permeant Infilled Quarry Profile , located in appendix E. It is intended that this feature is retained but infilled with a coarse graded stone to allow proposed restoration levels to continue to fall towards to the site boundary. A new perimeter ditch is to be installed immediately within the redline site boundary to ensure that all surface water flows generated on site are managed and routed through the existing attenuation lagoon. Since the PFA infilling works do not extend right to the site boundary (the topsoil bunds are present between the quarry infill works and the site boundary), a minimum depth of ditch of 600mm is proposed for this new site perimeter ditch.

Ditches are designed to either run with the topography of the land at a minimum 600mm deep or if draining against the lie of the land, at a minimum gradient of 1:500. There exists in the north-eastern corner of the site a natural low spot. It is intended that the new site perimeter ditch be installed to continually fall from its highest point at the south-eastern site corner to the existing lagoons. A short, filter drain connection is proposed between the existing perimeter ditch drain and the new site perimeter ditch to ensure that a localised low spot in the north-east corner of the site is adequately drained.

5.2 Filter Drains

A filter drain with a perforated collector pipe is also proposed on the eastern side of the access road as there is insufficient room to install an adequate ditch profile without re-grading and disturbing existing vegetation present on the existing PFA bank to the east of the access road.

The proposed ditch on the western side of the access road is intended to be installed within the current road space thereby narrowing the access road as shown on the aforementioned drainage layout drawing. Again, this is to avoid disturbing the existing vegetated PFA slope on the western side of the access road. The resultant minimum road width will be 6m wide.

Filter trenches are also proposed to be installed at the top of some embankments to intercept and control any surface water flowing towards the embankment and minimise surface flows across face of embankments. The filter trenches will be connected to the proposed ditches network as shown on the drainage layout drawing.

5.3 Attenuation Lagoon

The proposed network of ditches and pipes collect and convey all surface water flows on site and direct them to and through the existing settlement lagoons situated at the western edge of Phase 4. The construction of the existing lagoons is as described in Bingham Hall Partnership Ltd drawings 5764A-010B-General Lagoon Arrangement Plan. It is intended that these existing lagoons will be retained and used to attenuate the anticipated increase in surface water flows post restoration.

It is understood that the primary original purpose and arrangement of the lagoons was to allow for the settlement of sediment washed from the infilling works area to settle out prior to discharge from the site. The provision of two lagoons was to allow a duty and standby function, where one lagoon could be utilised for surface water runoff control whilst the other was being de-silted. The lagoons also enabled run off to be held and re-used as part of the site wide management and control during filling works for activities such as wheel washing and dust control.

It is suggested that once the reprofiling works are complete and the restoration soil layer has been installed, the lagoons can be operated for attenuation rather than settlement. This will be achieved by amending the flow control arrangement (see below) which will ensure that the lagoons act as detention rather than retention features. This means that the lagoons should only hold water temporarily in times of heavy rainfall and will drain down to empty once the major storm event has passed.

The geometry of one of the lagoons and a pass forward flow rate based on the predevelopment QBar rate has been modelled within the proposed drainage network. Simulation calculations which describe the systems response to the 1:2 year, 1:30 year and 1:100 year plus 40% climate change storm events are included at Appendix D.

Please note with regards to the appended MicroDrainage calculations, the reference under the column dealing with pipe diameters to -1, -2, and -3 and is representative of a pipe code which defines a certain profile ditch shape.

An assessment of the available storage capacity within these existing lagoons shows that each lagoon can hold circa 7500m³ of water with 500mm of freeboard. The simulation calculations included at Appendix E show that for the 1:100 year plus 40% climate change event, the maximum water level in one of the lagoons is 20.045m, considering the bed level of the pond being 19.10m, this creates a maximum water depth of 945mm. The dimensions for the plan area of the lagoon base, taken from Bingham Hall Partnership Ltd drawings 5764A-010B-General Lagoon Arrangement Plan, states the lagoon base to be 75m by 55m (4125m^2). This equates to a maximum stored volume of water within the lagoon of 3898m³.

5.4 Flow Control

It is understood from contract documentation provided by the Client that the lagoons were designed with a hydrobrake flow control device to limit flows from the site to 100l/s. From the pre-development greenfield runoff calculations undertaken at 3.3 above, it is proposed that new hydrobrake control unit limiting post development flows to 17.23l/s will be installed.

Drawing AAC5891_RPS_XX_XX_DR_C_105-01_Outfall Construction Details_P01 is included at Appendix C which shows how the approved Bingham Hall detailed control structures will be amended to allow a standard vortex flow control device to be fixed to the existing weir wall at the lowest bed level of the lagoon. The initial Bingham Hall design was taken from Bingham Hall drawing, 5764A-015 Lagoon Outlet Chamber Details found in Appendix F. The flow control will be constructed to allow the pre-development greenfield flow rate to pass forward uninterrupted, with any flows in excess of this figure being temporarily held back and discharged once the peak flow in the downstream system has passed.

5.5 Flooding

The simulation calculations at Appendix E highlight that during the 1:100 year plus 40% CC event, a small amount of flooding (4.164m3) occurs at the upstream end of pipe length 5.005. This is the road filter trench to be installed on the eastern side of the lagoon access road. The magnitude and position of the anticipated flooding is not considered to be significant, and any flood flows generated will be contained within the road area and will re-enter the drainage system either further downstream on the same road filter trench or into the ditchcourse on the opposite side of the road. In both cases the flood flows will be contained on site and routed through the attenuation lagoon.

6 DESIGN OF RESTORATION SOILS LAYER – DRAINAGE CONSIDERATIONS

The restorations soil layer consisting of the material and depths as listed in the table contained on DJA drawing “Restoration Plan with Slope Analysis ref 2872-4-1-1-DR-0003 S4-P1” included at Appendix A has been reviewed from a drainage viewpoint.

The laboratory tests referred to at Section 3.1 of this report, as detailed in RPS report 220608RJFR2782 Aberthaw Quarry Ground Investigation Factual Report indicate that the existing topsoil, subsoil and PFA material all have generally low permeability characteristics. A drainage layer as shown on the previously approved DJA drawing 1521/016A – Proposed Drainage System – Details, found in Appendix A, is intended to be installed to provide for a fit for purpose growing layer appropriate to agricultural grazing land. Further details of the restoration layer can be found in JFR2728 Hydrological/Hydrogeological Risk Assessment.

The design of the proposed ditches with a minimum depth of 600mm will ensure that whether surface water runoff is appearing as “quick flow” running across the surface, or “slow flow” migrating through the soil matrix and into the drainage layer, all of the surface water appearing as run off will be collected into the surface water network and routed through the attenuation system. The use of ditches and continued use of the existing lagoons will ensure that any sediment within the surface water runoff has chance to settle out before being discharged from the site.

7 FUTURE MAINTENANCE REQUIREMENTS

The following schedules describe the recommended maintenance activities for each of the proposed drainage components.

7.1 Ditches

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Quarterly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
	Reseed areas of poor vegetation growth; alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the ditch area
Occasional Maintenance	Repair erosion or other damage by re-turfing or reseeding	As required
Remedial Actions	Relevel uneven surfaces and reinstate design levels	As required
	Break up silt deposits and prevent compaction of the soil surface	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

7.2 Inlet and Outlet Headwalls

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Litter removal	As required
	Inspect vegetation above and around headwall and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from aprons	Annually
	Flap valves and grilles (if fitted): Check for and clear obstructions	Quarterly
Remedial Actions	Repair of erosion or other damage around headwalls	As required
Monitoring	Inspect structures for evidence of poor operation	Monthly/after large storms
	Inspect structures, pipework etc. for evidence of physical damage	Monthly/after large storms
	Inspect silt accumulation rates and establish appropriate removal frequencies	Half yearly
	Check flap valves	Half yearly

7.3 Hydrobrake Flow Control Manhole

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove sediment from flow control chambers	Annually
	Flow control devices: Check for and clear obstructions	Quarterly
	Repair of Penstock and flow control device	As required
Remedial Actions	Inspect structures for evidence of poor operation	Monthly/after large storm
Monitoring	Inspect structures, flow control and pipework etc. for evidence of physical damage	Monthly/after large storm
	Inspect silt accumulation rates and establish appropriate removal frequencies	Half yearly

7.4 Attenuation Lagoon

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	As required potentially monthly
	Cut grass – meadow grass in and around basin	Half yearly (spring, before nesting season, and autumn)
	Inspect vegetation to pond edge and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Remove 25% of bank vegetation from water's edge to a minimum of 1m above water level	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from forebay	1 – 5 years, or as required
	Remove sediment from one quadrant of the main body of ponds without sediment forebays	2 – 10 years (usually)
	Remove sediment from the main body of big ponds, when pool volume is reduced by 20%	>25 years (usually)
Occasional Maintenance	Repair of erosion or other damage	As required
Remedial Actions	Aerate pond when signs of eutrophication are detected	As required
	Realignment of rip rap or other damage	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Inspect structures for evidence of poor operation	Monthly/after large storms
Monitoring	Inspect banksides, structures, pipework etc. for evidence of physical damage	Monthly/after large storms
	Inspect water body for signs of eutrophication	Monthly (May - October)
	Inspect silt accumulation rates and establish appropriate removal frequencies	Half yearly
	Check penstocks and other mechanical devices	Half yearly

7.5 Pipes

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly, if required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
Remedial Actions	Repair/rehabilitate inlets and outlet	As required
Monitoring	Survey inside of pipe for sediment build-up and remove if necessary	Every 5 years or as required
	Inspect/check all inlets and outlets to ensure that they are in good condition and operating as designed	Annually

7.6 Filter Drains

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
Occasional Maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (e.g.: NJUG, 2007 or BS 3998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

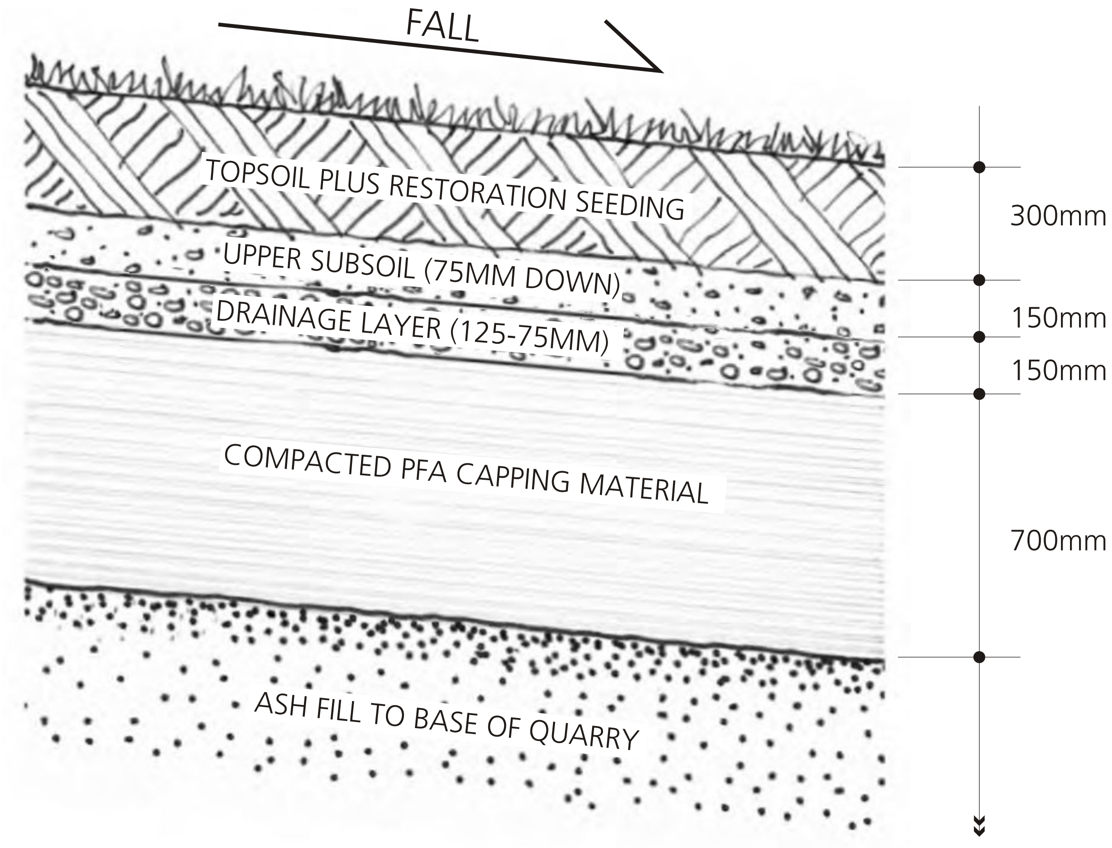
8 CONCLUSIONS AND RECOMMENDATIONS

It can be seen from the design drawings and calculations that the proposed drainage design operates satisfactorily during the simulated design storm events. From a review of predicted water levels within the lagoon, it is calculated that 3898m³ is required to attenuate the increased storm flows back to pre-development runoff rates.

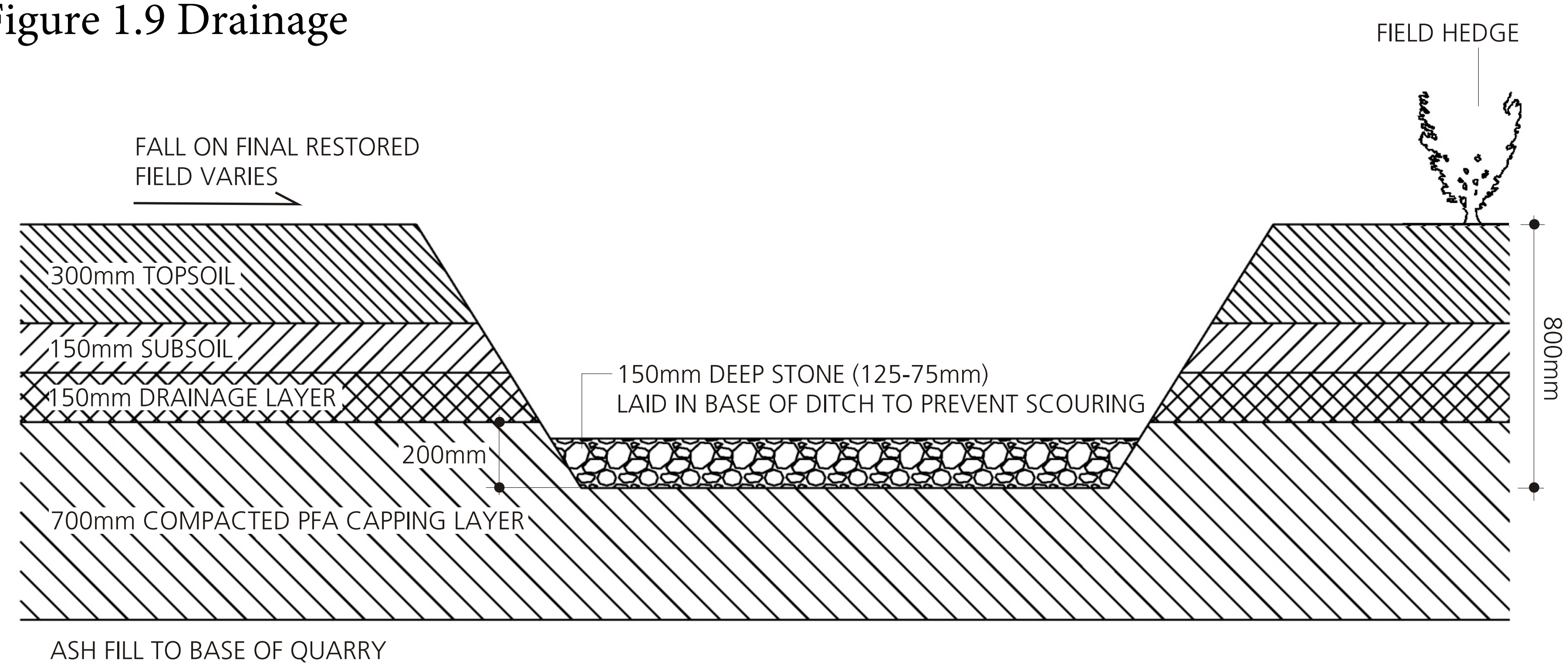
The proposed drainage network as described in the appended drawings and calculations will allow surface water runoff generated over the PFA infill areas to be managed appropriately and efficiently, in accordance with current best practice with no increase in downstream run off rates.

Appendix A – Restoration Plan with Slope Analysis

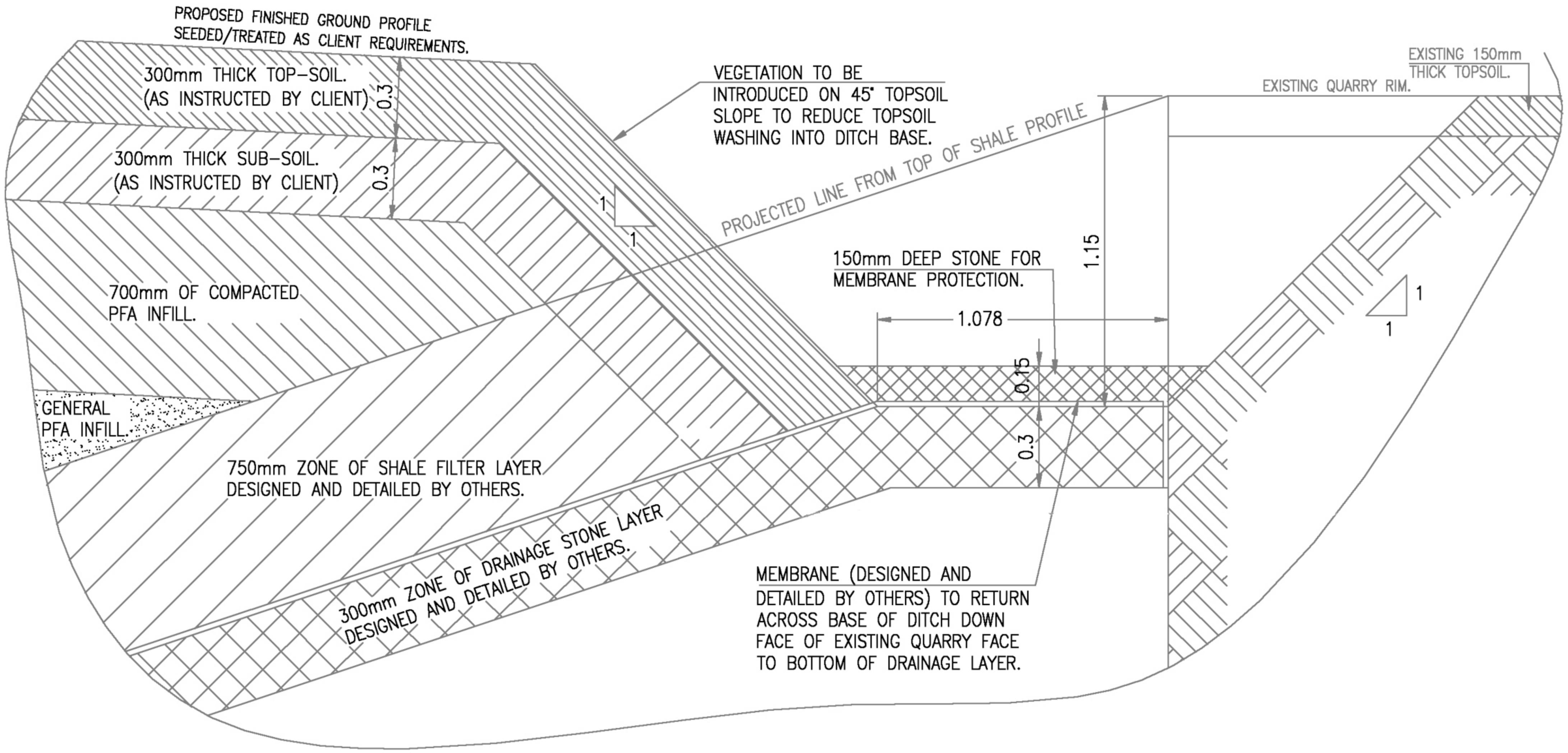
Figure 1.9 Drainage



Section to show restoration soil layers



Typical section through intermediate ditch



Section of Perimeter Ditch Drain

SCALE
0 0.5m 1.0m 2.0m

NOTE: Section of Perimeter Drain extracted from Bingham Hall Partnership Ltd Drawing No 5764A/064revA

Revision
A ADD NEW DITCH SECTION ON 12 JUNE 2009.

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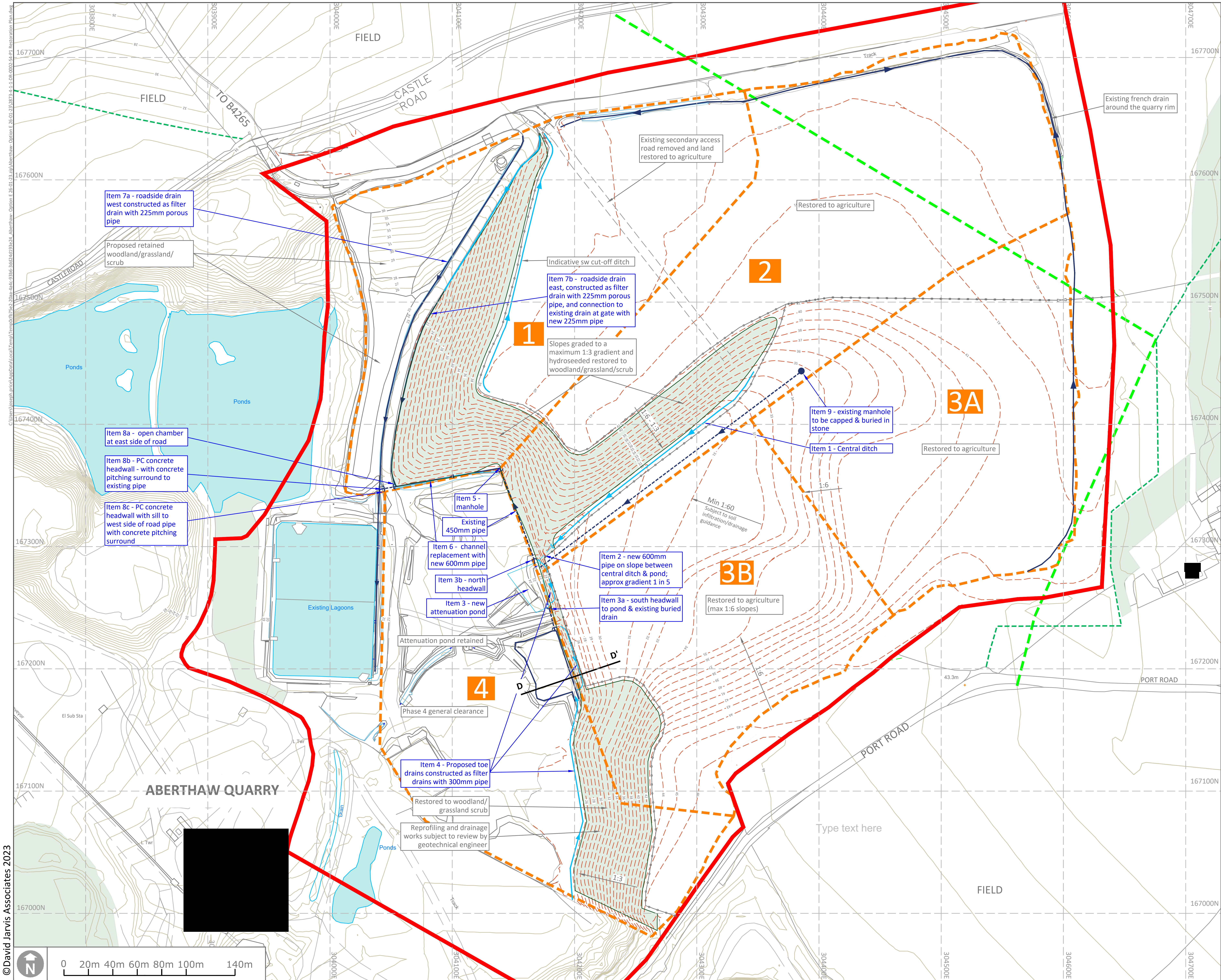
Client
RWE Npower:
Aberthaw Power Station

Project
ASH DISPOSAL
IN ABERTHAW QUARRY

Drawing Title
PROPOSED DRAINAGE SYSTEM - DETAILS

Scale	Date
1:20 at A3	JUNE 2009

Drawing No.
1521/016A



[redacted]

KEY

- Boundary: Application Site
- Boundary: Phase Boundaries
- 1 Consented Phasing
- 24 Existing Contours (at 1m intervals)
- 24 Proposed Restoration Contours (at 1m intervals)
- Existing drainage and direction of flow
- Proposed surface water drainage and direction of flow
- Existing buried drain
- Proposed buried drain
- Proposed woodland/ grassland/ scrub
- Proposed indicative field gate
- Proposed indicative fencing
- Existing footpath
- Consented footpath reinstatement to original alignment
- Item X — Quarry restoration proposed drainage works annotation Sept 2020

Notes

Related Drawings: DJA Drawing based on
2873-5-1-5 ASH QUARRY TOPO H MORRIS 180220 FE3691-01-3D
Emapsite: OS Mastermap and OS Terrain 5 Data

Status

DRAFT

DAVID JARVIS ASSOCIATES

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Client
RWE NPOWER ABERTHAW POWER STATION

Project
ABERTHAW QUARRY

Drawing Title
RESTORATION PLAN

Scale	Sheet Size	Date Plotted
1:2,000	A2	10/10/2023

Client Ref.	Drawing Ref.	Drawing No.	Version
-	2872-4-1-1	DR-0002	S4-P1

C:\Users\joseph.price\AppData\Local\Temp\Temp0cfb75e2-20aa-4a4c-93b6-3dd24d193e24_Aberthaw- Option E 26-01-23.zip\Aberthaw- Option E 26-01-23\2873-4-1-1-DR-0002-S4-P1

Appendix B – Greenfield Runoff Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	1	Soil	0.150
Area (ha)	50.000	Urban	0.000
SAAR (mm)	972	Region Number	Region 9

Results	**l/s**
QBAR Rural	29.7
QBAR Urban	29.7
Q1 year	26.2
Q1 year	26.2
Q2 years	27.6
Q5 years	36.0
Q10 years	42.2
Q20 years	48.5
Q25 years	50.7
Q30 years	52.4
Q50 years	57.6
Q100 years	64.8
Q200 years	73.4
Q250 years	76.4
Q1000 years	94.8

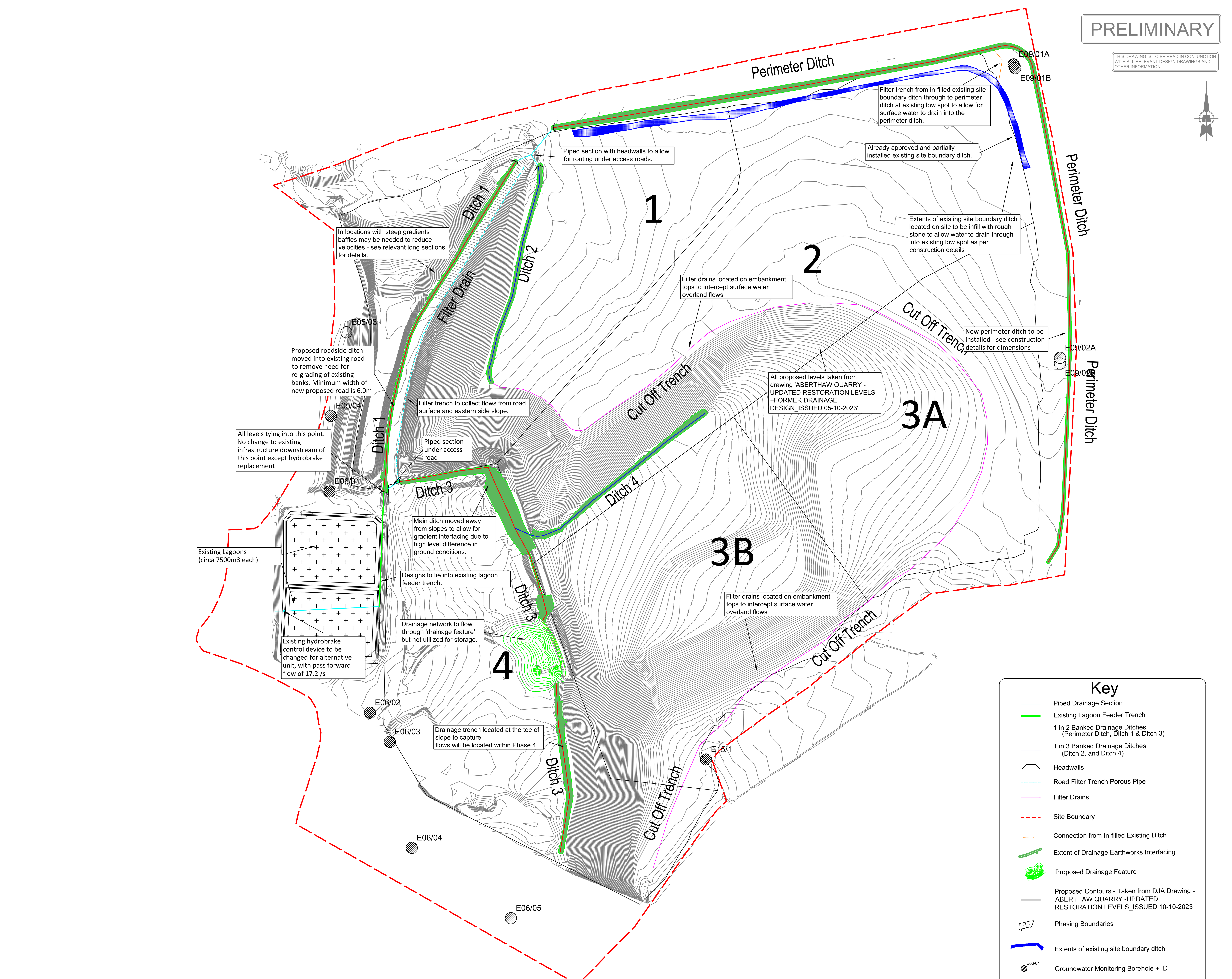
IH 124 Mean Annual Flood

Input

Return Period (years)	2	Soil	0.500
Area (ha)	50.000	Urban	0.000
SAAR (mm)	972	Region Number	Region 9

Results	**l/s**
QBAR Rural	405.4
QBAR Urban	405.4
Q2 years	376.5
Q1 year	356.7
Q2 years	376.5
Q5 years	490.5
Q10 years	575.6
Q20 years	661.1
Q25 years	690.7
Q30 years	714.7
Q50 years	784.8
Q100 years	883.7
Q200 years	1001.2
Q250 years	1041.8
Q1000 years	1293.1

Appendix C – RPS Drawings



Notes

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1:20 - 0, 200mm, 400mm, 600mm, 800mm, 1000, 1200, 1400, 1600, 1800, 2000
1:100 - 0, 1m, 2m, 3m, 4m, 5m, 6m, 7m, 8m, 9m, 10m
1:50 - 0, 1m, 2m, 3m, 4m, 5m
1:5 - 0, 100mm, 200mm, 300mm, 400mm, 500mm

Notes

- All drainage (Except for routing under roads) to be open course ditches
- Toe drains to be provided at the bottom of every slope
- Filter drains to exist at the top of every steep embankment (Greater than 1 in 4) to collect surface flows and help reduce cutting on steep embankments
- Location of main conveyance ditches to be assessed to allow for best interfacing of ditch banks back into slope gradients
- Baffles may be required within ditches that exceed steep gradients
- Proposed contours taken from DJ drawing - FINAL RESTORATION SURFACE LEVELS - ISSUED 29-08-23

Rev	Description	By	Ckd	Date
P08	Drawing updated to include revised drainage feature along ditch 3.			
P07	Drawing updated to suit revised surface levels taken from DJA drawing - FINAL RESTORATION SURFACE LEVELS - ISSUED 29-08-23	JP		31.08.23
P06	Environmental permit boundary shown as singular boundary for the site. Scale adjusted to 1:1500.	JP		06.07.23
P05	IPPC and application boundary added to drawing.	JP		16.06.23
P04	Removal of public right of way and associated headwalls	JP		09.06.23
P03	Drawing updated to reflect revised PFA infill levels (Drawing: 2873-4-1-1-DR-0002-S4-P1 Restoration Plan) and borehole locations added.	JP		31.05.23
P02	Drainage concept updated to reflect changes to slopes and removal of pipes as per client request.	JP		27:03:23
P01	First Issue	JP		15:09:22

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Client: RWE Generation UK

Project: Aberthaw Quarry Restoration

Title: Drainage Layout

Status	Scale	Date Created
Preliminary	1:1500 @A1	15.09.23
Task Team Manager	Information Author	Task Information Manager
SAS	JP	SAS

Document Number: AAC5891-RPS-xx-xx-DR-C-100-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P07

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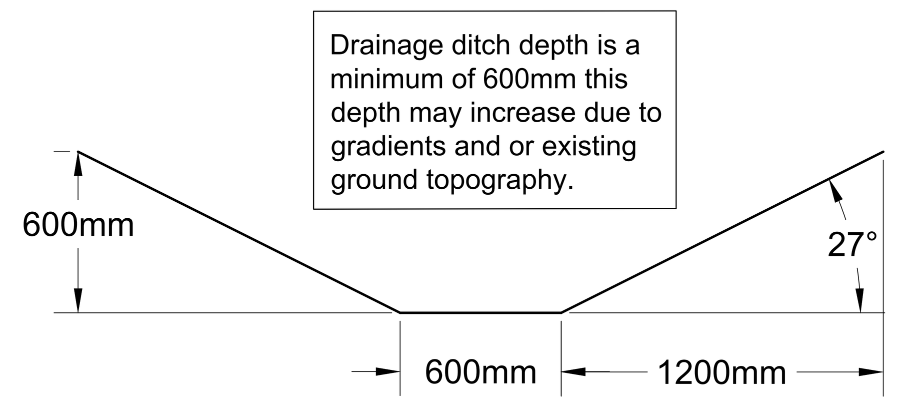
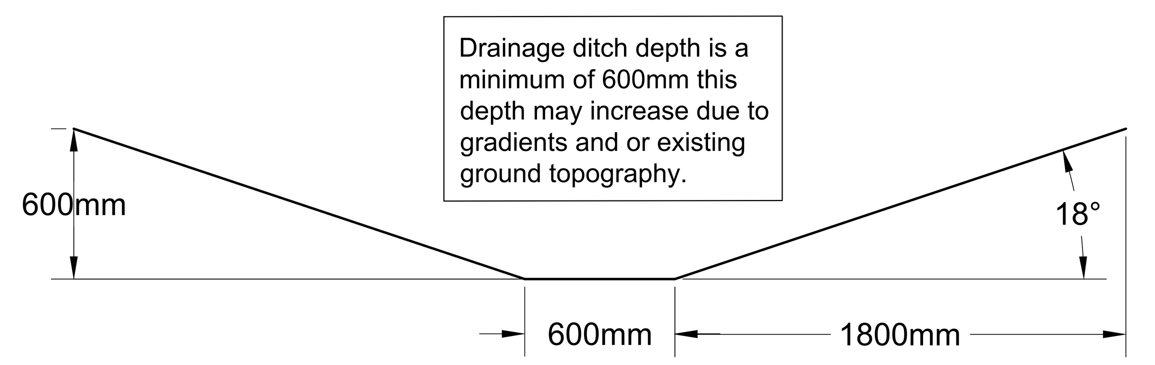
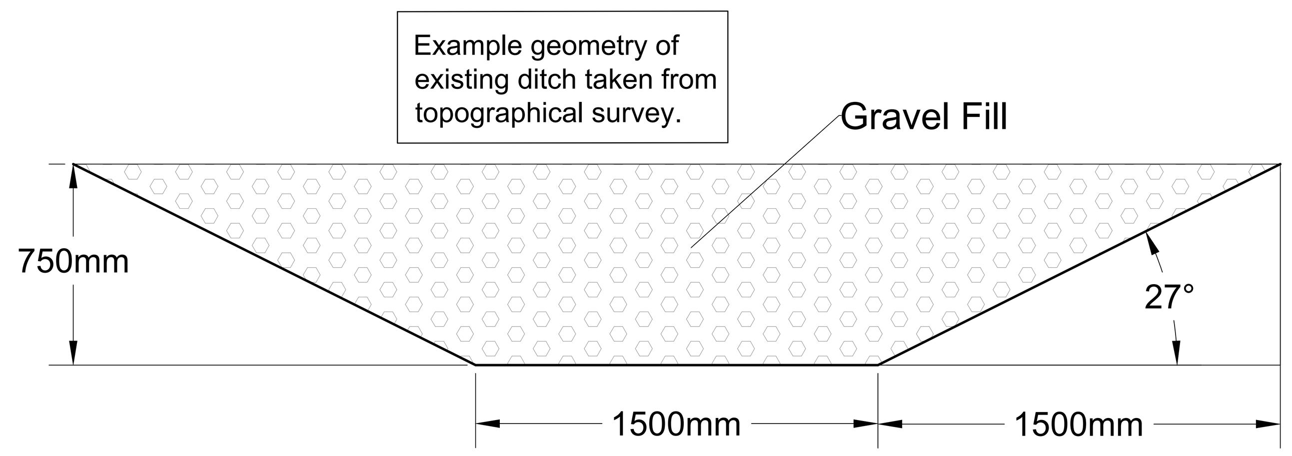
Minimum Depth 1 in 2 Bank Drainage Ditch
(Perimeter Drainage Ditch and Drainage Ditch 1)



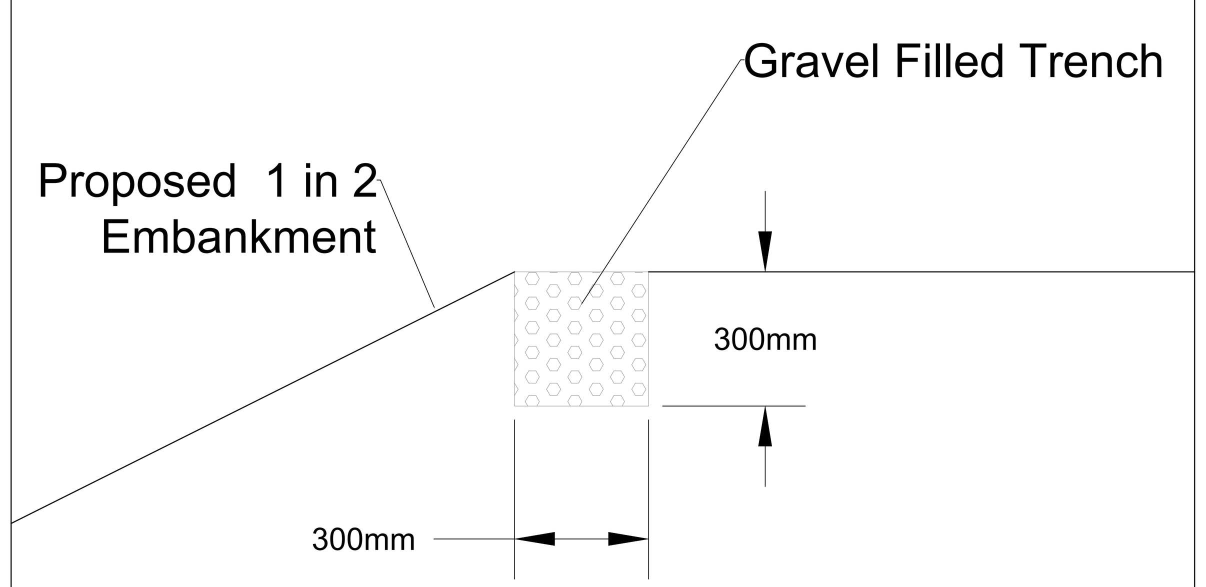
Minimum Depth 1 in 3 Bank Drainage Ditch
(Drainage Ditches 2, 3 and 4)



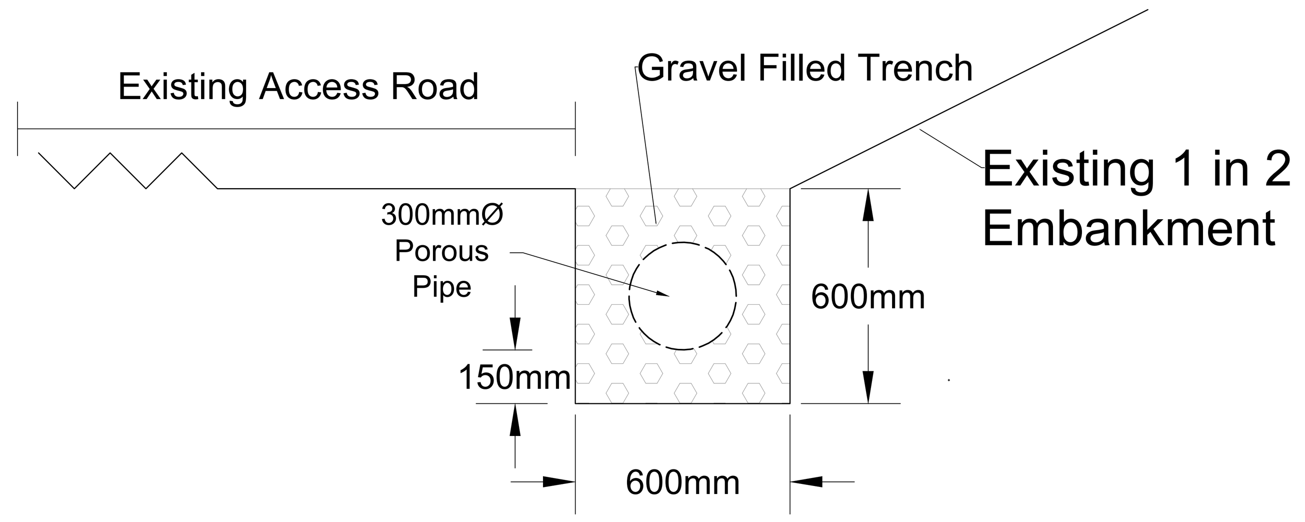
Existing Site Boundary Ditch To Be In-filled



Filter Trench

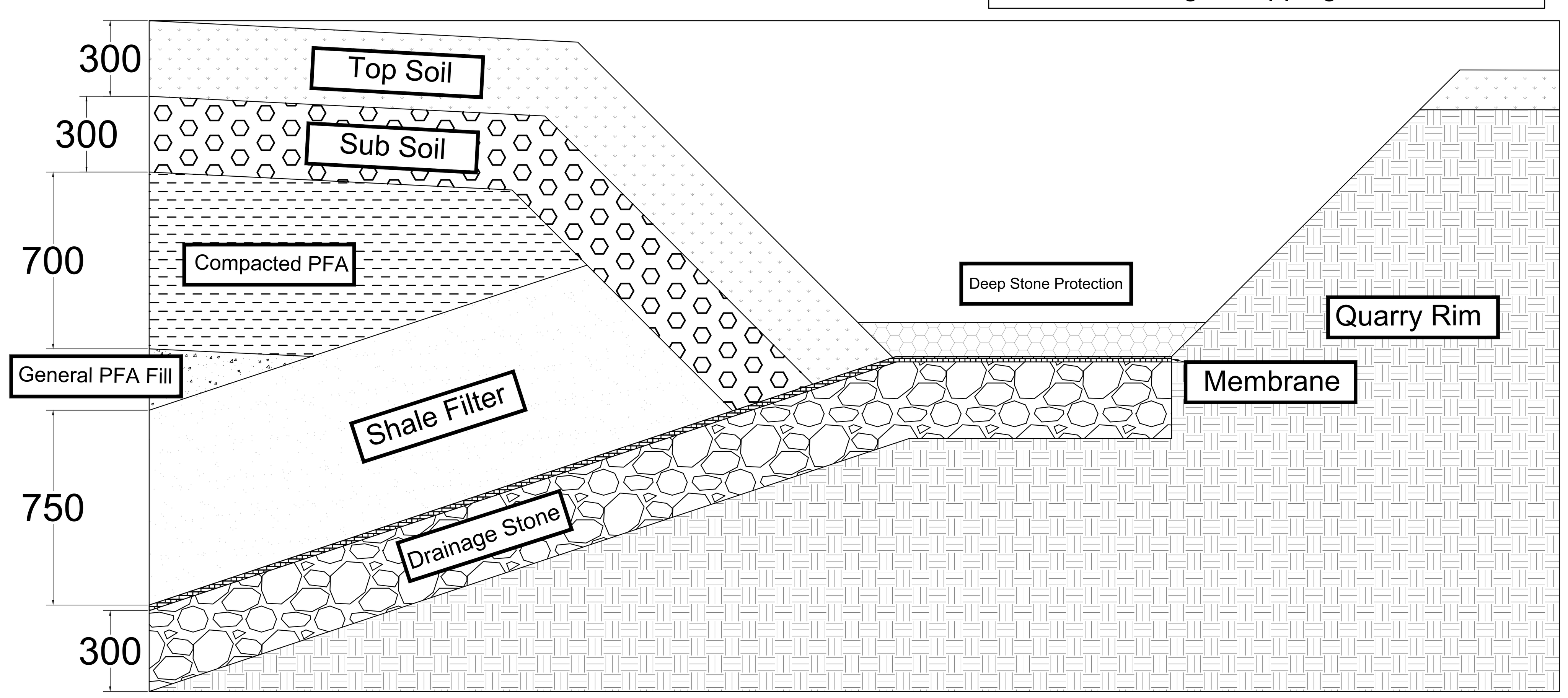


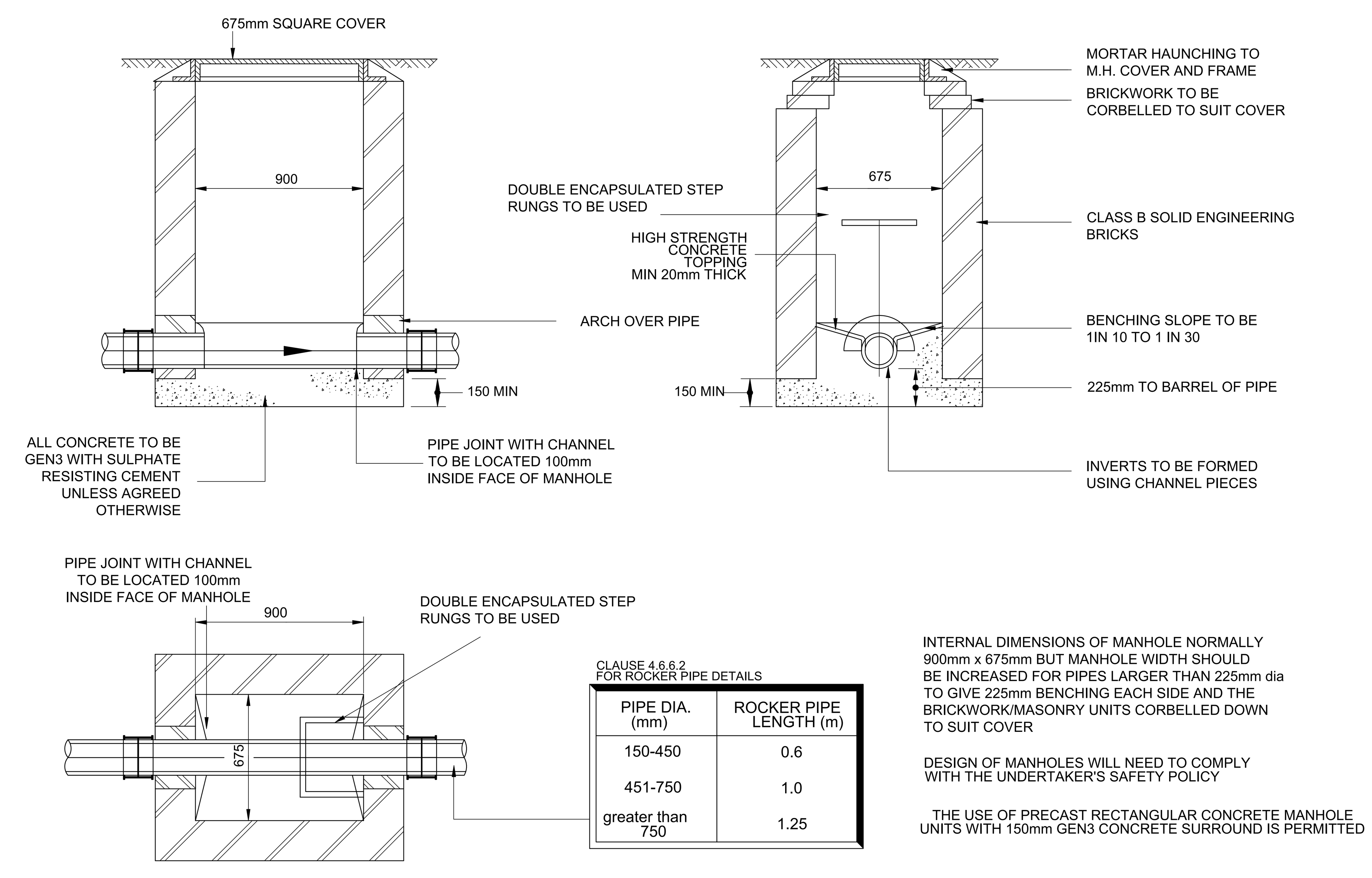
Road Filter Trench with 300mm Porous Pipe



Existing Site Boundary Ditch

Approved Detail Taken From David Jarvis Associates' Drawing '1521 016A Figure 1.9 Drainage. Capping details'





CLAUSE 4.6.6.2
FOR ROCKER PIPE DETAILS

PIPE DIA. (mm)	ROCKER PIPE LENGTH (m)
150-450	0.6
451-750	1.0
greater than 750	1.25

INTERNAL DIMENSIONS OF MANHOLE NORMALLY 900mm x 675mm BUT MANHOLE WIDTH SHOULD BE INCREASED FOR PIPES LARGER THAN 225mm dia TO GIVE 225mm BENCHING EACH SIDE AND THE BRICKWORK/MASONRY UNITS CORBELLED DOWN TO SUIT COVER

DESIGN OF MANHOLES WILL NEED TO COMPLY WITH THE UNDERTAKER'S SAFETY POLICY

THE USE OF PRECAST RECTANGULAR CONCRETE MANHOLE UNITS WITH 150mm GEN3 CONCRETE SURROUND IS PERMITTED

TYPICAL MANHOLE DETAIL - TYPE D
DEPTH TO SOFFIT OF LESS THAN 1.00m

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PRELIMINARY

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT DESIGN DRAWINGS AND OTHER INFORMATION

Rev	Description	By	Ckd	Date
P04	Removal of headwall detail until finalized detail design stage	JP		10.10.23
P03	Drawing updated to suit revised drainage designs	JP		27:03:23
P02	Only minimum and maximum perimeter ditch shown	JP		15:02:23
P01	First Issue	JP		15:09:22

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Client: RWE Generation UK

Project: Aberthaw Quarry Restoration

Title: Construction Details

Status	Scale @ A0	Date Created
Preliminary	NTS	03.08.2022

Task Team Manager	Information Author	Task Information Manager
SAS	JP	SAS

Document Number
AAC5891-RPS-xx-xx-DR-C-104-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P04

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NOT TO SCALE

Technical Specification		
Control Point	Head (m)	Flow (l/s)
Primary Design	1.500	17.200
Flush-Flo™	0.361	17.153
Kick-Flo®	0.496	10.177
Mean Flow		12.833

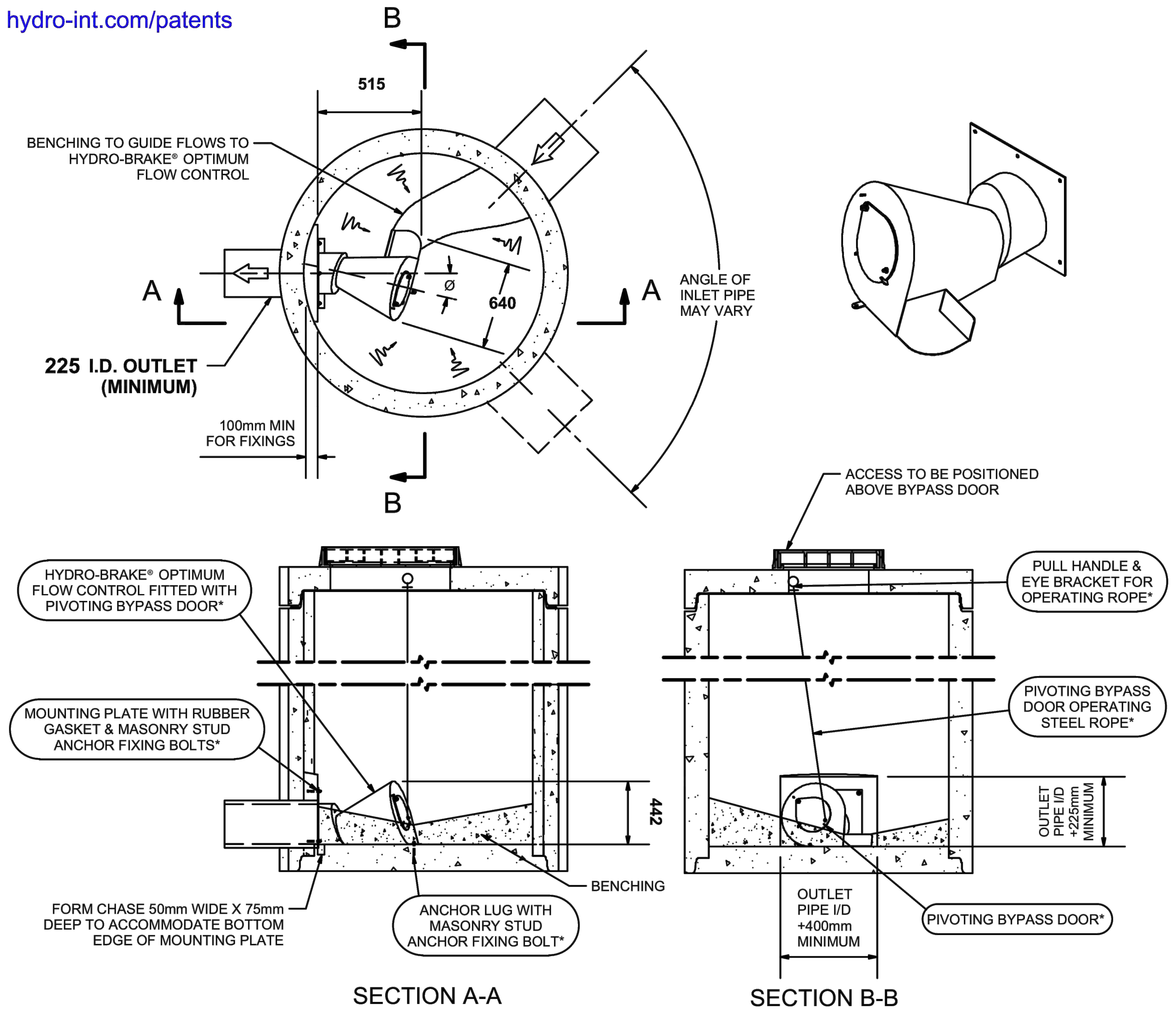
hydro-int.com/patents

Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet
- Indicative Weight: 34 kg

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

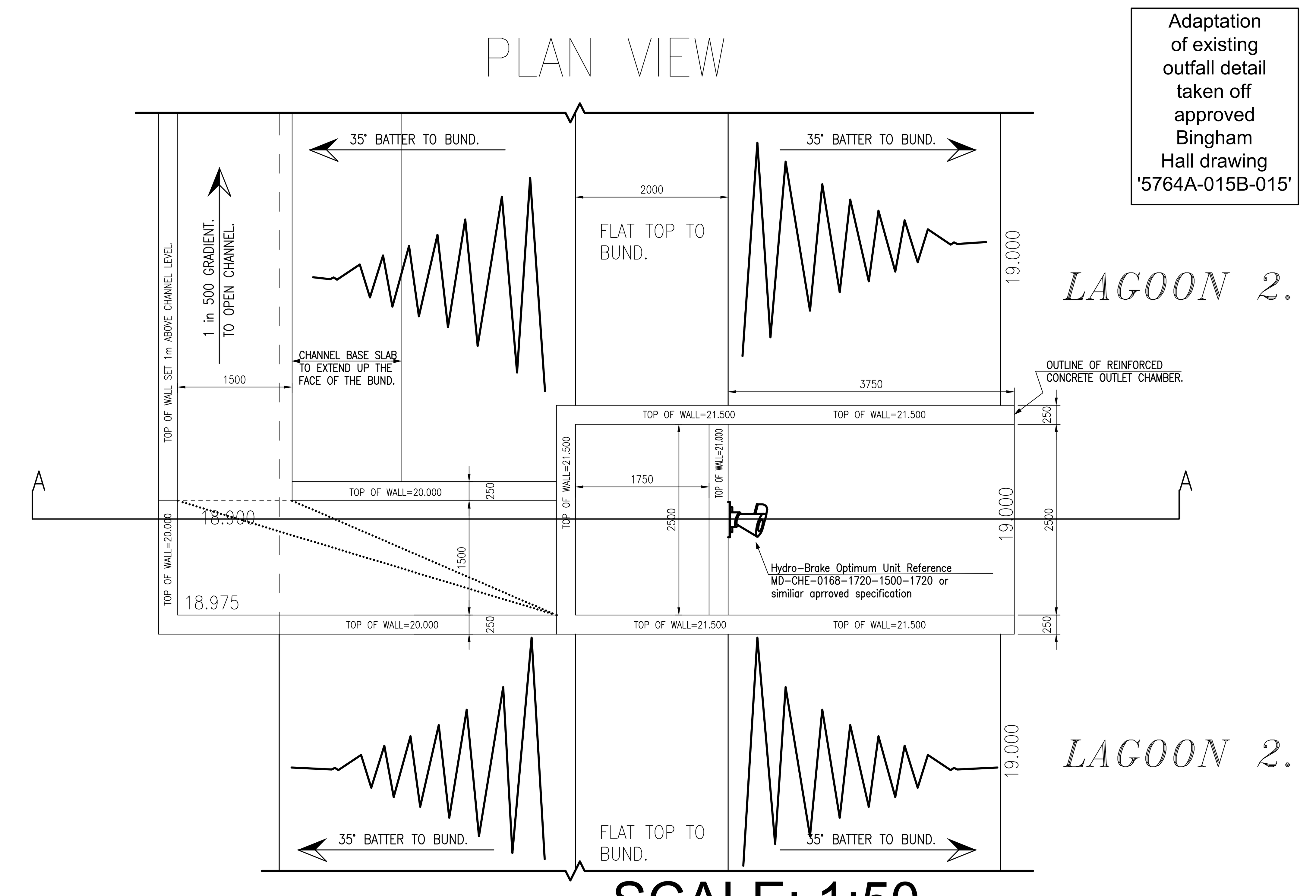
WRc Approved PT/329/0412



IMPORTANT: ⬭ LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

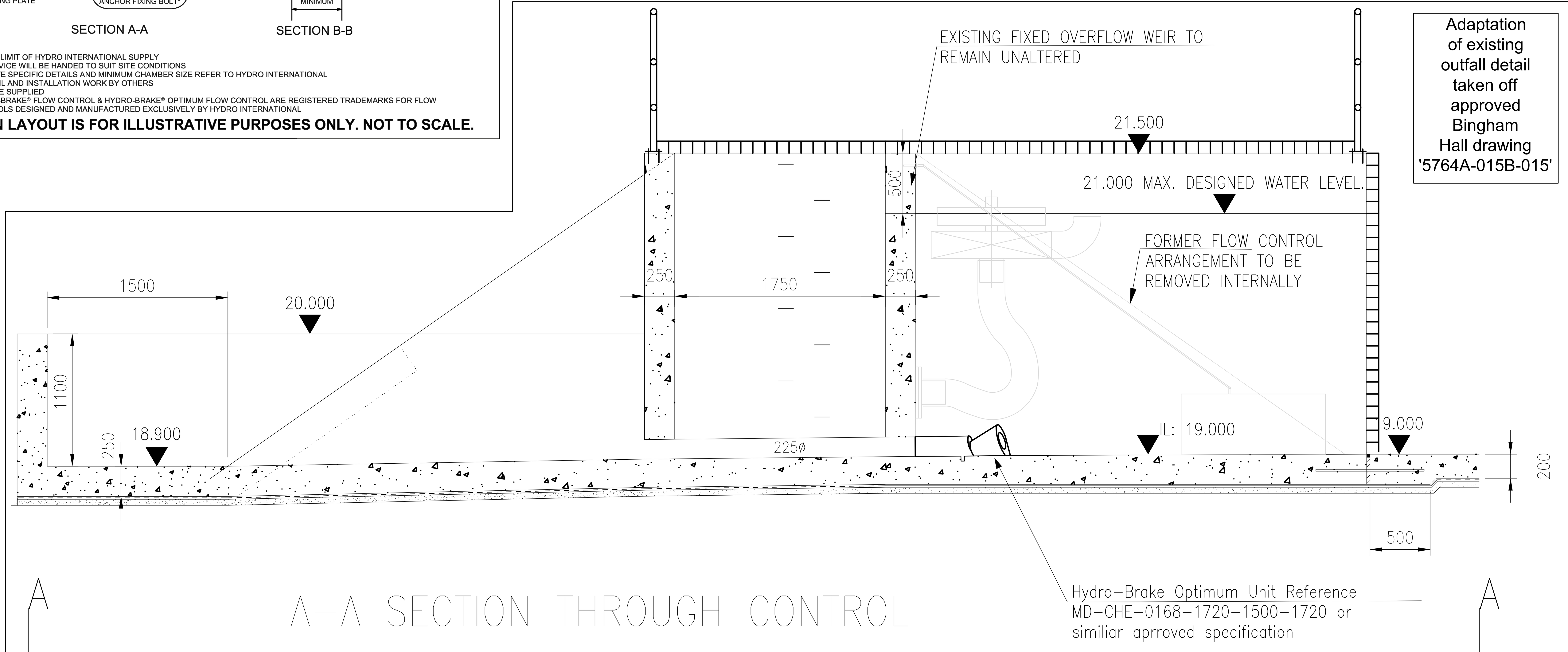
THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

PLAN VIEW



Adaptation of existing outfall detail taken off approved Bingham Hall drawing '5764A-015B-015'

SCALE: 1:50



Adaptation of existing outfall detail taken off approved Bingham Hall drawing '5764A-015B-015'

SCALE: 1:20

R:\Engineering\AAC5891 - Aberthaw Quarry (Izone)\CAD\08 Plot\AAC5891_RPS_XX_XX_DR_C_105_Outfall Construction Details.dwg, 10/10/2023 15:16:12, DWG To PDF.pc3

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Safety, Health & Environment Information

In addition to the hazards / risks normally associated with the types of work detailed on this drawing take note below. It is assumed that all works on this drawing will be carried out by a competent contractor, working, where appropriate, to an approved method statement.

Construction risks	Maintenance/Cleaning risks	Demolition/Adaption risks

Rev	Description	By	Ckd	Date
P01	First Issue	JP		28.03.23 2

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Client: RWE Generation UK

Project: Aberthaw Quarry Restoration

Title: Outfall Construction Details

Status	Scale	Date Created
Preliminary	AS INDICATED	20.03.2023

Task Team Manager	Information Author	Task Information Manager
SAS	JP	SAS

Document Number: AAC5891-RPS-xx-xx-DR-C-105-01

Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P01

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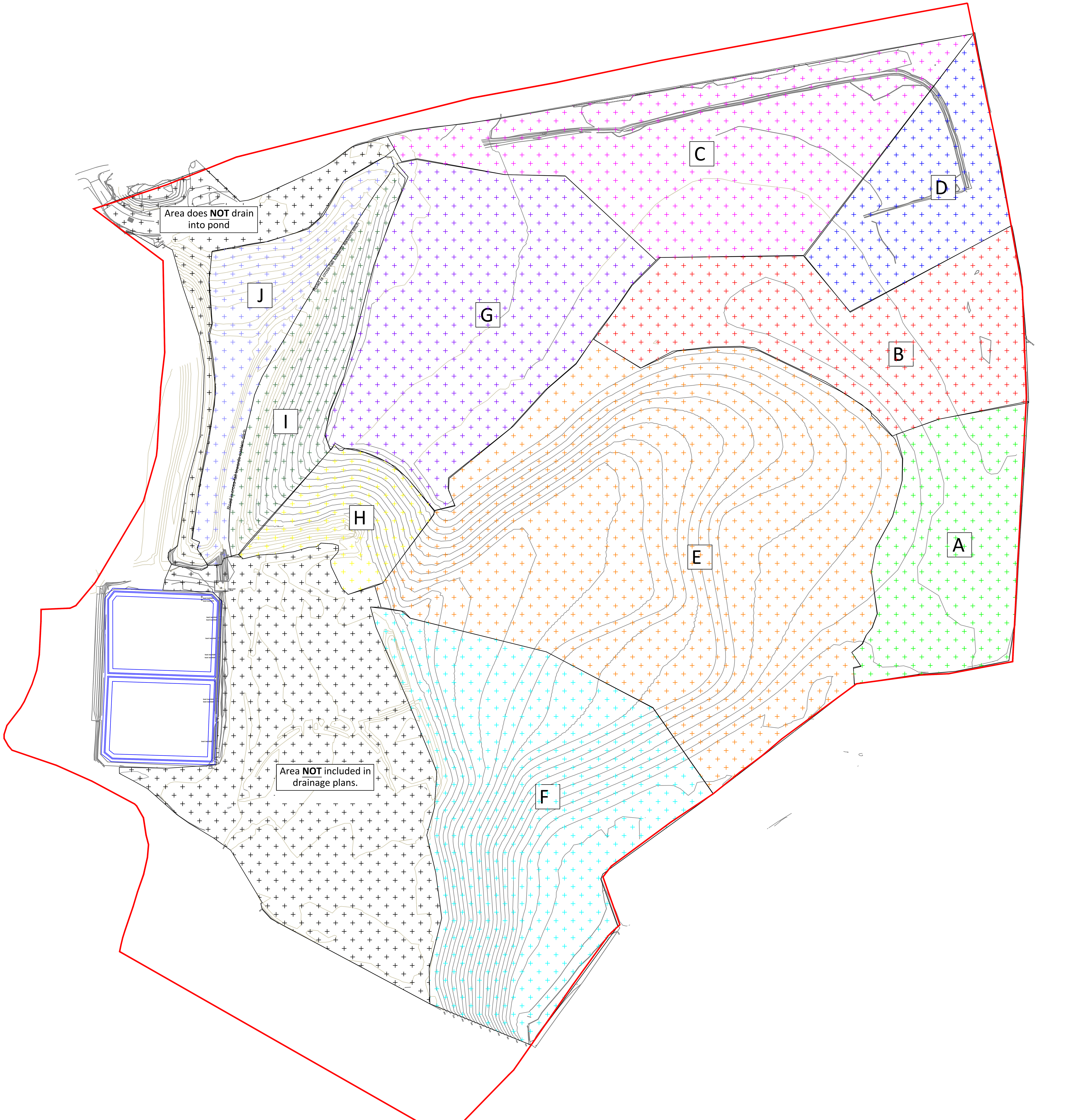

PRELIMINARY

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT DESIGN DRAWINGS AND OTHER INFORMATION

Key

- Site Boundary
- Drainage Area
- Existing Lagoon

Region	Gross Area (m^2)	Equivalent Impermeable Area (m^2)
A	19571.54	3327.16
B	27027.31	4594.64
C	34290.76	5829.43
D	15030.98	2555.27
E	79547.56	13523.09
F	43902.44	7463.41
G	36519.08	6208.24
H	8371.33	1423.13
I	12010.99	2041.87
J	12240.41	2080.87
TOTAL	288512.40	49047.11
AREA **NOT** INCLUDED IN REDEVELOPMENT PLANS	44092.07	N/A
AREA **NOT** DRAINING INTO POND	10656.59	N/A

Note. For the purposes of inputting drainable areas into Microdrainage to enable simulations of the proposed drainage infrastructure to be assessed, an "equivalent" impermeable area has been used. This has been estabilished through an assessment of the HOST class for the restored soils with a heavy PFA concentration, and equates to 17% of the gross area will generate surface water runoff from rainfall.

Notes

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3. This drawing should be read in conjunction with all other relevant drawings and specifications.

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1:20 - 0 200mm 400mm 600mm 800mm 1000 1200 1400 1600 1800 2000
1:100- 0 1m 2m 3m 4m 5m 6m 7m 8m 9m 10m
1:50 - 0 1m 2m 3m 4m 5m
1:5 - 0 100mm 200mm 300mm 400mm 500mm

Rev	Description	By	Ckd	Date
P04	Site boundary included on drawing.	JP		10.10.23
P03	Updated proposed levels included in drawing	JP		25.05.23
P02	Drawing updated to reflect new proposed contours and drainage areas.	JP		27:03:23
P01	First Issue	JP		15:09:22

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Client RWE Generation UK

Project Aberthaw Quarry Restoration

Title Surface Water Drainage Areas

Status	Scale	Date Created
Preliminary	1:1500 @A1	05.08.2022
Task Team Manager	**Information Author**	**Task Information Manager**
SAS	JP	SAS

Document Number
AAC5891-RPS-xx-xx-DR-C-112-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P04

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Appendix D – Simulation Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.322	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.685	4-8	2.782	8-12	1.173	12-16	0.263

Total Area Contributing (ha) = 4.903

Total Pipe Volume (m³) = 2836.688

Network Design Table for Surface Network 1

« - Indicates pipe capacity < flow

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
1.000	45.353	0.200	226.8	0.000	5.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.001	82.698	0.350	236.3	0.333	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.002	59.717	0.750	79.6	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.003	82.442	0.670	123.0	0.459	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.004	188.559	0.370	509.6	0.255	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
1.000	50.00	5.29	41.340	0.000	0.0	0.0	0.0	2.62	2799.1	0.0
1.001	50.00	5.82	41.140	0.333	0.0	0.0	0.0	2.57	2741.9	45.1
1.002	50.00	6.05	40.790	0.333	0.0	0.0	0.0	4.44	4733.3	45.1
1.003	50.00	6.43	40.040	0.792	0.0	0.0	0.0	3.57	3804.9	107.2
1.004	48.09	8.23	39.370	1.047	0.0	0.0	0.0	1.75	1862.7	136.4

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.005	382.897	0.760	503.8	0.583	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.006	32.842	0.070	469.2	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.007	24.576	0.770	31.9	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
2.000	5.997	0.020	299.9	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.001	44.844	0.120	373.7	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.002	80.730	0.440	183.5	0.621	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.003	77.415	0.210	368.6	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.004	14.370	0.210	68.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
1.008	16.202	0.880	18.4	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.009	8.747	1.160	7.5	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.010	99.796	9.710	10.3	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.011	42.742	3.780	11.3	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.012	17.720	0.430	41.2	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.013	51.457	0.150	343.0	0.208	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.014	55.588	0.140	397.1	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.015	47.579	0.950	50.1	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
3.000	48.919	0.120	407.7	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.001	62.689	0.370	169.4	0.746	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.002	22.422	0.710	31.6	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	40.05	11.87	39.000	1.630	0.0	0.0	0.0	1.76	1873.5	176.8
1.006	39.54	12.17	38.240	1.630	0.0	0.0	0.0	1.82	1941.9	176.8
1.007	39.44	12.22	38.170	1.630	0.0	0.0	0.0	7.02	7484.3	176.8
2.000	50.00	5.04	38.400	0.000	0.0	0.0	0.0	2.27	3339.1	0.0
2.001	50.00	5.41	38.380	0.000	0.0	0.0	0.0	2.04	2989.0	0.0
2.002	50.00	5.87	38.260	0.621	0.0	0.0	0.0	2.91	4273.8	84.1
2.003	50.00	6.50	37.820	0.621	0.0	0.0	0.0	2.05	3009.6	84.1
2.004	50.00	6.55	37.610	0.621	0.0	0.0	0.0	4.78	7010.5	84.1
1.008	39.36	12.27	37.400	2.251	0.0	0.0	0.0	5.69	1609.7	240.0
1.009	39.35	12.28	36.520	2.251	0.0	0.0	0.0	14.45	15412.7	240.0
1.010	39.13	12.42	35.360	2.251	0.0	0.0	0.0	12.38	13199.8	240.0
1.011	39.03	12.48	25.650	2.251	0.0	0.0	0.0	11.80	12583.7	240.0
1.012	38.95	12.53	21.870	2.251	0.0	0.0	0.0	6.17	6584.9	240.0
1.013	38.31	12.93	21.440	2.459	0.0	0.0	0.0	2.13	2273.3	255.1
1.014	37.60	13.40	21.290	2.459	0.0	0.0	0.0	1.98	2112.0	255.1
1.015	37.39	13.54	21.150	2.459	0.0	0.0	0.0	5.60	5971.8	255.1
3.000	50.00	5.42	24.540	0.000	0.0	0.0	0.0	1.95	2861.0	0.0
3.001	50.00	5.76	24.420	0.746	0.0	0.0	0.0	3.03	4448.3	101.0
3.002	50.00	5.82	24.050	0.746	0.0	0.0	0.0	7.04	10328.6	101.0

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.003	23.999	1.780	13.5	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.004	55.678	0.200	278.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.005	60.565	0.330	183.5	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.006	16.926	0.090	188.1	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.000	53.131	0.320	166.0	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.001	17.349	0.620	28.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.002	48.637	0.250	194.5	1.352	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.003	38.865	2.820	13.8	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.004	22.906	0.560	40.9	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.005	23.355	5.900	4.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.007	13.443	0.080	168.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.008	42.763	0.230	185.9	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.009	27.419	0.080	342.7	0.142	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.010	53.112	0.250	212.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
5.000	118.541	11.600	10.2	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit	
5.001	25.575	2.350	10.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.002	7.018	0.450	15.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.003	21.869	0.050	437.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.004	49.280	0.100	492.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.003	50.00	5.85	23.340	0.746	0.0	0.0	0.0	10.78	15817.8	101.0
3.004	50.00	6.25	21.560	0.746	0.0	0.0	0.0	2.36	3466.1	101.0
3.005	50.00	6.59	21.360	0.746	0.0	0.0	0.0	2.91	4273.2	101.0
3.006	50.00	6.69	21.030	0.746	0.0	0.0	0.0	2.88	4221.1	101.0
4.000	50.00	5.29	31.410	0.000	0.0	0.0	0.0	3.06	4493.7	0.0
4.001	50.00	5.33	31.090	0.000	0.0	0.0	0.0	7.48	10973.8	0.0
4.002	50.00	5.61	30.470	1.352	0.0	0.0	0.0	2.83	4149.9	183.1
4.003	50.00	5.68	30.220	1.352	0.0	0.0	0.0	10.66	15644.9	183.1
4.004	50.00	5.74	27.400	1.352	0.0	0.0	0.0	6.18	9073.1	183.1
4.005	50.00	5.76	26.840	1.352	0.0	0.0	0.0	19.90	29208.9	183.1
3.007	50.00	6.76	20.940	2.098	0.0	0.0	0.0	3.04	4466.7	284.1
3.008	50.00	7.01	20.860	2.098	0.0	0.0	0.0	2.89	4245.5	284.1
3.009	50.00	7.23	20.630	2.240	0.0	0.0	0.0	2.13	3122.0	303.3
3.010	50.00	7.55	20.550	2.240	0.0	0.0	0.0	2.70	3970.4	303.3
5.000	50.00	5.40	36.050	0.000	0.0	0.0	0.0	4.95	349.6	0.0
5.001	50.00	5.49	24.450	0.000	0.0	0.0	0.0	4.79	338.7	0.0
5.002	50.00	5.52	22.100	0.000	0.0	0.0	0.0	4.00	282.8	0.0
5.003	50.00	6.01	21.650	0.000	0.0	0.0	0.0	0.75	52.7	0.0
5.004	50.00	7.18	21.600	0.000	0.0	0.0	0.0	0.70	49.6	0.0

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
5.005	44.814	0.050	896.3	0.204	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.006	36.347	0.925	39.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.011	14.907	0.025	596.3	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
1.016	99.793	0.300	332.6	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.017	5.860	0.650	9.0	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.018	77.143	0.250	308.6	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.019	7.860	0.100	78.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
5.005	47.05	8.62	21.500	0.204	0.0	0.0	0.0	0.52	36.6	26.0
5.006	46.43	8.86	21.450	0.204	0.0	0.0	0.0	2.52	177.8	26.0
3.011	46.04	9.02	20.300	2.444	0.0	0.0	0.0	1.61	2362.4	304.7
1.016	36.35	14.27	20.200	4.903	0.0	0.0	0.0	2.28	2846.4	482.7
1.017	36.34	14.27	19.900	4.903	0.0	0.0	0.0	13.90	17372.9	482.7
1.018	35.62	14.82	19.250	4.903	0.0	0.0	0.0	2.36	2956.0	482.7
1.019	35.50	14.91	19.000	4.903	0.0	0.0	0.0	1.48	58.7«	482.7

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.333	0.333	0.333
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.459	0.459	0.459
1.004	-	-	100	0.255	0.255	0.255
1.005	-	-	100	0.583	0.583	0.583
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.621	0.621	0.621
2.003	-	-	100	0.000	0.000	0.000
2.004	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
1.010	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.208	0.208	0.208
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.000	0.000	0.000
3.001	-	-	100	0.746	0.746	0.746
3.002	-	-	100	0.000	0.000	0.000
3.003	-	-	100	0.000	0.000	0.000
3.004	-	-	100	0.000	0.000	0.000
3.005	-	-	100	0.000	0.000	0.000
3.006	-	-	100	0.000	0.000	0.000
4.000	-	-	100	0.000	0.000	0.000
4.001	-	-	100	0.000	0.000	0.000
4.002	-	-	100	1.352	1.352	1.352
4.003	-	-	100	0.000	0.000	0.000
4.004	-	-	100	0.000	0.000	0.000
4.005	-	-	100	0.000	0.000	0.000
3.007	-	-	100	0.000	0.000	0.000
3.008	-	-	100	0.000	0.000	0.000
3.009	-	-	100	0.142	0.142	0.142
3.010	-	-	100	0.000	0.000	0.000
5.000	-	-	100	0.000	0.000	0.000
5.001	-	-	100	0.000	0.000	0.000
5.002	-	-	100	0.000	0.000	0.000
5.003	-	-	100	0.000	0.000	0.000
5.004	-	-	100	0.000	0.000	0.000
5.005	-	-	100	0.204	0.204	0.204
5.006	-	-	100	0.000	0.000	0.000
3.011	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
1.018	-	-	100	0.000	0.000	0.000
1.019	-	-	100	0.000	0.000	0.000
				Total	Total	Total

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
				4.903	4.903	4.903

Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	S1	-1	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
1.001	S3	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.002	S98	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.003	S99	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.004	S4	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.005	S5	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.006	S100	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.007	S19	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.000	S21	-2	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
2.001	S91	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.002	S24	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.003	S25	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.004	S27	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.008	S20	600	0.000	0.000	Unclassified	1350	0	0.000	Unclassified
1.009	S28	-1	0.599	0.599	Unclassified	1350	0	0.599	Unclassified
1.010	S29	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.011	S102	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.012	S32	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.013	S101	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.014	S34	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.015	S36	-1	0.599	1.069	Unclassified	1500	0	0.599	Unclassified
3.000	S85	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.001	S86	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.002	S87	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.003	S92	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.004	S88	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.005	S93	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.006	S89	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.000	S50	-2	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
4.001	S94	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.002	S95	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.003	S52	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.004	S97	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.005	S46	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.007	S96	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.008	S90	-2	0.599	0.699	Unclassified	1500	0	0.599	Unclassified
3.009	S60	-2	0.599	0.699	Unclassified	1500	0	0.699	Unclassified
3.010	S66	-2	0.599	0.969	Unclassified	1500	0	0.599	Unclassified
5.000	S82	300	0.131	0.159	Unclassified	1350	0	0.159	Unclassified
5.001	S107	300	0.131	0.166	Unclassified	1350	0	0.131	Unclassified
5.002	S106	300	0.050	0.166	Unclassified	1350	0	0.166	Unclassified
5.003	S108	300	0.050	0.100	Unclassified	1350	0	0.050	Unclassified
5.004	S105	300	0.100	0.200	Unclassified	1350	0	0.100	Unclassified
5.005	S83	300	0.200	0.250	Unclassified	1350	0	0.200	Unclassified
5.006	S84	300	0.250	0.445	Unclassified	1350	0	0.250	Unclassified
3.011	S64	-2	0.969	0.994	Unclassified	1500	0	0.969	Unclassified
1.016	S39	-3	0.199	1.069	Unclassified	1500	0	1.069	Unclassified
1.017	S80	-3	0.199	2.249	Unclassified	1500	0	0.199	Unclassified
1.018	S103	-3	2.249	2.499	Unclassified	1200	0	2.249	Unclassified

Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.019	S104	225	0.004	2.275	Unclassified	3000	0	2.275	Unclassified

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.019	S81	19.129	18.900	0.000	0	0

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.322		

Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S104, DS/PN: 1.019, Volume (m³): 111.5

Unit Reference	MD-SHE-0179-1723-1500-1723
Design Head (m)	1.500
Design Flow (l/s)	17.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	179
Invert Level (m)	19.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	17.2
Flush-Flo™	0.445	17.2
Kick-Flo®	0.967	14.0
Mean Flow over Head Range	-	14.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.3	1.200	15.5	3.000	24.0	7.000	36.0
0.200	15.5	1.400	16.7	3.500	25.8	7.500	37.3
0.300	16.8	1.600	17.8	4.000	27.5	8.000	38.4
0.400	17.2	1.800	18.8	4.500	29.1	8.500	39.6
0.500	17.2	2.000	19.7	5.000	30.6	9.000	40.7
0.600	17.0	2.200	20.7	5.500	32.1	9.500	41.8
0.800	16.1	2.400	21.5	6.000	33.4		
1.000	14.2	2.600	22.4	6.500	34.8		

Storage Structures for Surface Network 1

Tank or Pond Manhole: S104, DS/PN: 1.019

Invert Level (m) 19.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3956.9	0.701	4240.1	1.401	4530.9	2.101	4832.9
0.101	3996.9	0.801	4281.2	1.501	4573.1	2.201	4874.6
0.201	4037.1	0.901	4322.5	1.601	4615.4	2.301	4916.5
0.301	4077.4	1.001	4363.9	1.701	4657.9	2.400	4958.0
0.401	4117.8	1.101	4405.4	1.801	4700.5		
0.501	4158.5	1.201	4447.1	1.901	4749.9		
0.601	4199.2	1.301	4488.9	2.001	4791.4		

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.329
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	OFF
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Summer	2	+0%					41.340
1.001	S3	15 Winter	2	+0%					41.210
1.002	S98	15 Winter	2	+0%					40.838
1.003	S99	15 Winter	2	+0%					40.132
1.004	S4	15 Winter	2	+0%					39.534
1.005	S5	15 Winter	2	+0%					39.194
1.006	S100	15 Winter	2	+0%					38.424
1.007	S19	15 Winter	2	+0%					38.250
2.000	S21	15 Summer	2	+0%					38.400
2.001	S91	15 Summer	2	+0%					38.380
2.002	S24	15 Winter	2	+0%					38.341
2.003	S25	15 Winter	2	+0%					37.917
2.004	S27	15 Winter	2	+0%					37.677
1.008	S20	15 Winter	2	+0%					37.590
1.009	S28	15 Winter	2	+0%					36.589
1.010	S29	15 Winter	2	+0%					35.428
1.011	S102	15 Winter	2	+0%					25.720
1.012	S32	15 Winter	2	+0%					21.976

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.600	0.000	0.00			0.0	OK	
1.001	S3	-0.530	0.000	0.02			45.4	OK	
1.002	S98	-0.552	0.000	0.01			44.8	OK	
1.003	S99	-0.508	0.000	0.03			103.1	OK	
1.004	S4	-0.436	0.000	0.07			121.6	OK	
1.005	S5	-0.406	0.000	0.09			154.0	OK	
1.006	S100	-0.416	0.000	0.12			152.1	OK	
1.007	S19	-0.520	0.000	0.05			152.2	OK	
2.000	S21	-0.600	0.000	0.00			0.0	OK	
2.001	S91	-0.600	0.000	0.00			0.0	OK	
2.002	S24	-0.519	0.000	0.02			77.9	OK	
2.003	S25	-0.503	0.000	0.03			77.2	OK	
2.004	S27	-0.533	0.000	0.03			77.0	OK	
1.008	S20	-0.410	0.000	0.22			207.1	OK	
1.009	S28	-0.531	0.000	0.05			206.7	OK	
1.010	S29	-0.532	0.000	0.02			206.4	OK	
1.011	S102	-0.530	0.000	0.03			206.6	OK	
1.012	S32	-0.494	0.000	0.08			207.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.013	S101	15 Winter	2	+0%					21.636
1.014	S34	15 Winter	2	+0%					21.492
1.015	S36	15 Winter	2	+0%					21.257
3.000	S85	15 Summer	2	+0%					24.540
3.001	S86	15 Winter	2	+0%					24.508
3.002	S87	15 Winter	2	+0%					24.111
3.003	S92	15 Winter	2	+0%					23.380
3.004	S88	15 Winter	2	+0%					21.660
3.005	S93	15 Winter	2	+0%					21.449
3.006	S89	15 Winter	2	+0%					21.151
4.000	S50	15 Summer	2	+0%					31.410
4.001	S94	15 Summer	2	+0%					31.090
4.002	S95	15 Winter	2	+0%					30.599
4.003	S52	15 Winter	2	+0%					30.284
4.004	S97	15 Winter	2	+0%					27.485
4.005	S46	15 Winter	2	+0%					26.879
3.007	S96	15 Winter	2	+0%					21.125
3.008	S90	15 Winter	2	+0%					21.030
3.009	S60	15 Winter	2	+0%					20.840
3.010	S66	15 Winter	2	+0%					20.730
5.000	S82	15 Summer	2	+0%					36.050
5.001	S107	15 Summer	2	+0%					24.450
5.002	S106	15 Summer	2	+0%					22.100
5.003	S108	15 Winter	2	+0%					21.669
5.004	S105	15 Winter	2	+0%					21.681
5.005	S83	15 Winter	2	+0%					21.682
5.006	S84	15 Winter	2	+0%					21.524
3.011	S64	15 Winter	2	+0%					20.571
1.016	S39	15 Winter	2	+0%					20.361
1.017	S80	15 Winter	2	+0%					19.958
1.018	S103	15 Winter	2	+0%					19.408
1.019	S104	720 Winter	2	+0%	2/60 Winter				19.314

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.013	S101	-0.404	0.000	0.12			212.3	OK	
1.014	S34	-0.398	0.000	0.13			211.2	OK	
1.015	S36	-0.493	0.000	0.06			211.5	OK	
3.000	S85	-0.600	0.000	0.00			0.0	OK	
3.001	S86	-0.512	0.000	0.03			94.0	OK	
3.002	S87	-0.539	0.000	0.02			93.8	OK	
3.003	S92	-0.560	0.000	0.01			93.9	OK	
3.004	S88	-0.500	0.000	0.04			93.7	OK	
3.005	S93	-0.511	0.000	0.03			93.3	OK	
3.006	S89	-0.479	0.000	0.04			93.6	OK	
4.000	S50	-0.600	0.000	0.00			0.0	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
4.001	S94	-0.600	0.000	0.00			0.0	OK	
4.002	S95	-0.471	0.000	0.06			169.6	OK	
4.003	S52	-0.536	0.000	0.02			169.5	OK	
4.004	S97	-0.515	0.000	0.04			169.9	OK	
4.005	S46	-0.561	0.000	0.01			170.1	OK	
3.007	S96	-0.415	0.000	0.12			260.7	OK	
3.008	S90	-0.430	0.000	0.10			260.1	OK	
3.009	S60	-0.390	0.000	0.14			271.2	OK	
3.010	S66	-0.420	0.000	0.10			269.4	OK	
5.000	S82	-0.300	0.000	0.00			0.0	OK	
5.001	S107	-0.300	0.000	0.00			0.0	OK	
5.002	S106	-0.300	0.000	0.00			0.0	OK	
5.003	S108	-0.281	0.000	0.00			0.1	OK	
5.004	S105	-0.219	0.000	0.02			0.8	OK	
5.005	S83	-0.118	0.000	0.66			22.7	OK	
5.006	S84	-0.226	0.000	0.14			22.6	OK	
3.011	S64	-0.329	0.000	0.33			287.5	OK	
1.016	S39	-0.339	0.000	0.20			480.6	OK	
1.017	S80	-0.442	0.000	0.13			479.9	FLOOD RISK	
1.018	S103	-0.342	0.000	0.20			477.0	OK	
1.019	S104	0.089	0.000	0.38			16.9	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.322	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.685	4-8	2.782	8-12	1.173	12-16	0.263

Total Area Contributing (ha) = 4.903

Total Pipe Volume (m³) = 2836.688

Network Design Table for Surface Network 1

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	45.353	0.200	226.8	0.000	5.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.001	82.698	0.350	236.3	0.333	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.002	59.717	0.750	79.6	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.003	82.442	0.670	123.0	0.459	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒
1.004	188.559	0.370	509.6	0.255	0.00	0.0	0.600	\/	-1	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.29	41.340	0.000	0.0	0.0	0.0	2.62	2799.1	0.0
1.001	50.00	5.82	41.140	0.333	0.0	0.0	0.0	2.57	2741.9	45.1
1.002	50.00	6.05	40.790	0.333	0.0	0.0	0.0	4.44	4733.3	45.1
1.003	50.00	6.43	40.040	0.792	0.0	0.0	0.0	3.57	3804.9	107.2
1.004	48.09	8.23	39.370	1.047	0.0	0.0	0.0	1.75	1862.7	136.4

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.005	382.897	0.760	503.8	0.583	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.006	32.842	0.070	469.2	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.007	24.576	0.770	31.9	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
2.000	5.997	0.020	299.9	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.001	44.844	0.120	373.7	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.002	80.730	0.440	183.5	0.621	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.003	77.415	0.210	368.6	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.004	14.370	0.210	68.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
1.008	16.202	0.880	18.4	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.009	8.747	1.160	7.5	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.010	99.796	9.710	10.3	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.011	42.742	3.780	11.3	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.012	17.720	0.430	41.2	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.013	51.457	0.150	343.0	0.208	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.014	55.588	0.140	397.1	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.015	47.579	0.950	50.1	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
3.000	48.919	0.120	407.7	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.001	62.689	0.370	169.4	0.746	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.002	22.422	0.710	31.6	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	40.05	11.87	39.000	1.630	0.0	0.0	0.0	1.76	1873.5	176.8
1.006	39.54	12.17	38.240	1.630	0.0	0.0	0.0	1.82	1941.9	176.8
1.007	39.44	12.22	38.170	1.630	0.0	0.0	0.0	7.02	7484.3	176.8
2.000	50.00	5.04	38.400	0.000	0.0	0.0	0.0	2.27	3339.1	0.0
2.001	50.00	5.41	38.380	0.000	0.0	0.0	0.0	2.04	2989.0	0.0
2.002	50.00	5.87	38.260	0.621	0.0	0.0	0.0	2.91	4273.8	84.1
2.003	50.00	6.50	37.820	0.621	0.0	0.0	0.0	2.05	3009.6	84.1
2.004	50.00	6.55	37.610	0.621	0.0	0.0	0.0	4.78	7010.5	84.1
1.008	39.36	12.27	37.400	2.251	0.0	0.0	0.0	5.69	1609.7	240.0
1.009	39.35	12.28	36.520	2.251	0.0	0.0	0.0	14.45	15412.7	240.0
1.010	39.13	12.42	35.360	2.251	0.0	0.0	0.0	12.38	13199.8	240.0
1.011	39.03	12.48	25.650	2.251	0.0	0.0	0.0	11.80	12583.7	240.0
1.012	38.95	12.53	21.870	2.251	0.0	0.0	0.0	6.17	6584.9	240.0
1.013	38.31	12.93	21.440	2.459	0.0	0.0	0.0	2.13	2273.3	255.1
1.014	37.60	13.40	21.290	2.459	0.0	0.0	0.0	1.98	2112.0	255.1
1.015	37.39	13.54	21.150	2.459	0.0	0.0	0.0	5.60	5971.8	255.1
3.000	50.00	5.42	24.540	0.000	0.0	0.0	0.0	1.95	2861.0	0.0
3.001	50.00	5.76	24.420	0.746	0.0	0.0	0.0	3.03	4448.3	101.0
3.002	50.00	5.82	24.050	0.746	0.0	0.0	0.0	7.04	10328.6	101.0

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.003	23.999	1.780	13.5	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.004	55.678	0.200	278.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.005	60.565	0.330	183.5	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.006	16.926	0.090	188.1	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.000	53.131	0.320	166.0	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.001	17.349	0.620	28.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.002	48.637	0.250	194.5	1.352	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.003	38.865	2.820	13.8	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.004	22.906	0.560	40.9	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.005	23.355	5.900	4.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.007	13.443	0.080	168.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.008	42.763	0.230	185.9	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.009	27.419	0.080	342.7	0.142	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.010	53.112	0.250	212.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
5.000	118.541	11.600	10.2	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit	
5.001	25.575	2.350	10.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.002	7.018	0.450	15.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.003	21.869	0.050	437.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.004	49.280	0.100	492.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.003	50.00	5.85	23.340	0.746	0.0	0.0	0.0	10.78	15817.8	101.0
3.004	50.00	6.25	21.560	0.746	0.0	0.0	0.0	2.36	3466.1	101.0
3.005	50.00	6.59	21.360	0.746	0.0	0.0	0.0	2.91	4273.2	101.0
3.006	50.00	6.69	21.030	0.746	0.0	0.0	0.0	2.88	4221.1	101.0
4.000	50.00	5.29	31.410	0.000	0.0	0.0	0.0	3.06	4493.7	0.0
4.001	50.00	5.33	31.090	0.000	0.0	0.0	0.0	7.48	10973.8	0.0
4.002	50.00	5.61	30.470	1.352	0.0	0.0	0.0	2.83	4149.9	183.1
4.003	50.00	5.68	30.220	1.352	0.0	0.0	0.0	10.66	15644.9	183.1
4.004	50.00	5.74	27.400	1.352	0.0	0.0	0.0	6.18	9073.1	183.1
4.005	50.00	5.76	26.840	1.352	0.0	0.0	0.0	19.90	29208.9	183.1
3.007	50.00	6.76	20.940	2.098	0.0	0.0	0.0	3.04	4466.7	284.1
3.008	50.00	7.01	20.860	2.098	0.0	0.0	0.0	2.89	4245.5	284.1
3.009	50.00	7.23	20.630	2.240	0.0	0.0	0.0	2.13	3122.0	303.3
3.010	50.00	7.55	20.550	2.240	0.0	0.0	0.0	2.70	3970.4	303.3
5.000	50.00	5.40	36.050	0.000	0.0	0.0	0.0	4.95	349.6	0.0
5.001	50.00	5.49	24.450	0.000	0.0	0.0	0.0	4.79	338.7	0.0
5.002	50.00	5.52	22.100	0.000	0.0	0.0	0.0	4.00	282.8	0.0
5.003	50.00	6.01	21.650	0.000	0.0	0.0	0.0	0.75	52.7	0.0
5.004	50.00	7.18	21.600	0.000	0.0	0.0	0.0	0.70	49.6	0.0

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
5.005	44.814	0.050	896.3	0.204	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.006	36.347	0.925	39.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.011	14.907	0.025	596.3	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
1.016	99.793	0.300	332.6	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.017	5.860	0.650	9.0	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.018	77.143	0.250	308.6	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.019	7.860	0.100	78.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
5.005	47.05	8.62	21.500	0.204	0.0	0.0	0.0	0.52	36.6	26.0
5.006	46.43	8.86	21.450	0.204	0.0	0.0	0.0	2.52	177.8	26.0
3.011	46.04	9.02	20.300	2.444	0.0	0.0	0.0	1.61	2362.4	304.7
1.016	36.35	14.27	20.200	4.903	0.0	0.0	0.0	2.28	2846.4	482.7
1.017	36.34	14.27	19.900	4.903	0.0	0.0	0.0	13.90	17372.9	482.7
1.018	35.62	14.82	19.250	4.903	0.0	0.0	0.0	2.36	2956.0	482.7
1.019	35.50	14.91	19.000	4.903	0.0	0.0	0.0	1.48	58.7«	482.7

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.333	0.333	0.333
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.459	0.459	0.459
1.004	-	-	100	0.255	0.255	0.255
1.005	-	-	100	0.583	0.583	0.583
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.621	0.621	0.621
2.003	-	-	100	0.000	0.000	0.000
2.004	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
1.010	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.208	0.208	0.208
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.000	0.000	0.000
3.001	-	-	100	0.746	0.746	0.746
3.002	-	-	100	0.000	0.000	0.000
3.003	-	-	100	0.000	0.000	0.000
3.004	-	-	100	0.000	0.000	0.000
3.005	-	-	100	0.000	0.000	0.000
3.006	-	-	100	0.000	0.000	0.000
4.000	-	-	100	0.000	0.000	0.000
4.001	-	-	100	0.000	0.000	0.000
4.002	-	-	100	1.352	1.352	1.352
4.003	-	-	100	0.000	0.000	0.000
4.004	-	-	100	0.000	0.000	0.000
4.005	-	-	100	0.000	0.000	0.000
3.007	-	-	100	0.000	0.000	0.000
3.008	-	-	100	0.000	0.000	0.000
3.009	-	-	100	0.142	0.142	0.142
3.010	-	-	100	0.000	0.000	0.000
5.000	-	-	100	0.000	0.000	0.000
5.001	-	-	100	0.000	0.000	0.000
5.002	-	-	100	0.000	0.000	0.000
5.003	-	-	100	0.000	0.000	0.000
5.004	-	-	100	0.000	0.000	0.000
5.005	-	-	100	0.204	0.204	0.204
5.006	-	-	100	0.000	0.000	0.000
3.011	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
1.018	-	-	100	0.000	0.000	0.000
1.019	-	-	100	0.000	0.000	0.000
				Total	Total	Total

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
				4.903	4.903	4.903

Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	S1	-1	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
1.001	S3	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.002	S98	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.003	S99	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.004	S4	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.005	S5	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.006	S100	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.007	S19	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.000	S21	-2	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
2.001	S91	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.002	S24	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.003	S25	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.004	S27	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.008	S20	600	0.000	0.000	Unclassified	1350	0	0.000	Unclassified
1.009	S28	-1	0.599	0.599	Unclassified	1350	0	0.599	Unclassified
1.010	S29	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.011	S102	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.012	S32	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.013	S101	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.014	S34	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.015	S36	-1	0.599	1.069	Unclassified	1500	0	0.599	Unclassified
3.000	S85	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.001	S86	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.002	S87	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.003	S92	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.004	S88	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.005	S93	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.006	S89	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.000	S50	-2	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
4.001	S94	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.002	S95	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.003	S52	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.004	S97	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.005	S46	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.007	S96	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.008	S90	-2	0.599	0.699	Unclassified	1500	0	0.599	Unclassified
3.009	S60	-2	0.599	0.699	Unclassified	1500	0	0.699	Unclassified
3.010	S66	-2	0.599	0.969	Unclassified	1500	0	0.599	Unclassified
5.000	S82	300	0.131	0.159	Unclassified	1350	0	0.159	Unclassified
5.001	S107	300	0.131	0.166	Unclassified	1350	0	0.131	Unclassified
5.002	S106	300	0.050	0.166	Unclassified	1350	0	0.166	Unclassified
5.003	S108	300	0.050	0.100	Unclassified	1350	0	0.050	Unclassified
5.004	S105	300	0.100	0.200	Unclassified	1350	0	0.100	Unclassified
5.005	S83	300	0.200	0.250	Unclassified	1350	0	0.200	Unclassified
5.006	S84	300	0.250	0.445	Unclassified	1350	0	0.250	Unclassified
3.011	S64	-2	0.969	0.994	Unclassified	1500	0	0.969	Unclassified
1.016	S39	-3	0.199	1.069	Unclassified	1500	0	1.069	Unclassified
1.017	S80	-3	0.199	2.249	Unclassified	1500	0	0.199	Unclassified
1.018	S103	-3	2.249	2.499	Unclassified	1200	0	2.249	Unclassified

Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.019	S104	225	0.004	2.275	Unclassified	3000	0	2.275	Unclassified

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.019	S81	19.129	18.900	0.000	0	0

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.322		

Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S104, DS/PN: 1.019, Volume (m³): 111.5

Unit Reference	MD-SHE-0179-1723-1500-1723
Design Head (m)	1.500
Design Flow (l/s)	17.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	179
Invert Level (m)	19.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.500	17.2
Flush-Flo™	0.445	17.2
Kick-Flo®	0.967	14.0
Mean Flow over Head Range	-	14.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	6.3	1.200	15.5	3.000	24.0	7.000	36.0
0.200	15.5	1.400	16.7	3.500	25.8	7.500	37.3
0.300	16.8	1.600	17.8	4.000	27.5	8.000	38.4
0.400	17.2	1.800	18.8	4.500	29.1	8.500	39.6
0.500	17.2	2.000	19.7	5.000	30.6	9.000	40.7
0.600	17.0	2.200	20.7	5.500	32.1	9.500	41.8
0.800	16.1	2.400	21.5	6.000	33.4		
1.000	14.2	2.600	22.4	6.500	34.8		

Storage Structures for Surface Network 1

Tank or Pond Manhole: S104, DS/PN: 1.019

Invert Level (m) 19.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3956.9	0.701	4240.1	1.401	4530.9	2.101	4832.9
0.101	3996.9	0.801	4281.2	1.501	4573.1	2.201	4874.6
0.201	4037.1	0.901	4322.5	1.601	4615.4	2.301	4916.5
0.301	4077.4	1.001	4363.9	1.701	4657.9	2.400	4958.0
0.401	4117.8	1.101	4405.4	1.801	4700.5		
0.501	4158.5	1.201	4447.1	1.901	4749.9		
0.601	4199.2	1.301	4488.9	2.001	4791.4		

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.329
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 30
Climate Change (%) 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Summer	30	+0%					41.340
1.001	S3	15 Winter	30	+0%					41.252
1.002	S98	15 Winter	30	+0%					40.872
1.003	S99	15 Winter	30	+0%					40.195
1.004	S4	15 Winter	30	+0%					39.628
1.005	S5	15 Winter	30	+0%					39.284
1.006	S100	15 Winter	30	+0%					38.508
1.007	S19	15 Winter	30	+0%					38.290
2.000	S21	15 Summer	30	+0%					38.400
2.001	S91	15 Summer	30	+0%					38.380
2.002	S24	15 Winter	30	+0%					38.379
2.003	S25	15 Winter	30	+0%					37.967
2.004	S27	15 Winter	30	+0%					37.706
1.008	S20	15 Winter	30	+0%					37.671
1.009	S28	15 Winter	30	+0%					36.621
1.010	S29	15 Winter	30	+0%					35.455
1.011	S102	15 Winter	30	+0%					25.750
1.012	S32	15 Winter	30	+0%					22.035

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.600	0.000	0.00			0.0	OK	
1.001	S3	-0.488	0.000	0.05			103.5	OK	
1.002	S98	-0.518	0.000	0.03			104.5	OK	
1.003	S99	-0.445	0.000	0.08			241.5	OK	
1.004	S4	-0.342	0.000	0.16			275.4	OK	
1.005	S5	-0.316	0.000	0.17			310.0	OK	
1.006	S100	-0.332	0.000	0.23			300.4	OK	
1.007	S19	-0.480	0.000	0.09			299.4	OK	
2.000	S21	-0.600	0.000	0.00			0.0	OK	
2.001	S91	-0.600	0.000	0.00			0.0	OK	
2.002	S24	-0.481	0.000	0.05			156.5	OK	
2.003	S25	-0.453	0.000	0.06			152.6	OK	
2.004	S27	-0.504	0.000	0.06			152.2	OK	
1.008	S20	-0.329	0.000	0.42			396.8	OK	
1.009	S28	-0.499	0.000	0.10			396.2	OK	
1.010	S29	-0.505	0.000	0.04			395.4	OK	
1.011	S102	-0.500	0.000	0.05			395.8	OK	
1.012	S32	-0.435	0.000	0.16			396.4	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.013	S101	30 Winter	30	+0%					21.722
1.014	S34	30 Winter	30	+0%					21.582
1.015	S36	30 Winter	30	+0%					21.313
3.000	S85	15 Winter	30	+0%					24.551
3.001	S86	15 Winter	30	+0%					24.551
3.002	S87	15 Winter	30	+0%					24.134
3.003	S92	15 Winter	30	+0%					23.408
3.004	S88	15 Winter	30	+0%					21.714
3.005	S93	15 Winter	30	+0%					21.493
3.006	S89	15 Winter	30	+0%					21.228
4.000	S50	15 Summer	30	+0%					31.410
4.001	S94	15 Summer	30	+0%					31.090
4.002	S95	15 Winter	30	+0%					30.669
4.003	S52	15 Winter	30	+0%					30.311
4.004	S97	15 Winter	30	+0%					27.530
4.005	S46	15 Winter	30	+0%					26.908
3.007	S96	15 Winter	30	+0%					21.206
3.008	S90	15 Winter	30	+0%					21.099
3.009	S60	15 Winter	30	+0%					20.933
3.010	S66	15 Winter	30	+0%					20.804
5.000	S82	15 Summer	30	+0%					36.050
5.001	S107	15 Summer	30	+0%					24.450
5.002	S106	15 Summer	30	+0%					22.100
5.003	S108	15 Winter	30	+0%					21.843
5.004	S105	15 Winter	30	+0%					21.843
5.005	S83	15 Winter	30	+0%	30/15 Summer				21.854
5.006	S84	15 Winter	30	+0%					21.561
3.011	S64	15 Winter	30	+0%					20.689
1.016	S39	15 Winter	30	+0%					20.448
1.017	S80	15 Winter	30	+0%					19.994
1.018	S103	960 Winter	30	+0%					19.545
1.019	S104	960 Winter	30	+0%	30/15 Summer				19.544

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.013	S101	-0.318	0.000	0.24			407.9	OK	
1.014	S34	-0.308	0.000	0.25			406.1	OK	
1.015	S36	-0.437	0.000	0.11			406.0	OK	
3.000	S85	-0.589	0.000	0.00			0.1	OK	
3.001	S86	-0.469	0.000	0.06			187.8	OK	
3.002	S87	-0.516	0.000	0.04			186.9	OK	
3.003	S92	-0.532	0.000	0.03			186.7	OK	
3.004	S88	-0.446	0.000	0.07			186.6	OK	
3.005	S93	-0.467	0.000	0.06			184.4	OK	
3.006	S89	-0.402	0.000	0.08			186.6	OK	
4.000	S50	-0.600	0.000	0.00			0.0	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
4.001	S94	-0.600	0.000	0.00			0.0	OK	
4.002	S95	-0.401	0.000	0.13			345.4	OK	
4.003	S52	-0.509	0.000	0.04			346.0	OK	
4.004	S97	-0.470	0.000	0.09			345.8	OK	
4.005	S46	-0.532	0.000	0.03			344.7	OK	
3.007	S96	-0.334	0.000	0.23			509.5	OK	
3.008	S90	-0.361	0.000	0.19			509.8	OK	
3.009	S60	-0.297	0.000	0.26			526.8	OK	
3.010	S66	-0.346	0.000	0.20			520.2	OK	
5.000	S82	-0.300	0.000	0.00			0.0	OK	
5.001	S107	-0.300	0.000	0.00			0.0	OK	
5.002	S106	-0.300	0.000	0.00			0.0	OK	
5.003	S108	-0.107	0.000	0.02			1.0	FLOOD RISK	
5.004	S105	-0.057	0.000	0.10			4.9	FLOOD RISK	
5.005	S83	0.054	0.000	1.42			48.6	FLOOD RISK	
5.006	S84	-0.189	0.000	0.29			48.3	OK	
3.011	S64	-0.211	0.000	0.63			552.1	OK	
1.016	S39	-0.252	0.000	0.38			897.6	OK	
1.017	S80	-0.406	0.000	0.25			896.4	FLOOD RISK	
1.018	S103	-0.205	0.000	0.05			117.0	OK	
1.019	S104	0.319	0.000	0.38			17.2	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.322	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.685	4-8	2.782	8-12	1.173	12-16	0.263

Total Area Contributing (ha) = 4.903

Total Pipe Volume (m³) = 2836.688

Network Design Table for Surface Network 1

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	45.353	0.200	226.8	0.000	5.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.001	82.698	0.350	236.3	0.333	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.002	59.717	0.750	79.6	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.003	82.442	0.670	123.0	0.459	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.004	188.559	0.370	509.6	0.255	0.00	0.0	0.600	\/	-1	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.29	41.340	0.000	0.0	0.0	0.0	2.62	2799.1	0.0
1.001	50.00	5.82	41.140	0.333	0.0	0.0	0.0	2.57	2741.9	45.1
1.002	50.00	6.05	40.790	0.333	0.0	0.0	0.0	4.44	4733.3	45.1
1.003	50.00	6.43	40.040	0.792	0.0	0.0	0.0	3.57	3804.9	107.2
1.004	48.09	8.23	39.370	1.047	0.0	0.0	0.0	1.75	1862.7	136.4

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.005	382.897	0.760	503.8	0.583	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.006	32.842	0.070	469.2	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.007	24.576	0.770	31.9	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
2.000	5.997	0.020	299.9	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.001	44.844	0.120	373.7	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.002	80.730	0.440	183.5	0.621	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.003	77.415	0.210	368.6	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
2.004	14.370	0.210	68.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
1.008	16.202	0.880	18.4	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.009	8.747	1.160	7.5	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.010	99.796	9.710	10.3	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.011	42.742	3.780	11.3	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.012	17.720	0.430	41.2	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.013	51.457	0.150	343.0	0.208	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.014	55.588	0.140	397.1	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
1.015	47.579	0.950	50.1	0.000	0.00	0.0	0.600	\/	-1	Pipe/Conduit	
3.000	48.919	0.120	407.7	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.001	62.689	0.370	169.4	0.746	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.002	22.422	0.710	31.6	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	40.05	11.87	39.000	1.630	0.0	0.0	0.0	1.76	1873.5	176.8
1.006	39.54	12.17	38.240	1.630	0.0	0.0	0.0	1.82	1941.9	176.8
1.007	39.44	12.22	38.170	1.630	0.0	0.0	0.0	7.02	7484.3	176.8
2.000	50.00	5.04	38.400	0.000	0.0	0.0	0.0	2.27	3339.1	0.0
2.001	50.00	5.41	38.380	0.000	0.0	0.0	0.0	2.04	2989.0	0.0
2.002	50.00	5.87	38.260	0.621	0.0	0.0	0.0	2.91	4273.8	84.1
2.003	50.00	6.50	37.820	0.621	0.0	0.0	0.0	2.05	3009.6	84.1
2.004	50.00	6.55	37.610	0.621	0.0	0.0	0.0	4.78	7010.5	84.1
1.008	39.36	12.27	37.400	2.251	0.0	0.0	0.0	5.69	1609.7	240.0
1.009	39.35	12.28	36.520	2.251	0.0	0.0	0.0	14.45	15412.7	240.0
1.010	39.13	12.42	35.360	2.251	0.0	0.0	0.0	12.38	13199.8	240.0
1.011	39.03	12.48	25.650	2.251	0.0	0.0	0.0	11.80	12583.7	240.0
1.012	38.95	12.53	21.870	2.251	0.0	0.0	0.0	6.17	6584.9	240.0
1.013	38.31	12.93	21.440	2.459	0.0	0.0	0.0	2.13	2273.3	255.1
1.014	37.60	13.40	21.290	2.459	0.0	0.0	0.0	1.98	2112.0	255.1
1.015	37.39	13.54	21.150	2.459	0.0	0.0	0.0	5.60	5971.8	255.1
3.000	50.00	5.42	24.540	0.000	0.0	0.0	0.0	1.95	2861.0	0.0
3.001	50.00	5.76	24.420	0.746	0.0	0.0	0.0	3.03	4448.3	101.0
3.002	50.00	5.82	24.050	0.746	0.0	0.0	0.0	7.04	10328.6	101.0

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.003	23.999	1.780	13.5	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.004	55.678	0.200	278.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.005	60.565	0.330	183.5	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.006	16.926	0.090	188.1	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.000	53.131	0.320	166.0	0.000	5.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.001	17.349	0.620	28.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.002	48.637	0.250	194.5	1.352	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.003	38.865	2.820	13.8	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.004	22.906	0.560	40.9	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
4.005	23.355	5.900	4.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.007	13.443	0.080	168.0	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.008	42.763	0.230	185.9	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.009	27.419	0.080	342.7	0.142	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
3.010	53.112	0.250	212.4	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
5.000	118.541	11.600	10.2	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit	
5.001	25.575	2.350	10.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.002	7.018	0.450	15.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.003	21.869	0.050	437.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.004	49.280	0.100	492.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.003	50.00	5.85	23.340	0.746	0.0	0.0	0.0	10.78	15817.8	101.0
3.004	50.00	6.25	21.560	0.746	0.0	0.0	0.0	2.36	3466.1	101.0
3.005	50.00	6.59	21.360	0.746	0.0	0.0	0.0	2.91	4273.2	101.0
3.006	50.00	6.69	21.030	0.746	0.0	0.0	0.0	2.88	4221.1	101.0
4.000	50.00	5.29	31.410	0.000	0.0	0.0	0.0	3.06	4493.7	0.0
4.001	50.00	5.33	31.090	0.000	0.0	0.0	0.0	7.48	10973.8	0.0
4.002	50.00	5.61	30.470	1.352	0.0	0.0	0.0	2.83	4149.9	183.1
4.003	50.00	5.68	30.220	1.352	0.0	0.0	0.0	10.66	15644.9	183.1
4.004	50.00	5.74	27.400	1.352	0.0	0.0	0.0	6.18	9073.1	183.1
4.005	50.00	5.76	26.840	1.352	0.0	0.0	0.0	19.90	29208.9	183.1
3.007	50.00	6.76	20.940	2.098	0.0	0.0	0.0	3.04	4466.7	284.1
3.008	50.00	7.01	20.860	2.098	0.0	0.0	0.0	2.89	4245.5	284.1
3.009	50.00	7.23	20.630	2.240	0.0	0.0	0.0	2.13	3122.0	303.3
3.010	50.00	7.55	20.550	2.240	0.0	0.0	0.0	2.70	3970.4	303.3
5.000	50.00	5.40	36.050	0.000	0.0	0.0	0.0	4.95	349.6	0.0
5.001	50.00	5.49	24.450	0.000	0.0	0.0	0.0	4.79	338.7	0.0
5.002	50.00	5.52	22.100	0.000	0.0	0.0	0.0	4.00	282.8	0.0
5.003	50.00	6.01	21.650	0.000	0.0	0.0	0.0	0.75	52.7	0.0
5.004	50.00	7.18	21.600	0.000	0.0	0.0	0.0	0.70	49.6	0.0

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
5.005	44.814	0.050	896.3	0.204	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.006	36.347	0.925	39.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.011	14.907	0.025	596.3	0.000	0.00	0.0	0.600	\/	-2	Pipe/Conduit	
1.016	99.793	0.300	332.6	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.017	5.860	0.650	9.0	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.018	77.143	0.250	308.6	0.000	0.00	0.0	0.600	\/	-3	Pipe/Conduit	
1.019	7.860	0.100	78.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
5.005	47.05	8.62	21.500	0.204	0.0	0.0	0.0	0.52	36.6	26.0
5.006	46.43	8.86	21.450	0.204	0.0	0.0	0.0	2.52	177.8	26.0
3.011	46.04	9.02	20.300	2.444	0.0	0.0	0.0	1.61	2362.4	304.7
1.016	36.35	14.27	20.200	4.903	0.0	0.0	0.0	2.28	2846.4	482.7
1.017	36.34	14.27	19.900	4.903	0.0	0.0	0.0	13.90	17372.9	482.7
1.018	35.62	14.82	19.250	4.903	0.0	0.0	0.0	2.36	2956.0	482.7
1.019	35.50	14.91	19.000	4.903	0.0	0.0	0.0	1.48	58.7«	482.7

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.333	0.333	0.333
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.459	0.459	0.459
1.004	-	-	100	0.255	0.255	0.255
1.005	-	-	100	0.583	0.583	0.583
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.621	0.621	0.621
2.003	-	-	100	0.000	0.000	0.000
2.004	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
1.010	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.208	0.208	0.208
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.000	0.000	0.000
3.001	-	-	100	0.746	0.746	0.746
3.002	-	-	100	0.000	0.000	0.000
3.003	-	-	100	0.000	0.000	0.000
3.004	-	-	100	0.000	0.000	0.000
3.005	-	-	100	0.000	0.000	0.000
3.006	-	-	100	0.000	0.000	0.000
4.000	-	-	100	0.000	0.000	0.000
4.001	-	-	100	0.000	0.000	0.000
4.002	-	-	100	1.352	1.352	1.352
4.003	-	-	100	0.000	0.000	0.000
4.004	-	-	100	0.000	0.000	0.000
4.005	-	-	100	0.000	0.000	0.000
3.007	-	-	100	0.000	0.000	0.000
3.008	-	-	100	0.000	0.000	0.000
3.009	-	-	100	0.142	0.142	0.142
3.010	-	-	100	0.000	0.000	0.000
5.000	-	-	100	0.000	0.000	0.000
5.001	-	-	100	0.000	0.000	0.000
5.002	-	-	100	0.000	0.000	0.000
5.003	-	-	100	0.000	0.000	0.000
5.004	-	-	100	0.000	0.000	0.000
5.005	-	-	100	0.204	0.204	0.204
5.006	-	-	100	0.000	0.000	0.000
3.011	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
1.018	-	-	100	0.000	0.000	0.000
1.019	-	-	100	0.000	0.000	0.000
				Total	Total	Total

Area Summary for Surface Network 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
				4.903	4.903	4.903

Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	S1	-1	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
1.001	S3	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.002	S98	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.003	S99	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.004	S4	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.005	S5	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.006	S100	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.007	S19	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.000	S21	-2	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
2.001	S91	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.002	S24	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.003	S25	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
2.004	S27	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.008	S20	600	0.000	0.000	Unclassified	1350	0	0.000	Unclassified
1.009	S28	-1	0.599	0.599	Unclassified	1350	0	0.599	Unclassified
1.010	S29	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.011	S102	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.012	S32	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.013	S101	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.014	S34	-1	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
1.015	S36	-1	0.599	1.069	Unclassified	1500	0	0.599	Unclassified
3.000	S85	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.001	S86	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.002	S87	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.003	S92	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.004	S88	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.005	S93	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.006	S89	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.000	S50	-2	0.599	0.599	Unclassified	1200	0	0.599	Unclassified
4.001	S94	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.002	S95	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.003	S52	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.004	S97	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
4.005	S46	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.007	S96	-2	0.599	0.599	Unclassified	1500	0	0.599	Unclassified
3.008	S90	-2	0.599	0.699	Unclassified	1500	0	0.599	Unclassified
3.009	S60	-2	0.599	0.699	Unclassified	1500	0	0.699	Unclassified
3.010	S66	-2	0.599	0.969	Unclassified	1500	0	0.599	Unclassified
5.000	S82	300	0.131	0.159	Unclassified	1350	0	0.159	Unclassified
5.001	S107	300	0.131	0.166	Unclassified	1350	0	0.131	Unclassified
5.002	S106	300	0.050	0.166	Unclassified	1350	0	0.166	Unclassified
5.003	S108	300	0.050	0.100	Unclassified	1350	0	0.050	Unclassified
5.004	S105	300	0.100	0.200	Unclassified	1350	0	0.100	Unclassified
5.005	S83	300	0.200	0.250	Unclassified	1350	0	0.200	Unclassified
5.006	S84	300	0.250	0.445	Unclassified	1350	0	0.250	Unclassified
3.011	S64	-2	0.969	0.994	Unclassified	1500	0	0.969	Unclassified
1.016	S39	-3	0.199	1.069	Unclassified	1500	0	1.069	Unclassified
1.017	S80	-3	0.199	2.249	Unclassified	1500	0	0.199	Unclassified
1.018	S103	-3	2.249	2.499	Unclassified	1200	0	2.249	Unclassified

Network Classifications for Surface Network 1

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.019	S104	225	0.004	2.275	Unclassified	3000	0	2.275	Unclassified

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.019	S81	19.129	18.900	0.000	0	0

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.322		

Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S104, DS/PN: 1.019, Volume (m^3): 111.5

Unit Reference	MD-SHE-0179-1723-1500-1723
Design Head (m)	1.500
Design Flow (l/s)	17.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	179
Invert Level (m)	19.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	17.2
Flush-Flo™	0.445	17.2
Kick-Flo®	0.967	14.0
Mean Flow over Head Range	-	14.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.3	1.200	15.5	3.000	24.0	7.000	36.0
0.200	15.5	1.400	16.7	3.500	25.8	7.500	37.3
0.300	16.8	1.600	17.8	4.000	27.5	8.000	38.4
0.400	17.2	1.800	18.8	4.500	29.1	8.500	39.6
0.500	17.2	2.000	19.7	5.000	30.6	9.000	40.7
0.600	17.0	2.200	20.7	5.500	32.1	9.500	41.8
0.800	16.1	2.400	21.5	6.000	33.4		
1.000	14.2	2.600	22.4	6.500	34.8		

Storage Structures for Surface Network 1

Tank or Pond Manhole: S104, DS/PN: 1.019

Invert Level (m) 19.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3956.9	0.701	4240.1	1.401	4530.9	2.101	4832.9
0.101	3996.9	0.801	4281.2	1.501	4573.1	2.201	4874.6
0.201	4037.1	0.901	4322.5	1.601	4615.4	2.301	4916.5
0.301	4077.4	1.001	4363.9	1.701	4657.9	2.400	4958.0
0.401	4117.8	1.101	4405.4	1.801	4700.5		
0.501	4158.5	1.201	4447.1	1.901	4749.9		
0.601	4199.2	1.301	4488.9	2.001	4791.4		

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.329
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 100
Climate Change (%) 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Summer	100	+40%					41.340
1.001	S3	15 Winter	100	+40%					41.304
1.002	S98	15 Winter	100	+40%					40.904
1.003	S99	15 Winter	100	+40%					40.256
1.004	S4	15 Winter	100	+40%					39.721
1.005	S5	15 Winter	100	+40%					39.381
1.006	S100	15 Winter	100	+40%					38.608
1.007	S19	15 Winter	100	+40%					38.349
2.000	S21	15 Winter	100	+40%					38.434
2.001	S91	15 Winter	100	+40%					38.434
2.002	S24	15 Winter	100	+40%					38.435
2.003	S25	15 Winter	100	+40%					38.025
2.004	S27	30 Winter	100	+40%					37.800
1.008	S20	30 Winter	100	+40%					37.792
1.009	S28	30 Winter	100	+40%					36.673
1.010	S29	30 Winter	100	+40%					35.495
1.011	S102	30 Winter	100	+40%					25.795
1.012	S32	30 Winter	100	+40%					22.102

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.600	0.000	0.00			0.0	OK	
1.001	S3	-0.436	0.000	0.08			186.6	OK	
1.002	S98	-0.486	0.000	0.06			188.0	OK	
1.003	S99	-0.384	0.000	0.14			432.5	OK	
1.004	S4	-0.249	0.000	0.29			496.6	FLOOD RISK	
1.005	S5	-0.219	0.000	0.31			556.5	FLOOD RISK	
1.006	S100	-0.232	0.000	0.41			531.7	FLOOD RISK	
1.007	S19	-0.421	0.000	0.16			533.1	OK	
2.000	S21	-0.566	0.000	0.00			0.2	OK	
2.001	S91	-0.546	0.000	0.00			0.9	OK	
2.002	S24	-0.425	0.000	0.08			281.9	OK	
2.003	S25	-0.395	0.000	0.11			275.4	OK	
2.004	S27	-0.410	0.000	0.09			234.1	OK	
1.008	S20	-0.208	0.000	0.76			710.3	FLOOD RISK	
1.009	S28	-0.447	0.000	0.17			711.1	OK	
1.010	S29	-0.465	0.000	0.06			711.5	OK	
1.011	S102	-0.455	0.000	0.10			711.6	OK	
1.012	S32	-0.368	0.000	0.29			711.2	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.013	S101	30 Winter	100	+40%				
1.014	S34	30 Winter	100	+40%				
1.015	S36	30 Winter	100	+40%				
3.000	S85	15 Winter	100	+40%				
3.001	S86	15 Winter	100	+40%				
3.002	S87	15 Winter	100	+40%				
3.003	S92	15 Winter	100	+40%				
3.004	S88	15 Winter	100	+40%				
3.005	S93	15 Winter	100	+40%				
3.006	S89	15 Winter	100	+40%				
4.000	S50	15 Summer	100	+40%				
4.001	S94	15 Summer	100	+40%				
4.002	S95	15 Winter	100	+40%				
4.003	S52	15 Winter	100	+40%				
4.004	S97	15 Winter	100	+40%				
4.005	S46	15 Winter	100	+40%				
3.007	S96	15 Winter	100	+40%				
3.008	S90	15 Winter	100	+40%				
3.009	S60	15 Winter	100	+40%				
3.010	S66	15 Winter	100	+40%				
5.000	S82	15 Summer	100	+40%				
5.001	S107	15 Summer	100	+40%				
5.002	S106	15 Summer	100	+40%				
5.003	S108	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
5.004	S105	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
5.005	S83	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
5.006	S84	15 Winter	100	+40%				
3.011	S64	15 Winter	100	+40%				
1.016	S39	15 Winter	100	+40%				
1.017	S80	30 Winter	100	+40%				
1.018	S103	1440 Winter	100	+40%	100/180 Winter			
1.019	S104	1440 Winter	100	+40%	100/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.013	S101	21.825	-0.215	0.000	0.43			733.2	FLOOD RISK
1.014	S34	21.687	-0.203	0.000	0.45			730.0	FLOOD RISK
1.015	S36	21.376	-0.374	0.000	0.20			731.2	OK
3.000	S85	24.610	-0.530	0.000	0.00			0.5	OK
3.001	S86	24.610	-0.410	0.000	0.11			343.1	OK
3.002	S87	24.168	-0.482	0.000	0.08			342.2	OK
3.003	S92	23.432	-0.508	0.000	0.05			340.2	OK
3.004	S88	21.773	-0.387	0.000	0.13			339.8	OK
3.005	S93	21.551	-0.409	0.000	0.11			334.6	OK
3.006	S89	21.328	-0.302	0.000	0.15			342.9	OK
4.000	S50	31.410	-0.600	0.000	0.00			0.0	OK

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

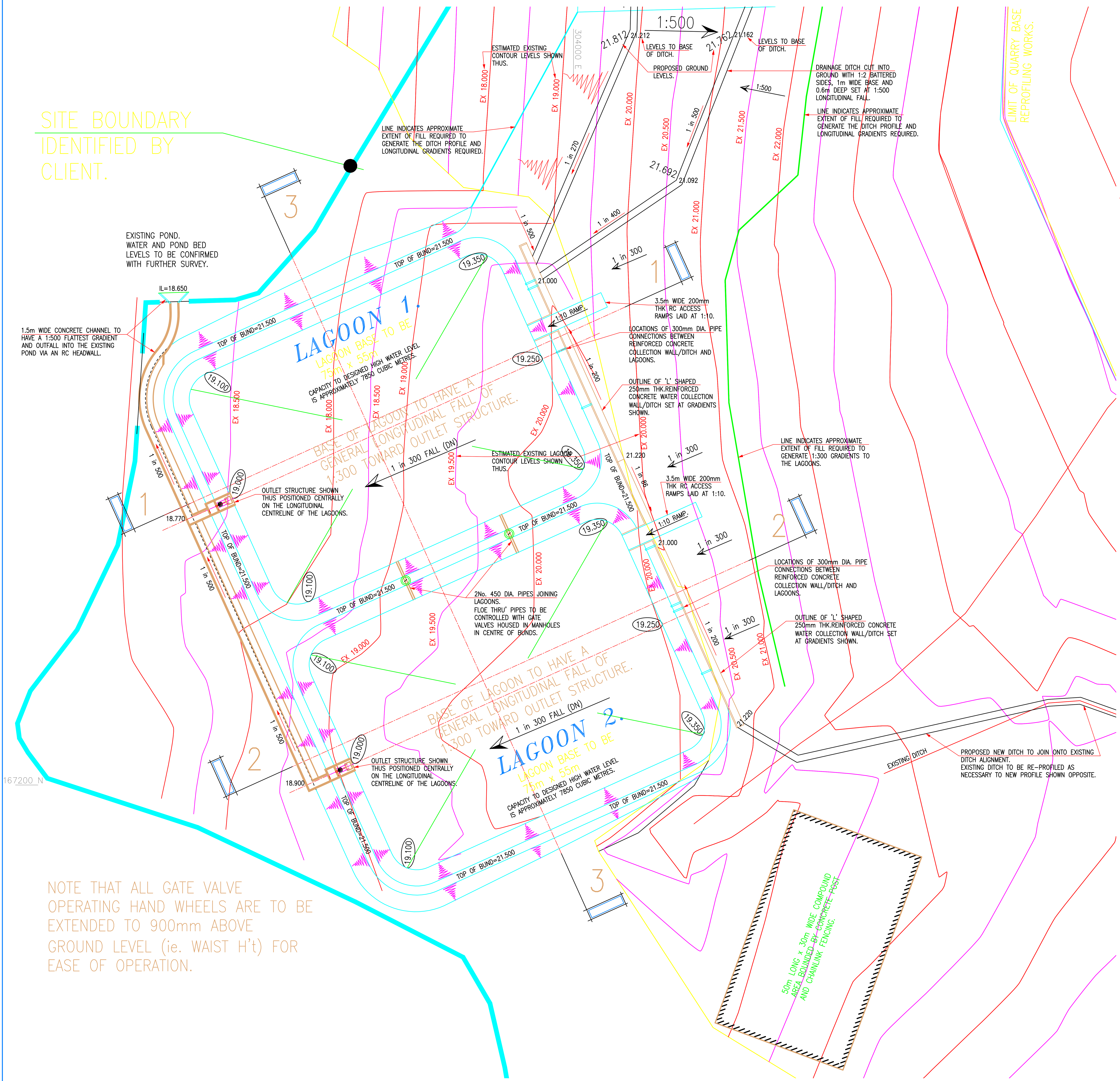
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
4.001	S94	31.090	-0.600	0.000	0.00			0.0	OK
4.002	S95	30.740	-0.330	0.000	0.23			625.1	OK
4.003	S52	30.349	-0.471	0.000	0.07			626.6	OK
4.004	S97	27.590	-0.410	0.000	0.16			625.9	OK
4.005	S46	26.931	-0.509	0.000	0.05			623.7	OK
3.007	S96	21.311	-0.229	0.000	0.41			921.8	FLOOD RISK
3.008	S90	21.189	-0.271	0.000	0.35			925.7	FLOOD RISK
3.009	S60	21.042	-0.188	0.000	0.48			947.9	FLOOD RISK
3.010	S66	20.918	-0.232	0.000	0.35			936.7	FLOOD RISK
5.000	S82	36.050	-0.300	0.000	0.00			0.0	OK
5.001	S107	24.450	-0.300	0.000	0.00			0.0	OK
5.002	S106	22.100	-0.300	0.000	0.00			0.0	OK
5.003	S108	22.000	0.050	0.040	0.10			4.6	FLOOD
5.004	S105	22.000	0.100	0.167	0.20			9.4	FLOOD
5.005	S83	22.004	0.204	4.164	2.31			79.1	FLOOD
5.006	S84	21.597	-0.153	0.000	0.48			79.1	OK
3.011	S64	20.828	-0.072	0.000	1.15			1000.6	OK
1.016	S39	20.573	-0.127	0.000	0.67			1585.7	OK
1.017	S80	20.051	-0.349	0.000	0.44			1585.8	FLOOD RISK
1.018	S103	20.045	0.295	0.000	0.06			152.6	SURCHARGED
1.019	S104	20.045	0.820	0.000	0.38			17.2	SURCHARGED

PN	US/MH Name	Level Exceeded
1.013	S101	
1.014	S34	
1.015	S36	
3.000	S85	
3.001	S86	
3.002	S87	
3.003	S92	
3.004	S88	
3.005	S93	
3.006	S89	
4.000	S50	
4.001	S94	
4.002	S95	
4.003	S52	
4.004	S97	
4.005	S46	
3.007	S96	
3.008	S90	
3.009	S60	
3.010	S66	
5.000	S82	
5.001	S107	

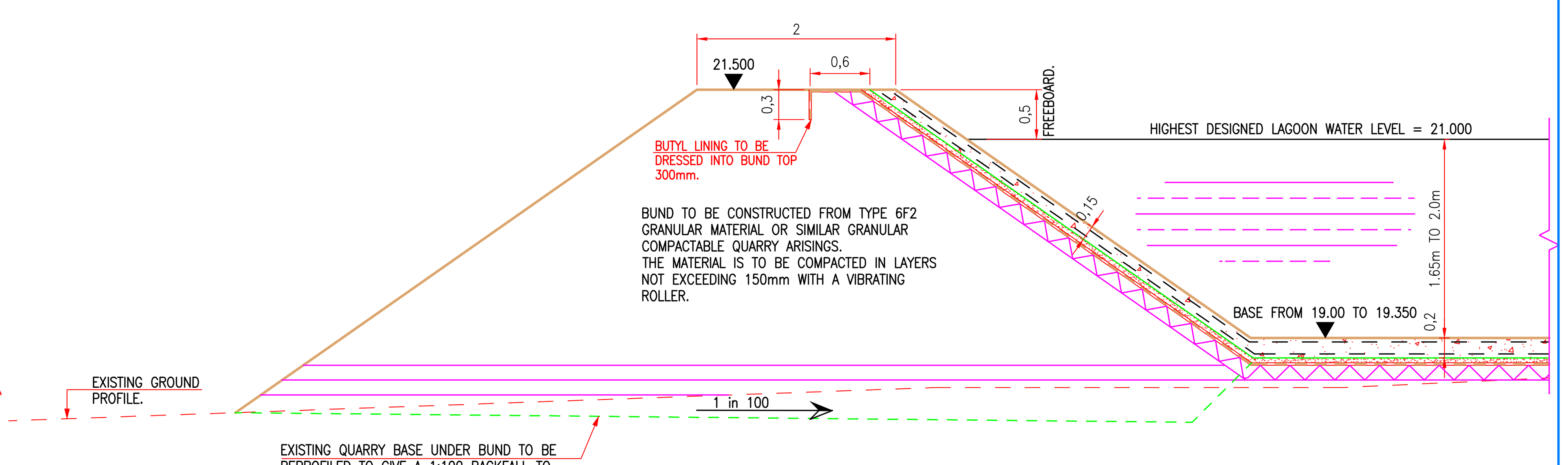
Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Level Exceeded
5.002	S106	
5.003	S108	4
5.004	S105	4
5.005	S83	4
5.006	S84	
3.011	S64	
1.016	S39	
1.017	S80	
1.018	S103	
1.019	S104	

Appendix E – Bingham Hall Partnership Drawings



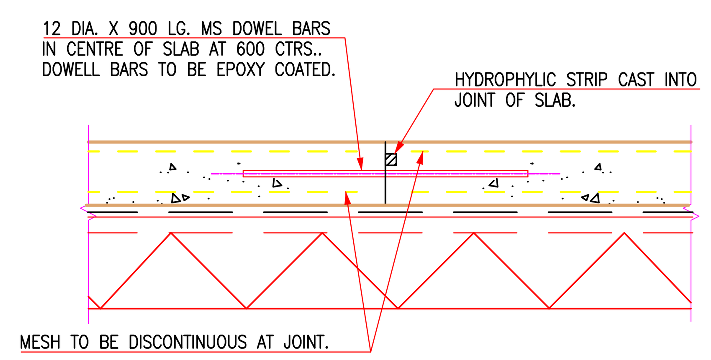
PLAN ON SETTLEMENT LAGOONS.



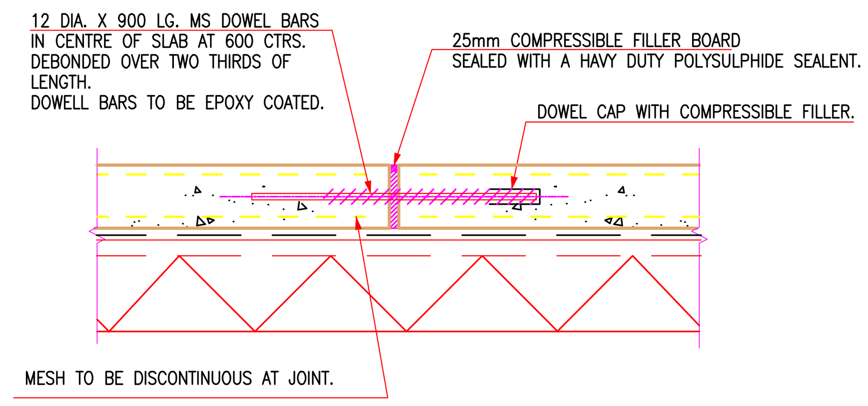
EXISTING QUARRY BASE UNDER BUND TO BE REPROFILED TO GIVE A 1:100 BACKFALL TO AID WALL DESIGN. THE FORMATION IS TO BE ORIGINAL QUARRY FLOOR.

THE CONCRETE TO THE LAGOON BASE AND BATTERS TO BE GRADE RC45 USING 20mm AGGREGATE WITH 2 LAYERS OF A393 MESH FABRIC (1 LAYER TOP & 1 LAYER BOTTOM) WITH 40mm OF COVER. CONSTRUCTION JOINTS WITHIN THE BASE CONCRETE TO BE AT 6m MAXIMUM CENTRES WITH EVERY 4th JOINT BEING A MOVEMENT JOINT. EACH LAGOON IS TO HAVE 3No. LONGITUDINAL CONSTRUCTION JOINTS SPACED EQUALLY THRU' THE LAGOONS. THE LAGOONS CONCRETE IS TO BE LAID ON 50mm CONCRETE BLINDING (RC45) ON 'BUTYL' RUBBER LINING BY SPECIALIST ON EITHER FINE STONE DUST OR PFA FINISH TO 150mm THK COMPACTED HARDCORE.

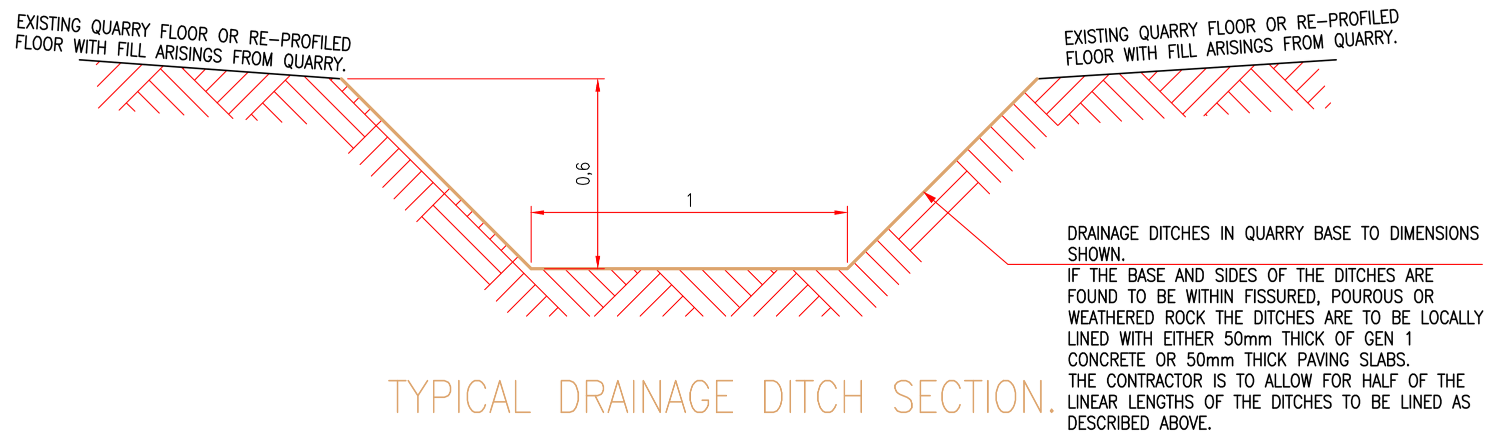
TYPICAL BUND SECTION TO WESTERN (LOWER) END OF LAGOON.



CONSTRUCTION JOINT.
(C.J.)



EXPANSION JOINT.
(EXP.J.)



TYPICAL DRAINAGE DITCH SECTION.

NOTES.

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT BHPL AND SPECIALISTS DRAWINGS & SPECIFICATIONS.
2. ALL REINFORCED CONCRETE DRAINAGE CHANNELS TO BE GRADE RC45 USING 20mm AGGREGATE AND WITH 40mm OF COVER TO THE REINFORCEMENT.
3. ALL REINFORCED CONCRETE DRAINAGE CHANNELS ARE TO RECEIVE MOVEMENT JOINTS AT 6m MAXIMUM CENTRES, THESE WILL CONSIST OF 900mm LONG R12 DOWELL BARS AT 600mm CENTRES WITH THE JOINT SEALED WITH A HYDROPHYLIC STRIP BY 'SIKA' OR SIMILAR APPROVED.
4. THE REINFORCED CONCRETE OUTFALL CHAMBERS ARE TO BE GRADE RC45 (20mm AGG.) CONCRETE WITH 40mm OF COVER TO THE REINFORCEMENT, THE CHAMBER IS DESIGNED AS A WATER RETAINING STRUCTURE.
5. THE FLOATING OUTLET BOOM ARRANGEMENT IS TO BE DESIGNED AND DETAILED BY SPECIALIST.
6. THE CONCRETE TO THE LAGOON BASE AND BATTERS TO BE GRADE RC45 (20mm AGG.) WITH 2 LAYERS OF A393 MESH FABRIC (1 LAYER TOP & 1 LAYER BOTTOM) WITH 40mm OF COVER.
7. CONSTRUCTION JOINTS WITHIN THE BASE CONCRETE TO BE AT 6m MAXIMUM CENTRES WITH EVERY 4th JOINT BEING A MOVEMENT JOINT.
8. EACH LAGOON IS TO HAVE 3No. LONGITUDINAL JOINTS SPACED EQUALLY THRU' THE LAGOONS.
9. THE ACCESS RAMPS TO THE LAGOONS ARE TO BE 200mm THICK WITH SAME SPECIFICATION AS THE LAGOON BASE, THE FINISH TO THE RAMPS IS TO BE TAMPED TRANSVERSLY TO THE GRADIENT.
10. THE LAGOONS CONCRETE IS TO BE LAID ON 50mm CONCRETE BLINDING (RC45) ON 'BUTYL' RUBBER LINING BY SPECIALIST ON A MINIMUM OF 150mm THICK OF STONE DUSTED WELL COMPACTED HARDCORE OR SUITABLE QUARRY ARISINGS.

REV	BY	DATE	REVISION
B	PH	04-05-06	CONC. GRADES UPDATED,NOTE TO DITCH AMENDED,CONTRACTORS COMPOUND ADDED.
A	PH	14-03-06	LAGOON SIZES REDUCED, GRADIENTS TO LAGOON BASE INTRODUCED.

ARCHITECT

CLIENT: RWEnpower

SCALE	DRAWN	DRAWING SIZE	DATE	CHECKED
1:500,1:50,1:20	PH	A1	09/02/06	

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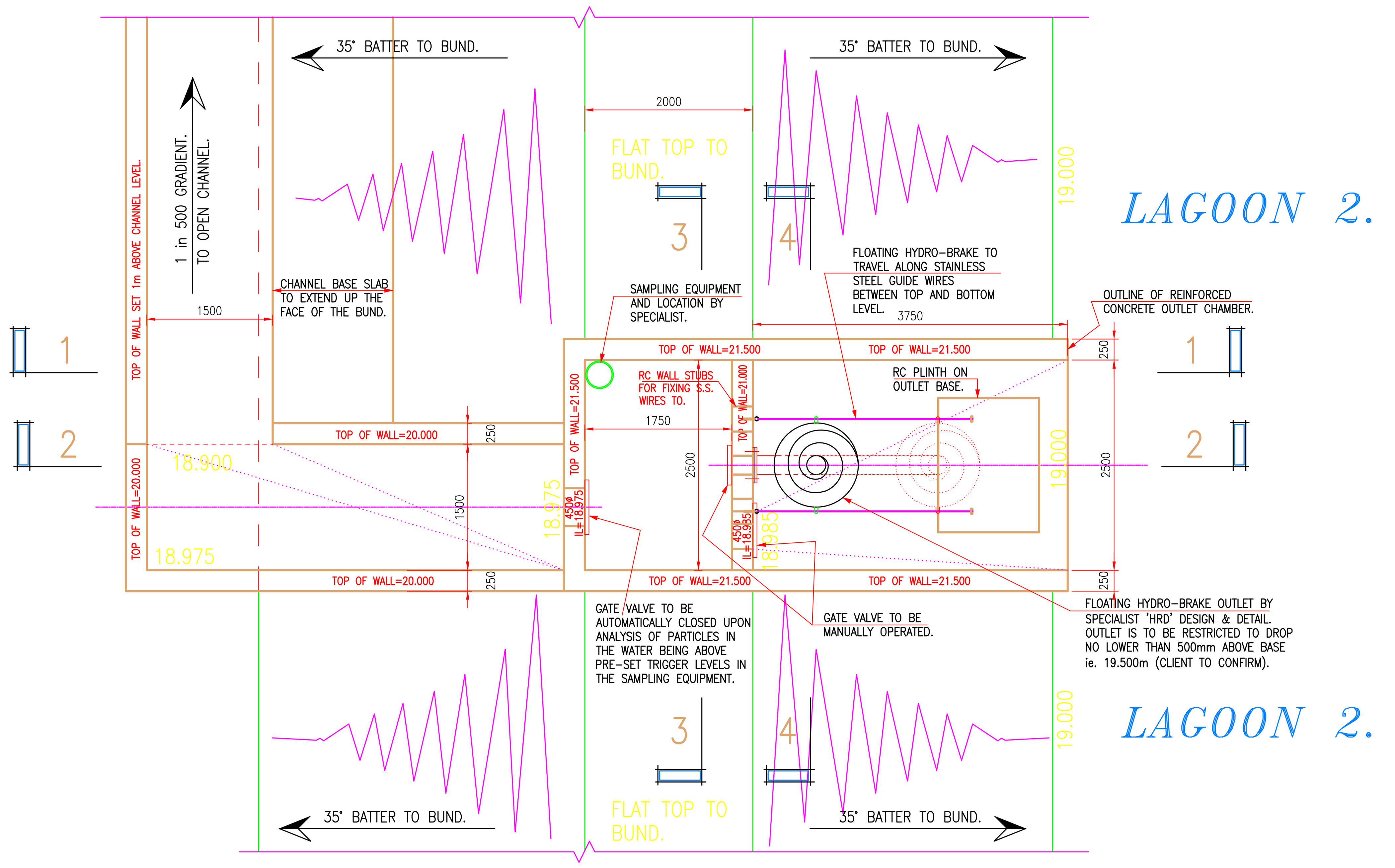
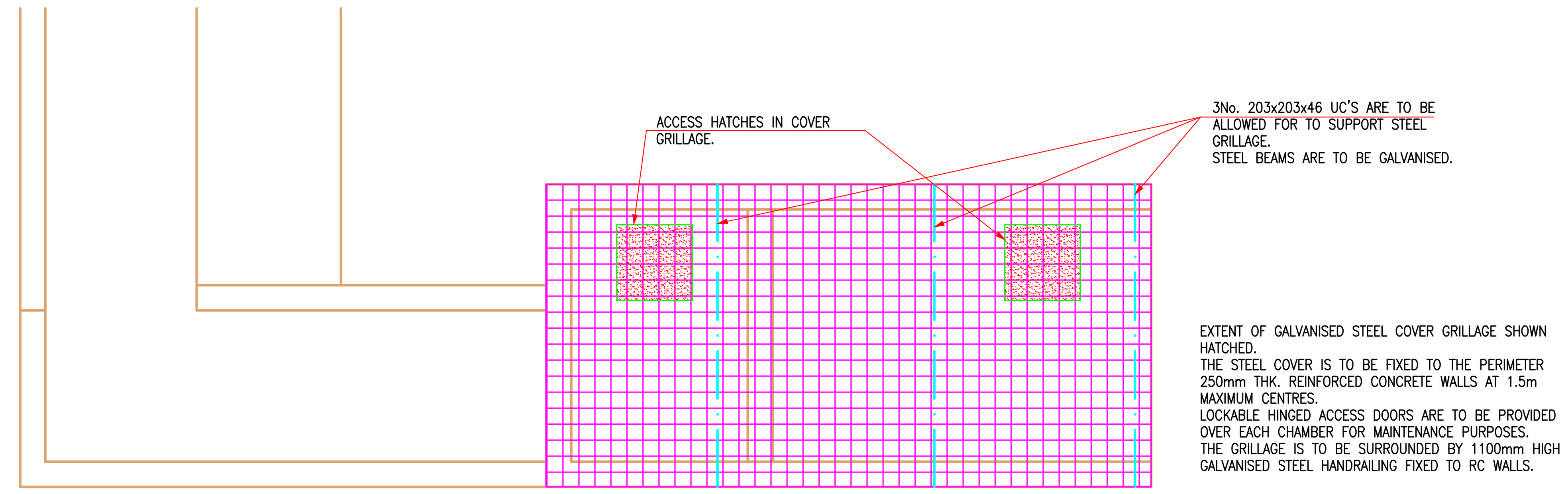
PROJECT TITLE: QUARRY WORKS AT ABERTHAW.

DRAWING TITLE: GENERAL LAGOON ARRANGEMENT PLAN.

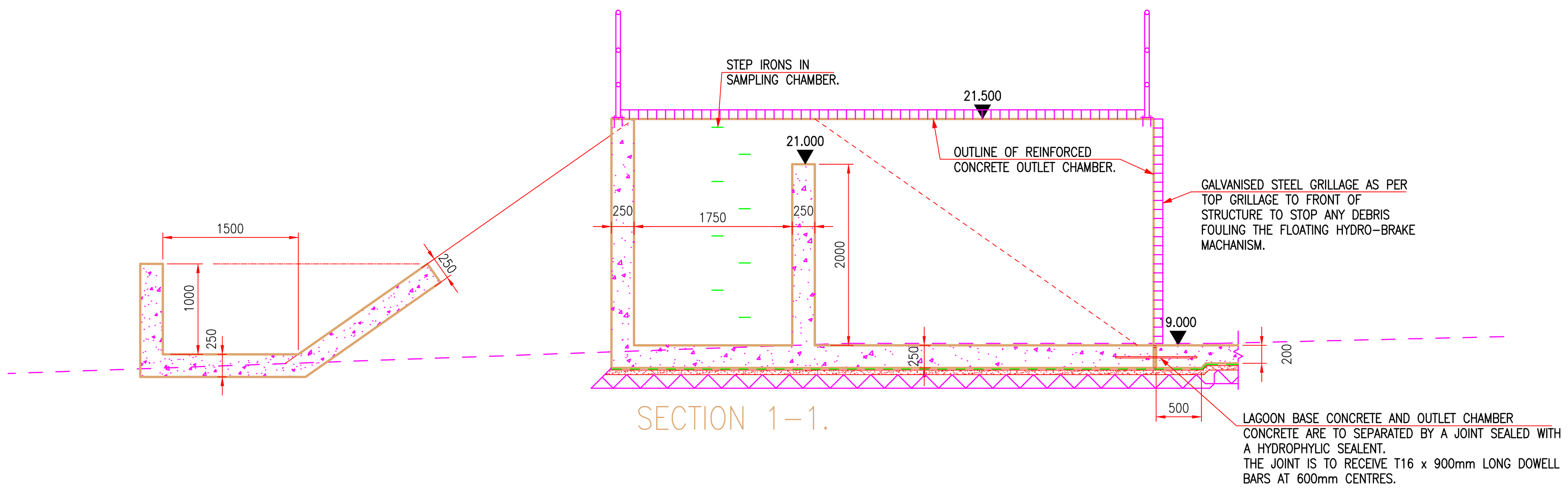
PROJECT NO./DWG NO.	DRAWING STATUS	REV
5764A / 010	For Tender	B



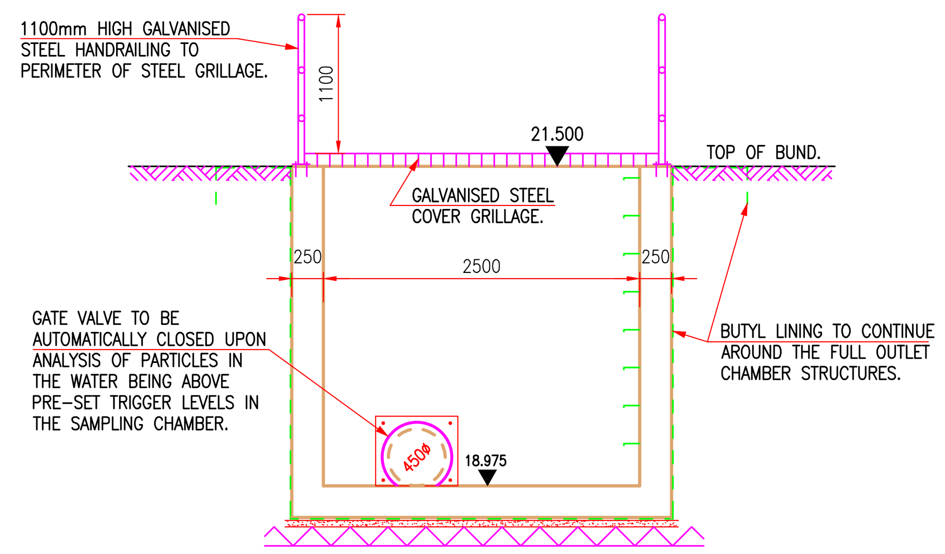
PLAN ON OUTFALL CHAMBER – LAGOON 2.
PLAN ON OUTFALL CHAMBER – LAGOON 1 SIMILAR.



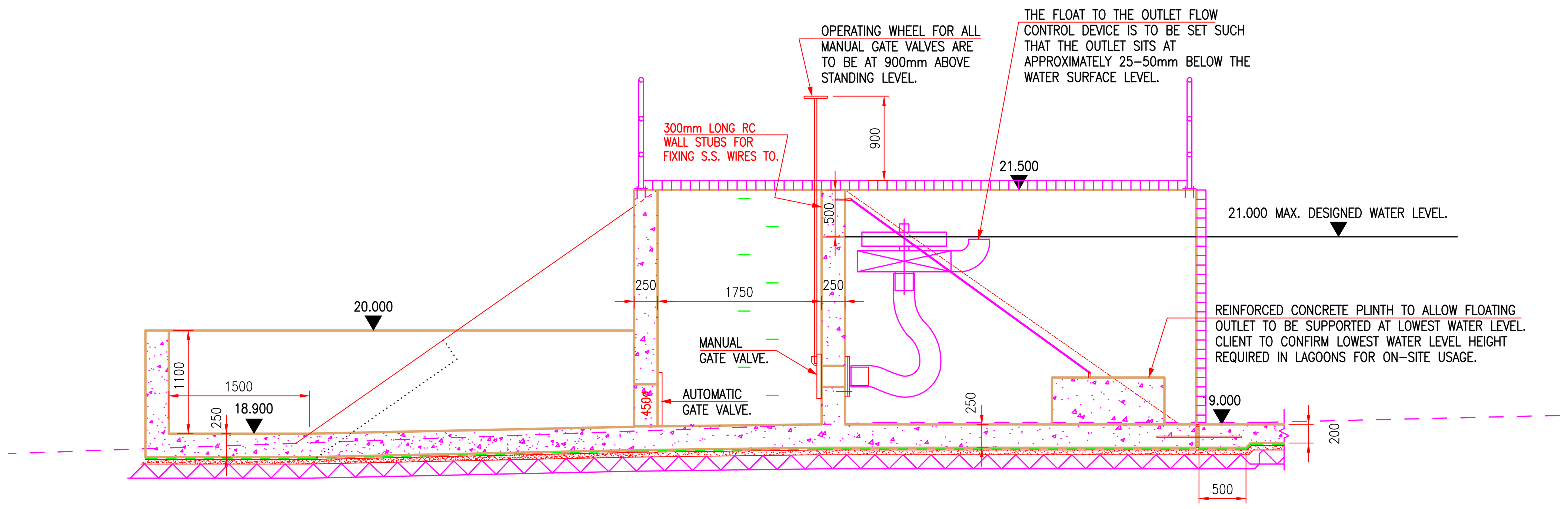
PLAN ON EXTENT OF OPEN TYPE GRILLAGE



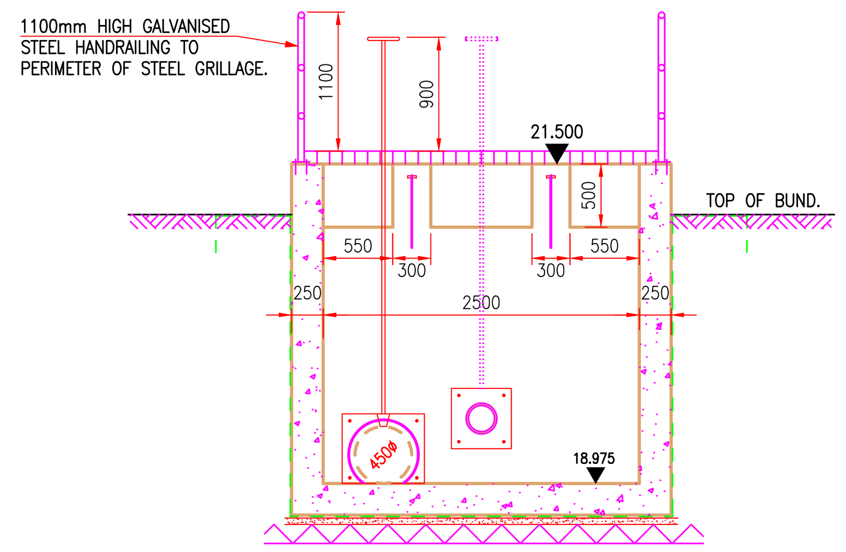
SECTION 1–1.



SECTION 3–3.



SECTION 2–2.



SECTION 4–4.

NOTES.

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT BHPL AND SPECIALISTS DRAWINGS & SPECIFICATIONS.
2. ALL REINFORCED CONCRETE DRAINAGE CHANNELS TO BE GRADE RC45 (20mm AGG.) WITH 40mm OF COVER TO THE REINFORCEMENT.
3. ALL REINFORCED CONCRETE DRAINAGE CHANNELS ARE TO RECEIVE MOVEMENT JOINTS AT 6m MAXIMUM CENTRES, THESE WILL CONSIST OF 900mm LONG R12 DOWELL BARS AT 600mm CENTRES WITH THE JOINT SEALED WITH A HYDROPHYLIC STRIP BY 'SIKA' OR SIMILAR APPROVED.
4. THE REINFORCED CONCRETE OUTFALL CHAMBERS ARE TO BE GRADE RC45 (20mm AGG) CONCRETE WITH 40mm OF COVER TO THE REINFORCEMENT, THE CONCRETE IS TO BE DESIGNED AS A WATER RETAINING STRUCTURE.
5. THE FLOATING OUTLET BOOM ARRANGEMENT IS TO BE DESIGNED AND DETAILED BY SPECIALIST.
6. THE CONCRETE TO THE LAGOON BASE AND BATTERS TO BE GRADE RC45 (20mm AGG) WITH 2 LAYERS OF A393 MESH FABRIC (1 LAYER TOP & 1 LAYER BOTTOM) WITH 40mm OF COVER.
7. CONSTRUCTION JOINTS WITHIN THE BASE CONCRETE TO BE AT 6m MAXIMUM CENTRES WITH EVERY 4th JOINT BEING A MOVEMENT JOINT.
8. EACH LAGOON IS TO HAVE 3No. LONGITUDINAL JOINTS SPACED EQUALLY THRU' THE LAGOONS.
9. THE ACCESS RAMPS TO THE LAGOONS ARE TO BE 200mm THICK WITH SAME SPECIFICATION AS THE LAGOON BASE, THE FINISH TO THE RAMPS IS TO BE TAMPED TRANSVERSLY TO THE GRADIENT.
10. THE LAGOONS CONCRETE IS TO BE LAID ON 50mm CONCRETE BLINDING (RC45) ON 'BUTYL' RUBBER LINING BY SPECIALIST ON A MINIMUM OF 150mm THICK OF STONE DUSTED WELL COMPACTED HARDCORE.

REV	BY	DATE	REVISION
B	PH	04–05–06	CONCRETE GRADES UPDATED.
A	PH	15–03–06	OUTLET DEVICE CHANGED; OUTLET CHAMBER UPDATED TO SUIT.

ARCHITECT				
CLIENT: RWEnpower				
SCALE	DRAWN	DRAWING SIZE	DATE	CHECKED
1:50	PH	A1	12/02/06	

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PROJECT TITLE: QUARRY WORKS AT ABERTHAW.

DRAWING TITLE: LAGOON OUTLET CHAMBER DETAILS.

PROJECT NO./DWG NO.	DRAWING STATUS	REV
5764A / 015	For Tender	B

FOR PHASE 1 SECTIONS REFER TO BHPL DRAWING 5764A/039.

REV	BY	DATE	REVISION

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PROJECT TITLE: QUARRY WORKS AT ABERTHAW.

DRAWING TITLE: FINAL PERMANENT INFILLED QUARRY PROFILE.

ARCHITECT: N/A

CLIENT: RWEnpower.

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PROJECT NO./DWG NO.	REV	DRAWING STATUS
5764A/066		CONSTRUCTION

Appendix F – Journal Sources

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PERMEABILITY CHARACTERISTICS OF SOIL-FLY ASH MIX

[redacted]

ABSTRACT

Permeability is vital to every project where the flow of water through soil is a concern (e.g. dam seepage, cutoff wall and diaphragm wall). There are numerous studies about the vertical permeability of soil since ASTM D2434 Standard Test Method for Permeability of Granular Soils (Constant Head & Falling Head) is being followed. On the contrary, there are only a few studies that focused on the horizontal permeability of soils. Five (5) soil samples with different mixes of silty sand and fly ash were obtained for comparison. Rigorous laboratory tests was performed to determine the individual properties. Tests such as specific gravity tests, Atterberg limit tests (liquid limit, plastic limit and plasticity index), emax and emin test/relative density tests, particle size analyses, microscopic characterizations, elemental composition tests and permeability tests were performed to garner data that were utilized for the model. A new permeability set-up was used in the determination of the horizontal permeability. A relationship between the percentage of fly ash and the coefficient of permeability was established, the said relationship was utilized to develop a model that will predict the coefficient of permeability when the percentage of fly ash is available.

Keywords: fly ash, permeability, horizontal permeability, waste, regression.

INTRODUCTION

The properties of soil changes over time, it can be influenced by its physical content, climate and weather. It can reveal a lot of information by just analyzing the soil profile of a certain area.

When designing structures, it is very important for engineers to understand the soil underneath because it will affect the way it is designed. It is used by geotechnical engineers in designing foundations, retaining walls, etc. Without its knowledge, lives would be at stake. Geotechnical properties include the grain size distribution, Atterberg limits, specific gravity, maximum and minimum index densities, soil classification, permeability, shear strength and compressibility.

Permeability is vital to every project where the flow of water through soil is a concern (e.g. dam seepage, cutoff wall and diaphragm wall). Permeability refers to the susceptibility of a material to allow fluid to move through its pores. In the context of soil, permeability generally relates to the propensity of a soil to allow fluid to move through its void spaces [redacted]

It was proposed that fly ash is mixed with silty sand since power plants discharge large amounts of fly ash as waste but only half of them are used and the remaining half is trashed to land and sea, its disposal became an environmental concern. The utilization of fly ash may be a viable alternative for porous backfill material because fly ashes generally consist of silt-sized particles and consequently possess high permeability [redacted] of soil-sly ash mixture since there was a lack of information on the horizontal permeability of the said mixes.

METHODOLOGY

[redacted] said that fly ashes generally consist of silt-sized particles and consequently possess high permeability. To check the effect of fly ash on soil, varying amounts [0% (100S), 25% (25FA75S), 50% (50FA50S), 75% (75FA25S) and 100% (100FA)] of fly ash were utilized.

Each soil mix underwent rigorous laboratory tests: specific gravity test based on ASTM D854 was utilized, it is the standard of determining the density of the soil. Atterberg limit tests based on ASTM D4318 for determining the Liquid Limit, Plastic Limit and the Plasticity Index of the Soil. For emax and emin Tests and Relative Density, ASTM D4253 and ASTM D4254 were used to determine the maximum and minimum index densities for soils. Particle size analysis uses ASTM D422 to determine the percentage of different grain sizes in a soil.

The scanning electron microscopy (SEM) was used to evaluate the microscopic characterization of each soil mixture. Scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (SEM/EDX) is the best known of the surface analytical techniques. High resolution images of surface topography are produced using these tests. Using the Energy Dispersive X-ray Spectroscopy (EDX), chemical composition of soil is determined to give information on the elements present in the soil.

Permeability of the different soil mixes were determined by the constant head test method and falling head test method. The direction of flow of water is also important, thus, vertical and horizontal orientations of permeameter were used. A proposed set-up by [redacted] for permeameter was used and modified to determine the horizontal permeability of the soil mixtures, shown on Figure-1. The equation utilized for the permeability set-up is Eq. 1.

A proposed Regression model based on the data garnered was formulated. Regression modelling is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the

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relationship between a dependent variable and one or more independent variables.

The said models were validated using Equality Line and other Models. Validation using equality line usually involves a 45-degree line as a guideline that provides insight into the measured variables and as a critical part of the analysis. When the data are near the 45-degree line, this means that the residual is small and the predicted coefficient of permeability is near the measured coefficient of permeability. Validation using other previous models developed such as works of [redacted] were considered for comparison. Once models were valid, the research provided conclusions and a recommendations.

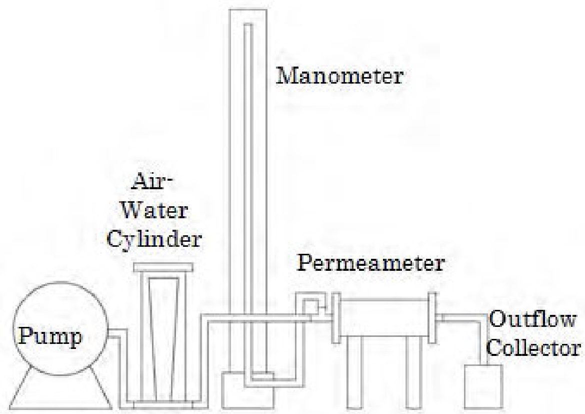

Figure-1. Horizontal Permeability Set-up.

The light intensity thus attractiveness is inversely proportional with the particular distance *r* from the light source. Thus the light and attractiveness is decrease as the distance increase.

$$k=Ql/Aht \quad (1)$$

where:

k = coefficient of permeability, cm/s;
Q= quantity (volume) of water discharged during test, cm^3;
l= length between manometer outlets, cm;
A = cross-sectional area of specimen, cm^2;
H = head (difference in manometer levels) during test, cm;
T = time required for quantity Q to be discharged during test, s.

RESULTS & DISCUSSIONS

Physical and Chemical Properties

Using ASTM D854 the specific gravity of each soil blend was determined. The summary of the specific gravity of various soil mixtures are shown in Table-1:

Table-1. Summary of Specific Gravity.

Soil Mixture	G_s
100FA	2.02
75FA25S	2.11
50FA50S	2.31
25FA75S	2.49
100S	2.58

The specific gravity of the soil mixes was reduced by the addition of fly ash (Prabakar, *et al*. 2004) since the usual of the specific gravity of fly ash is low. With the results shown on Table-1, the addition of fly ash reduces the specific gravity of a soil mixture, thus we can agree with the statement of [redacted] this is due to the light weight property of fly ash.

Table-2. Summary of Atterberg Limits.

Soil Mixture	LL	PL	PI
100FA	66	65	1
75FA25S	64	57	7
50FA50S	61	49	12
25FA75S	59	45	14
100S	52	32	20

The effect of adding fly ash in the mixture, due to its silty property, is that it reduced the plasticity of a soil mixture. Based on established literatures (e.[redacted] fly ash is considered as silt material, it is expected to have a plasticity index less than 1. Results are shown in Table-2.

ASTM D4253 and ASTM D4254 were used to determine the maximum and minimum void ratios of the different soil-fly ash mixes.

Table-3. Summary of e_{min} and $e_{max.}$

Soil Mixture	e_{min}	e_{max}
100FA	0.27	1.99
75FA25S	0.37	1.98
50FA50S	0.47	1.94
25FA75S	0.72	1.93
100S	0.84	1.78

It can be noticed from Table-3, the Maximum Void Ratio (e_{max}) ranges from 1.78 to 1.99 because the fine contents of the fly ash contributed to the percentage of voids. 100S has the lowest value while 100FA has the highest, also from Table-3, 100S has the lowest fines content, while 100FA garners the highest. Their fines content and microfabric may have contributed to the minimum and maximum void ratio.

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These minimum and maximum void ratios together with the target relative density of 90% were used to determine the void ratio to be utilized for the permeability specimens.

Table-4. Summary of Particle Size Analysis Results.

Soil Blend	% Passing #200	D_{10}	D_{30}	D_{60}
100F	61.83	0.029	0.03	0.04
75FA25S	50.78	0.019	0.032	0.06
50FA50S	29.79	0.032	0.0375	0.12
25FA75S	25.79	0.015	0.042	0.15
100S	21.84	0.01	0.4	1.2

Summary of results from the particle size analyses are shown on Table-4. 100FA has the greatest percentage of fines compared with other blends. Fly ash and soil are considered fines but the classification differ, fly ash is silt and soil is plastic. It can also be noticed that mixing fly ash with other soils increases the fines content.

In the Energy Dispersive X-ray Spectroscopy (EDX), chemical composition of soil is determined to give information on the element present in the soil, shown in Table 5. Oxygen (O) is very abundant, followed by Silicon (for Silty Sand) and Calcium (for Fly Ash). Silicon and Calcium are predominant in the soil elemental composition. Due to the presence of Oxygen and other dominant elements: Silica (from Silicon), Lime (from Calcium) and Alumina (from Aluminum) are the dominant minerals in the soil sample.

Table-5. Summary of Elemental Composition.

Element	Composition (%) for Silty Sand	Composition (%) for Fly Ash
C, Carbon	17.39	5.41
O, Oxygen	46.65	40.64
Al, Aluminum	11.52	5.26
Si, Silicon	15.63	9.1
K, Potassium	1.05	0.78
Ca, Calcium	0.24	21.82
Fe, Iron	5.72	16.34
Cu, Copper	1.8	0.26
S, Sulfur	0	0.39

Most of the soil properties and characteristics like strength, compressibility and permeability are ascribed by its microfabric or microstructure. The scanning electron microscopy (SEM) was used to evaluate the microfabric of soil, fly ash and bentonite. Scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (SEM/EDX) is the best known of the surface analytical techniques. High resolution images of surface topography, are produced using these tests.

Pure soils were initially tested to check their microscopic characteristics, mixed soils were also tested thereafter.

As shown in Figure-2, with 500x magnification for 100S, it is a combination of extremely strandy grains, large angular grains and abundant silt grains formed the micro fabric. The silt grains have a rough surface. The particles are well-graded microscopically. The smaller particles tend to fill the voids created by the larger particles shown in the figure, thus creating a smaller inter-particle void. Looking closer to magnification of 1000x and 5000x, strand-like particles are present, his indicates that these elongated particles also fill the voids, giving small passageways for water to permeate.

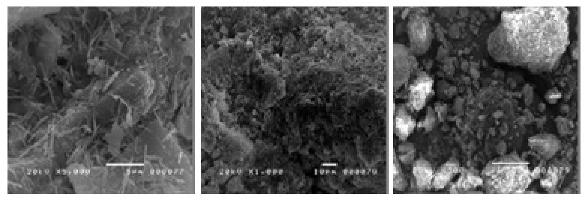

Figure-2. Microfabric of 100S (5000x, 1000x and 500x Magnification).

As shown in Figure-3, with 500x magnification for fly ash, it is a combination of larger silt grains and smaller silt grains to form the micro fabric. Fly ash is a silt thus normally 0.002-0.05 mm in size. As seen on the 500x magnification, particles have almost similar size, forming larger inter-particle void, compared with silty sand and bentonite, to allow water to pass through. On the 1000x and 5000x magnification, the surface of the particle is not smooth, this create passageway/voids for water to pass through.

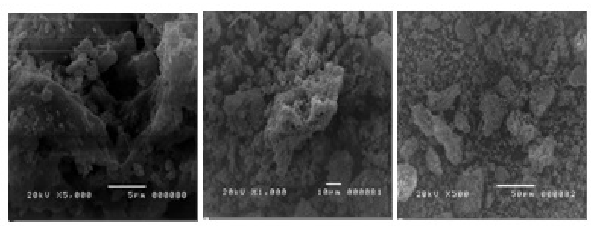

Figure-3. Microfabric of 100FA (5000x, 1000x and 500x Magnification).

As shown in Figure-4, with 500x magnification for 50FA50S, it is a combination of extremely strandy grains, large angular grains and abundant larger silt grains and smaller silt grains formed the micro fabric. The silt grains have a rough surface. Looking closer to magnification of 1000x and 5000x, strand-like particles are present but no prevalent compared with the pure soil, the soil particles may contribute to the reduction of permeability but the silt grains of fly ash will counteract to allow water to drain faster.

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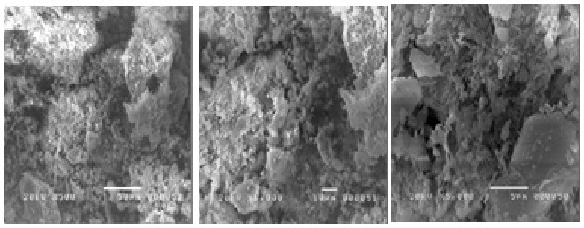

Figure-4. Microfabric of 50FA50S (5000x, 1000x and 500x Magnification).

Permeability Characteristics

A proposed approach in determining the vertical permeability of the various soil mixtures was utilized, it was referred on the study of [redacted] and was modified. Shown in Table-6, are the range of permeability values gathered for the vertical oriented constant head permeability test, to determine the effect of fly ash when added to soil, a box and whisker plot is delineated, shown on Figure-5.

Table-6. Range of permeability values for vertical oriented permeability test.

Soil Mixture	Minimum k, cm/s,	Maximum k, cm/s
100FA	4.53E-05	5.52E-05
75FA25S	3.40E-05	3.80E-05
50FA50S	2.55E-05	3.16E-05
25FA75S	2.05E-05	2.51E-05
100S	1.47E-05	2.09E-05

It is prevalent that the permeability is increased when the amount of fly ash is increased. It now agrees with the study of Prashanth (2001) that fly ashes generally consist of silt-sized particles and consequently possess high permeability. Thus, the amount of fly ash increase the permeability of the soil mixes.

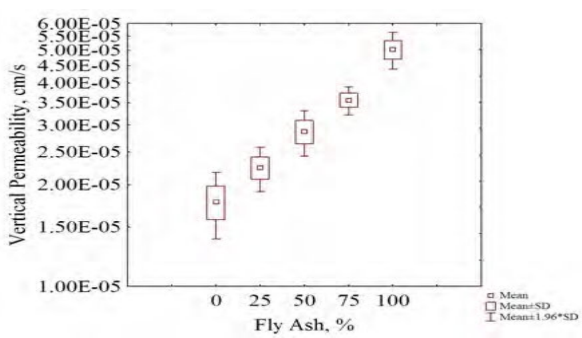

Figure-5. Effect of fly ash on the vertical permeability when added to soil.

The horizontal permeability of the various soil mixtures is important because it can discerned how long the contaminated water penetrated in the horizontal direction. Shown in Table-7, are the range of permeability values gathered for the horizontal oriented constant head permeability test. To determine the effect of fly ash in the horizontal permeability when added to soil, a box and whisker plot is delineated, shown on Figure-6.

Table-7. Range of permeability values for horizontal oriented permeability test.

Soil Mixture	Minimum k, cm/s	Maximum k, cm/s
100FA	6.02E-05	7.28E-05
75FA25S	4.25E-05	5.02E-05
50FA50S	3.40E-05	4.04E-05
25FA75S	3.04E-05	3.70E-05
100S	2.21E-05	2.70E-05

It can also be noticed that the horizontal permeability values are larger than the vertical permeability values. This agrees with the collected data of Das (2008), where he stated that the horizontal permeability is always larger than the vertical permeability. This is due to the pressure head induced during the permeability test. The specimen is laid in a horizontal position, which experiences no pressure drop within its body, unlike the vertical specimen, which experiences pressure drop, resulting to a slower flow of water.

The permeability of silty sand ranges: (1) vertical oriented $1.47x10^{-05}$ cm/s to $2.09x10^{-05}$ cm/s and (2) horizontal oriented $2.21x10^{-05}$ cm/s to $2.70x10^{-05}$ cm/s. 100S' microfabric having a combination of extremely strandy grains, large angular grains and abundant rough-surfaced silt grains contributed to the drainage.

Fly ash is the recommended addition to the soil mixtures since waste materials are aimed to be utilized and the addition of fly ash to soils changes the inter-particle void ratio [redacted] which is prevalent to the microscopic characterization test for 100F.

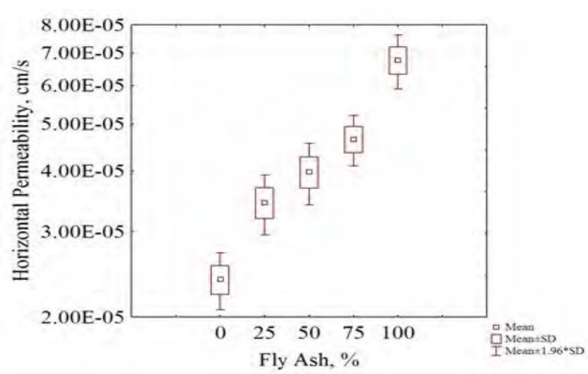

Figure-6. Effect of fly ash on the horizontal permeability when added to soil.

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It is a combination of larger silt grains and smaller silt grains to form the micro fabric. Silt particles have almost similar size, forming larger inter-particle void, contributing to a much larger inter-particle voids. Due to a larger inter-particle voids, the permeability of pure fly-ash ranges: (1) vertical oriented $4.51x10^{-05}$ cm/s to $5.35x10^{-05}$ cm/s and (2) horizontal oriented $1.93x10^{-05}$ cm/s to $7.29x10^{-05}$ cm/s.

75FA25S, 50FA50S, 25FA75S, 96S4FA are the mixtures that include fly ash and soil, their microfabric is a combination of extremely strandy grains, large angular grains and abundant larger rough-surfaced silt grains and smaller rough-surfaced silt grains. Shown on Figure 4 and Figure 5, as the amount of fly ash is increased, the drainage also increased. Due to the contribution of fly ash to the inter-particle voids of the soil mixtures, the permeability of mixture of soil and fly-ash ranges: (1) vertical oriented $1.93x10^{-05}$ cm/s to $3.80x10^{-05}$ cm/s and (2) horizontal oriented $2.52x10^{-05}$ cm/s to $5.02x10^{-05}$ cm/s.

To validate the results of the vertical oriented and the horizontal oriented permeability tests, their ratio must be within the given range of Das (2008). The collected usual ratio of horizontal and vertical permeability of soils by Das (2008) is with the range of 1.2-3.3, thus, the data gathered are between 1.3-1.5, and thus ratios are within Das' desired range.

Regression Model

To check the effect of fly ash when added to soil, soil-fly ash mixtures such as 100F, 75FA25S, 50FA50S, 25FA75S and 100S were tested. Their permeability values were used to generate regression models. The said models were able to establish a relationship between the percentage of fly ash and permeability. The delineated regression models are shown on Figures-7 and 8.

It can be noticed that the regression models follow the trend that was observed with the experimental values of the soil-fly ash mixtures - because of the silty property of fly ash, once it is increased, the drainage is also increased. The increase in drainage is due to its microfabric, which is a combination of extremely strandy grains, large angular grains and abundant larger rough-surfaced silt grains and smaller rough-surfaced silt grains that contributes to a much larger inter-particle void.

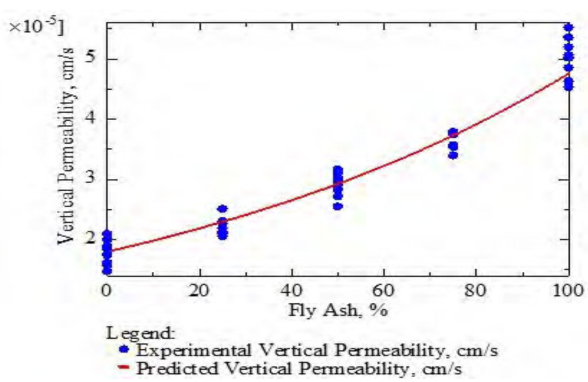

Figure-7. Regression Model for Kv and % of Fly Ash.

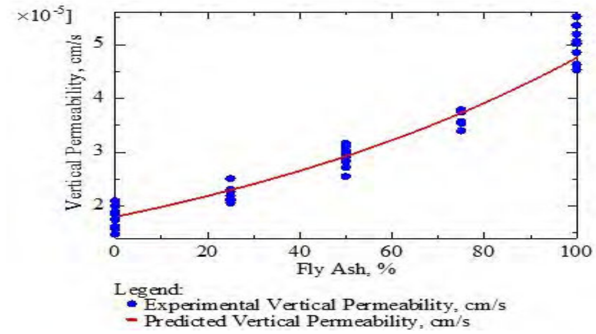

Figure-8. Regression Model for Kh and % of Fly Ash.

The models utilize the percentage of fly ash as the independent variable, while the vertical and horizontal permeabilities, kv and kh, are the dependent variables, respectively. These models can predict the permeability (vertical or horizontal oriented) of any soil-fly ash mix, once the percentage of fly ash is available.

$$k_v = exp^{-10.924} * exp^{9.708x10^{-3} * \%FA} \quad (2)$$

$$k_h = exp^{-10.600} * exp^{9.475x10^{-3} * \%FA} \quad (3)$$

where:

kv = vertical permeability, cm/sec;
kh = horizontal permeability, cm/sec;
%FA = Percentage of fly ash.

Validation

To check the Experimental Data vs. Regression Model, the measured Coefficients of Permeability for each soil mix were compared with the predicted Coefficient of Permeability of Regression Model. A line that shows equality between the variable measured (Experimental Data) on the horizontal axis of a diagram and the variable predicted (Regression Model Data) on the vertical axis. The equality line graph is shown on Figure-9 and 10.

Furthermore, the capability of our proposed Regression model of permeability may be validated by various references. Models developed by [redacted] were considered. The equation developed by [redacted] which utilizes values of D_{10} of the different soil mixtures. Shamsai's formula was also applied to validate. The equation utilizes the percentage of fines, particles passing Sieve #200.

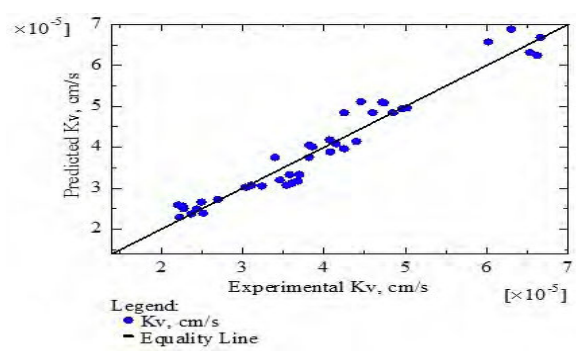

Figure-9. Regression Model Equality Line for Kv.

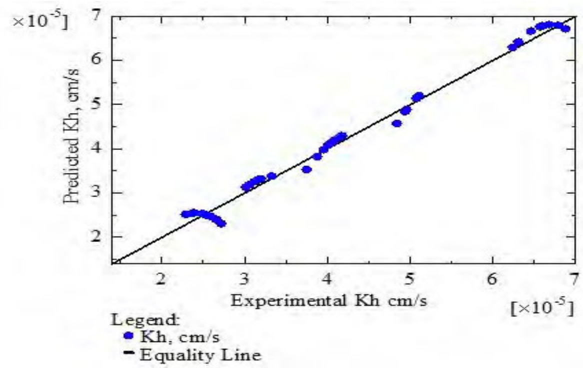

Figure-10. Regression Model Equality Line for Kh.

To validate, data gathered during the series of experiments have been utilized. It is shown in Figure 9. The two (2) models, [redacted] were compared and analyzed with the model proposed in the study. It can be noticed that the predicted k follows the same trend as the equations from [redacted] equation does not rely with the value of void ratio.

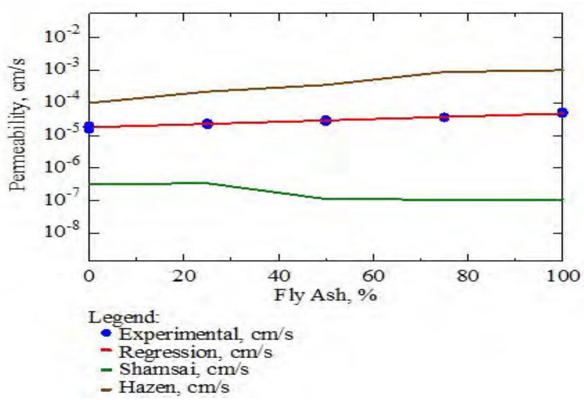

Figure-11. Comparison with other Models.

Based on Figure-11, Hazen's model has the lowest peameability, the equation only relies on the D_{30}, which is a rough estimate on the range of permeability that can be attained. Hazen's formula can be a boundary of the permeability values that are desired. While Shamsai's model utilizes the void ratio (e) as an independent parameter, it gave unusual lower values of permeability of fly ash. Compared to Hazen's and Shamsai's, the regression model is near the experimental data, which signifies that the generated model is valid

CONCLUSIONS

Fly ash is the recommended addition to silty sand, since waste materials are aimed to be utilized. The addition of fly ash to soils changes the inter-particle void ratio [redacted] it increases the permeability, thus, the microscopic characteristics of the soil mixtures may contribute to the increase in permeability.

Based on the tests, fly ash is a combination of larger silt grains and smaller silt grains to form the micro fabric. Silt particles have almost similar size, forming larger inter-particle void, contributing to a much larger inter-particle voids. Due to a larger inter-particle voids, the permeability of pure fly-ash ranges: (1) vertical oriented $4.51x10^{-05}$ cm/s to $5.35x10^{-05}$ cm/s and (2) horizontal oriented $1.93x10^{-05}$ cm/s to $7.29x10^{-05}$ cm/s.

75FA25S, 50FA50S, 25FA75S, 96S4FA are the mixtures that include fly ash and soil, their microfabric is a combination of extremely strandy grains, large angular grains and abundant larger rough-surfaced silt grains and smaller rough-surfaced silt grains. As the amount of fly ash is increased, the drainage also increased. Due to the contribution of fly ash to the inter-particle voids of the soil mixtures, the permeability of mixture of soil and fly-ash ranges: (1) vertical oriented 1.93x10-05 cm/s to 3.80x10-05 cm/s and (2) horizontal oriented $2.52x10^{-05}$ cm/s to $5.02x10^{-05}$ cm/s.

REFERENCES

[1] [redacted]

[redacted]

[redacted]

[4] American Society for Testing and Materials. (n.d.). Standard classification of soils for engineering purposes (Unified Soil Classification System). ASTM D2487.

[5] American Society for Testing and Materials. (n.d.). Standard Test Method for Particle-Size Analysis of Soils. ASTM D422.

[6] American Society for Testing and Materials. (n.d.). Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort. ASTM D698.

[7] American Society for Testing and Materials. (n.d.). Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. ASTM D4318.

[8] American Society for Testing and Materials. (n.d.). Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table. ASTM D4253.

[9] American Society for Testing and Materials. (n.d.). Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density. ASTM D4254.

[10] American Society for Testing and Materials. (n.d.). Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer. ASTM D854. Retrieved from ASTM D854.

[11] American Society for Testing and Materials. (n.d.). Test Method for Shrinkage Factors of Soils by the Mercury Method. ASTM D427.

[12] [redacted]

VOL. 10, NO. 15, AUGUST 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

[33] [redacted]

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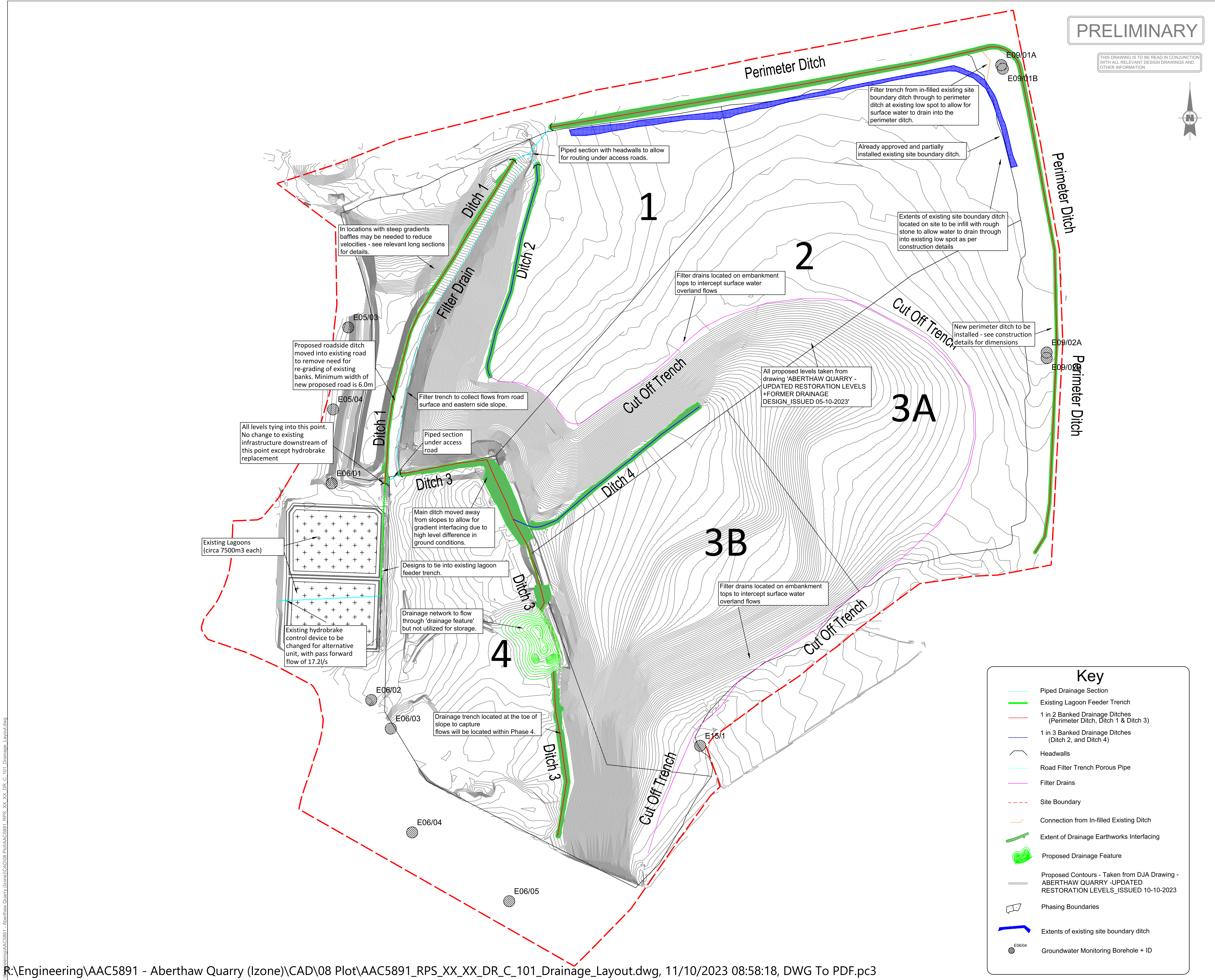

Notes

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1:20 - 0 200mm 400mm 600mm 800mm 1000 1200 1400 1600 1800 2000
1:100- 0 1m 2m 3m 4m 5m 6m 7m 8m 9m 10m
1:50 - 0 1m 2m 3m 4m 5m
1:5 - 0 100mm 200mm 300mm 400mm 500mm

Notes

- All drainage (Except for routing under roads) to be open course ditches
- Toe drains to be provided at the bottom of every slope
- Filter drains to exist at the top of every steep embankment (Greater than 1 in 4) to collect surface flows and help reduce cutting on steep embankments
- Location of main conveyance ditches to be assessed to allow for best interfacing of ditch banks back into slope gradients
- Baffles may be required within ditches that exceed steep gradients
- Proposed contours taken from DJ drawing - FINAL RESTORATION SURFACE LEVELS - ISSUED 29-08-23

Rev	Description	By	Ckd	Date
P08	Drawing updated to include revised drainage feature along ditch 3.			
P07	Drawing updated to suit revised surface levels taken from DJA drawing - FINAL RESTORATION SURFACE LEVELS - ISSUED 29-08-23	JP		31.08.23
P06	Environmental permit boundary shown as singular boundary for the site. Scale adjusted to 1:1500.	JP		06.07.23
P05	IPPC and application boundary added to drawing.	JP		16.06.23
P04	Removal of public right of way and associated headwalls	JP		09.06.23
P03	Drawing updated to reflect revised PFA infill levels (Drawing: 2873-4-1-1-DR-0002-S4-P1 Restoration Plan) and borehole locations added.	JP		31.05.23
P02	Drainage concept updated to reflect changes to slopes and removal of pipes as per client request.	JP		27:03:23
P01	First Issue	JP		15:09:22

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Client: RWE Generation UK

Project: Abertham Quarry Restoration

Title: Drainage Layout

Status	Scale	Date Created
Preliminary	1:1500 @A1	15.09.23
Task Team Manager	**Information Author**	**Task Information Manager**
SAS	JP	SAS

Document Number
AAC5891-RPS-xx-xx-DR-C-100-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P07

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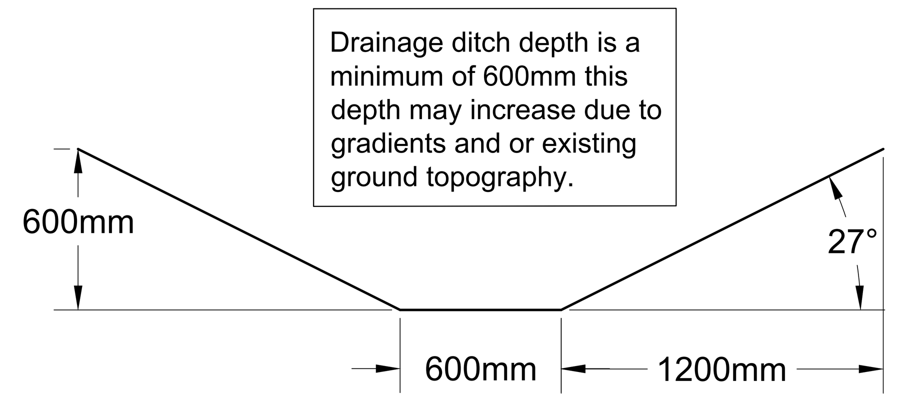
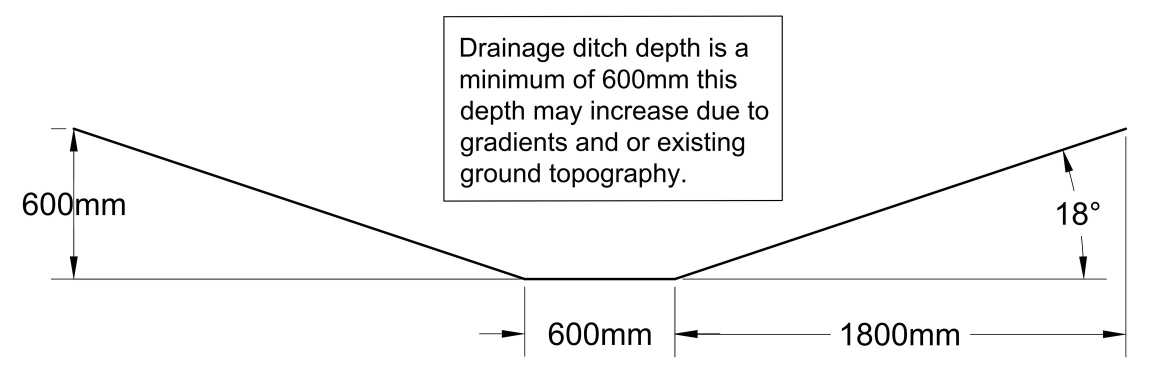
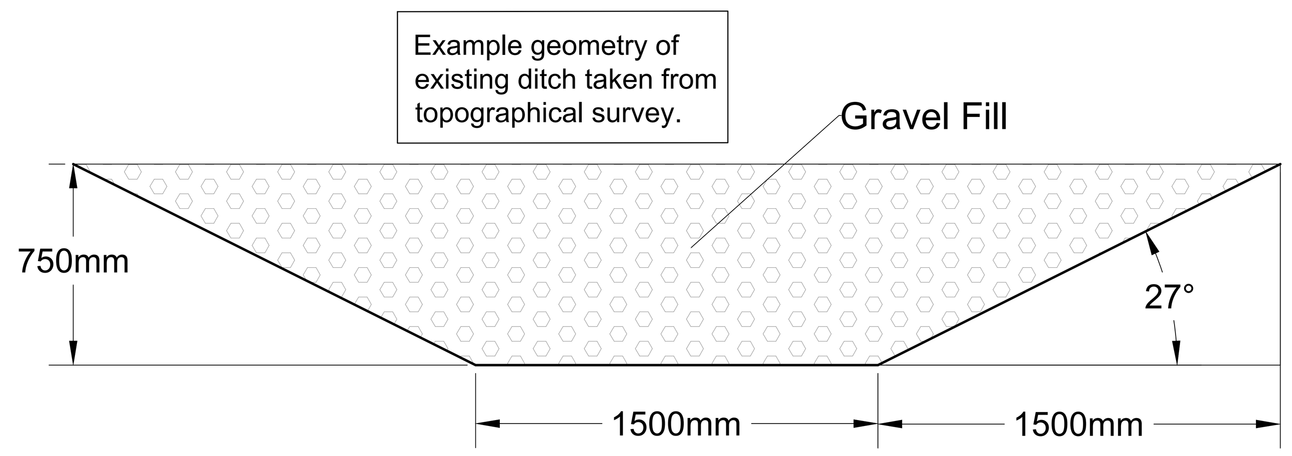
Minimum Depth 1 in 2 Bank Drainage Ditch
(Perimeter Drainage Ditch and Drainage Ditch 1)



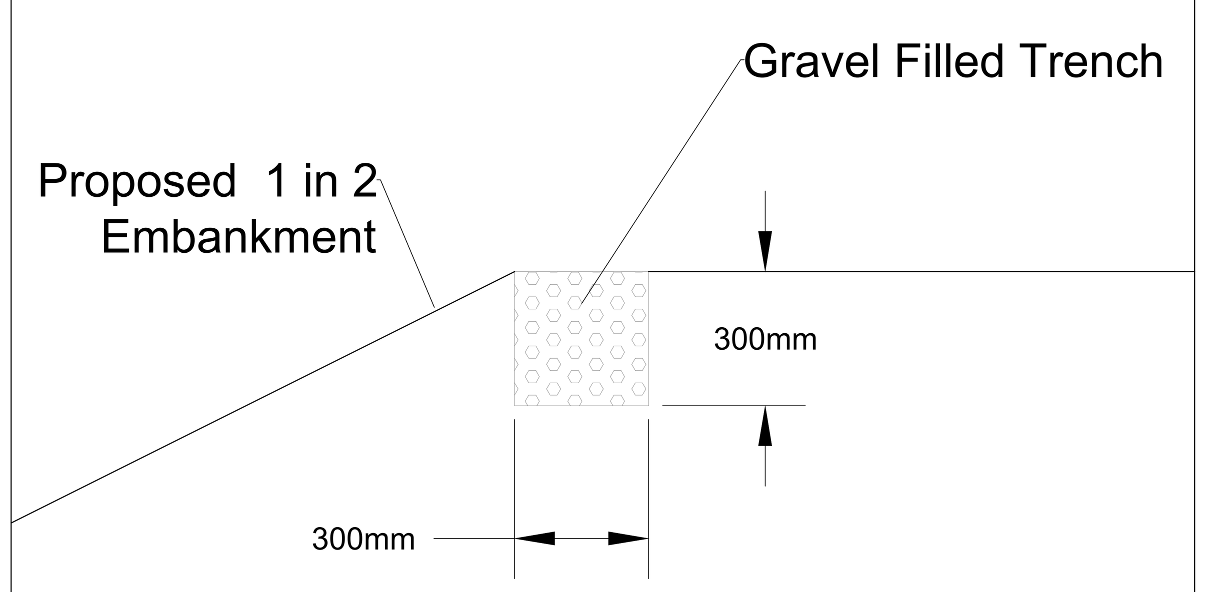
Minimum Depth 1 in 3 Bank Drainage Ditch
(Drainage Ditches 2, 3 and 4)



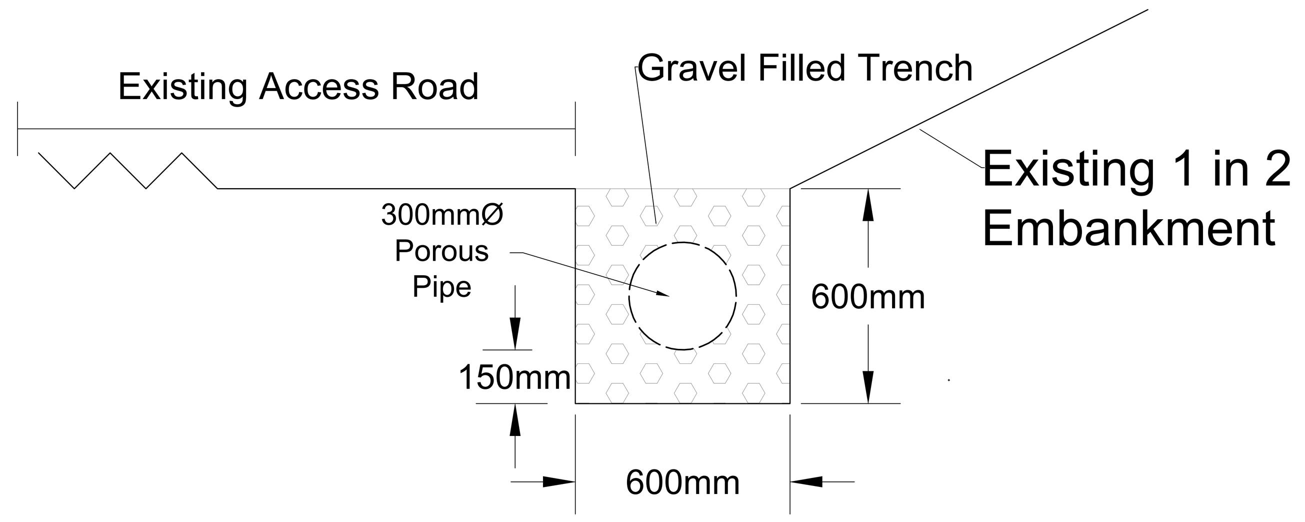
Existing Site Boundary Ditch To Be In-filled



Filter Trench

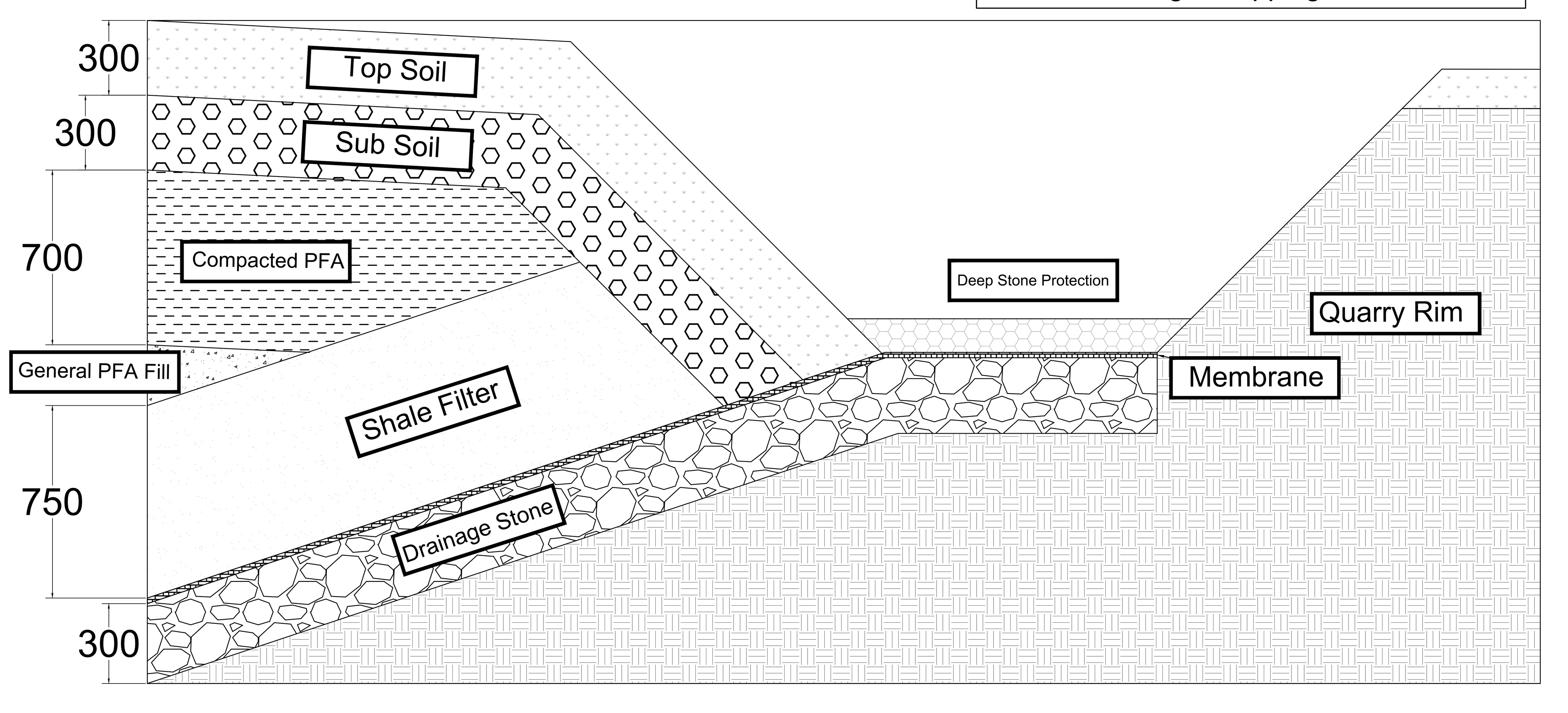


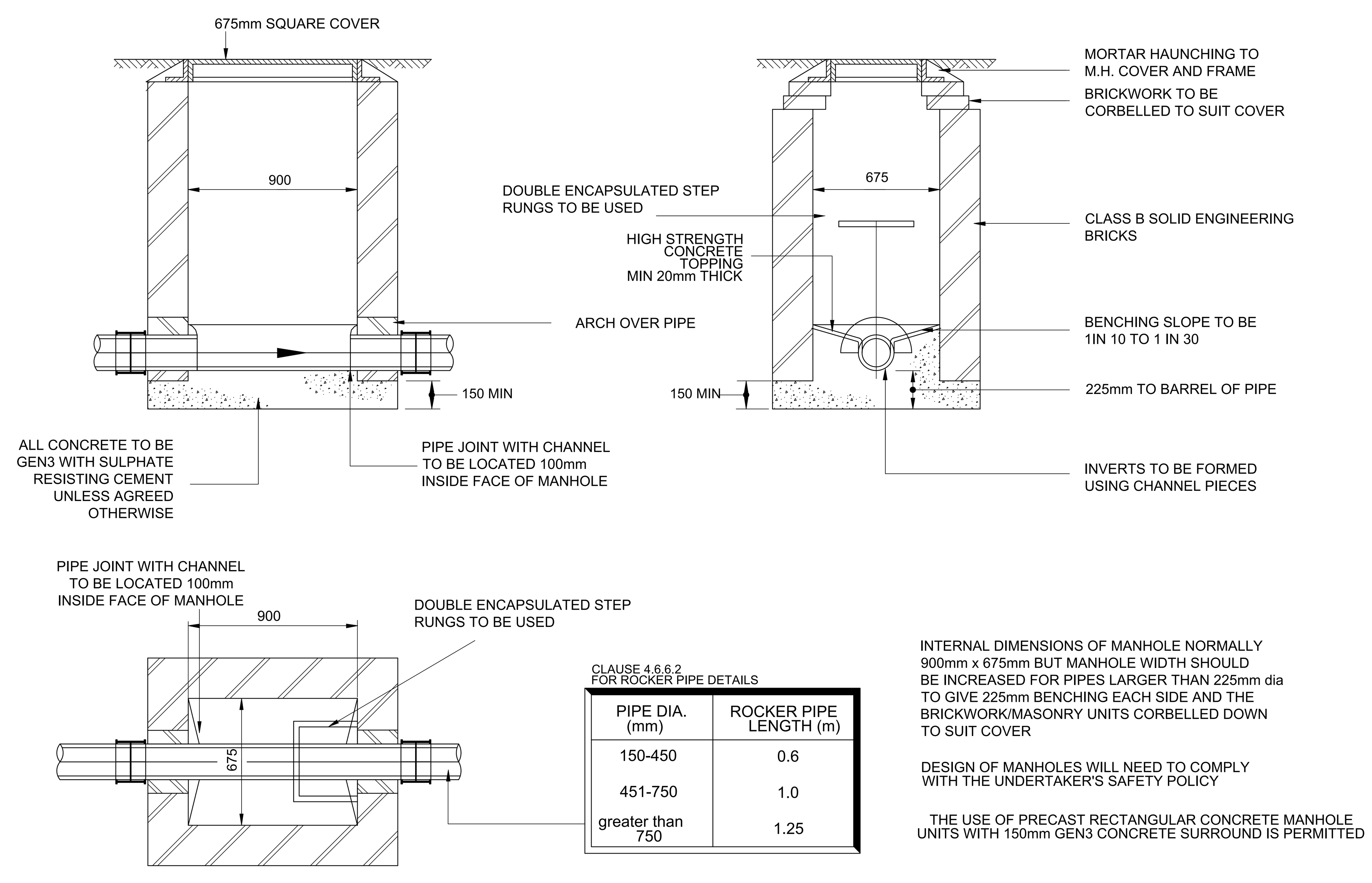
Road Filter Trench with 300mm Porous Pipe



Existing Site Boundary Ditch

Approved Detail Taken From David Jarvis Associates' Drawing '1521 016A Figure 1.9 Drainage. Capping details'





CLAUSE 4.6.6.2 FOR ROCKER PIPE DETAILS

PIPE DIA. (mm)	ROCKER PIPE LENGTH (m)
150-450	0.6
451-750	1.0
greater than 750	1.25

INTERNAL DIMENSIONS OF MANHOLE NORMALLY 900mm x 675mm BUT MANHOLE WIDTH SHOULD BE INCREASED FOR PIPES LARGER THAN 225mm dia TO GIVE 225mm BENCHING EACH SIDE AND THE BRICKWORK/MASONRY UNITS CORBELLED DOWN TO SUIT COVER

DESIGN OF MANHOLES WILL NEED TO COMPLY WITH THE UNDERTAKER'S SAFETY POLICY

THE USE OF PRECAST RECTANGULAR CONCRETE MANHOLE UNITS WITH 150mm GEN3 CONCRETE SURROUND IS PERMITTED

TYPICAL MANHOLE DETAIL - TYPE D
DEPTH TO SOFFIT OF LESS THAN 1.00m

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PRELIMINARY

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT DESIGN DRAWINGS AND OTHER INFORMATION

Rev	Description	By	Ckd	Date
P04	Removal of headwall detail until finalized detail design stage	JP		10.10.23
P03	Drawing updated to suit revised drainage designs	JP		27:03:23
P02	Only minimum and maximum perimeter ditch shown	JP		15:02:23
P01	First Issue	JP		15:09:22

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Client RWE Generation UK

Project Aberthaw Quarry Restoration

Title Construction Details

Status	Scale @ A0	Date Created
Preliminary	NTS	03.08.2022
Task Team Manager	Information Author	Task Information Manager
SAS	JP	SAS

Document Number
AAC5891-RPS-xx-xx-DR-C-104-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P04

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NOT TO SCALE

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.500	17.200
Flush-Flo™	0.361	17.153
Kick-Flo®	0.496	10.177
Mean Flow		12.833

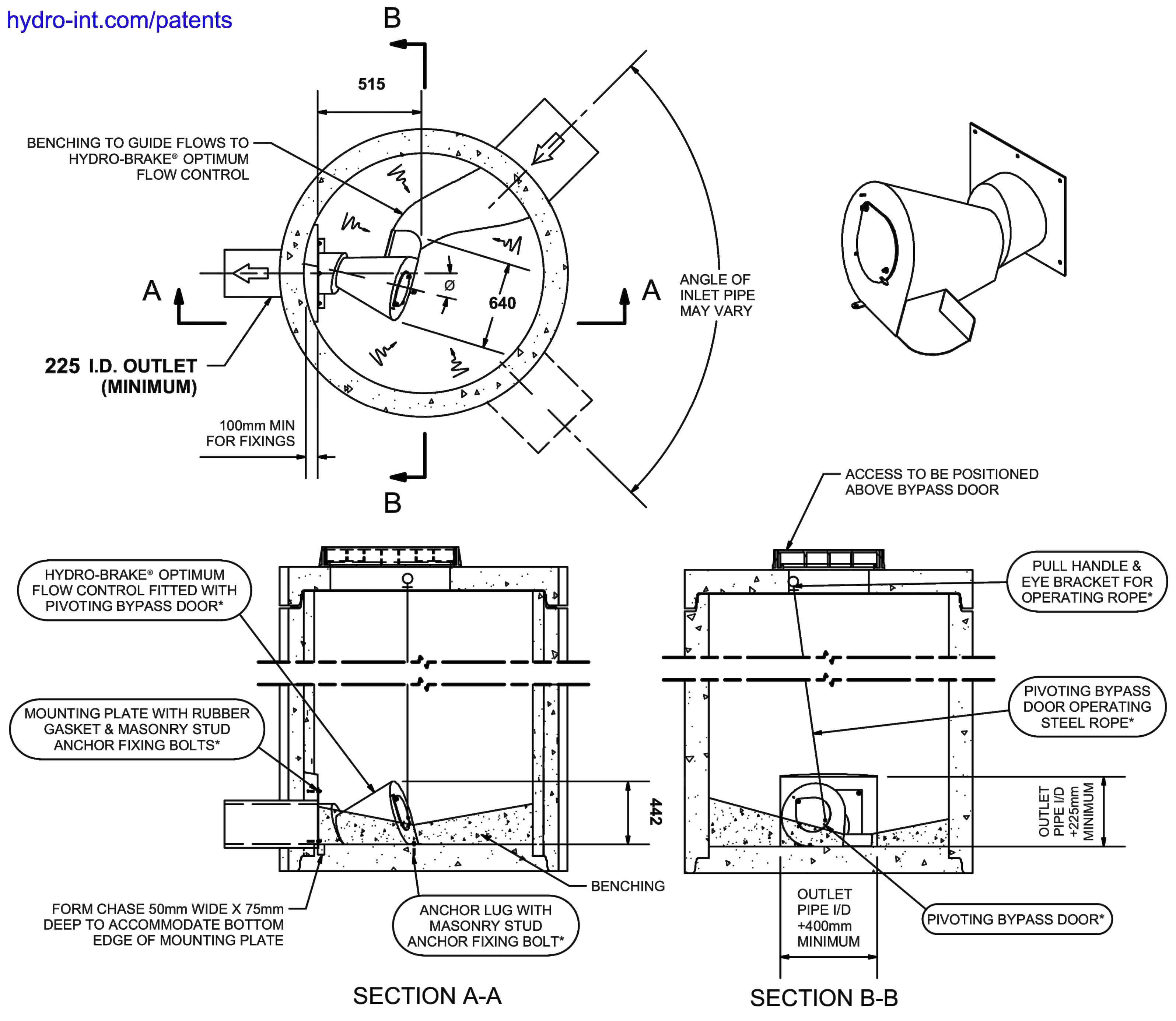
hydro-int.com/patents

Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet
- Indicative Weight: 34 kg

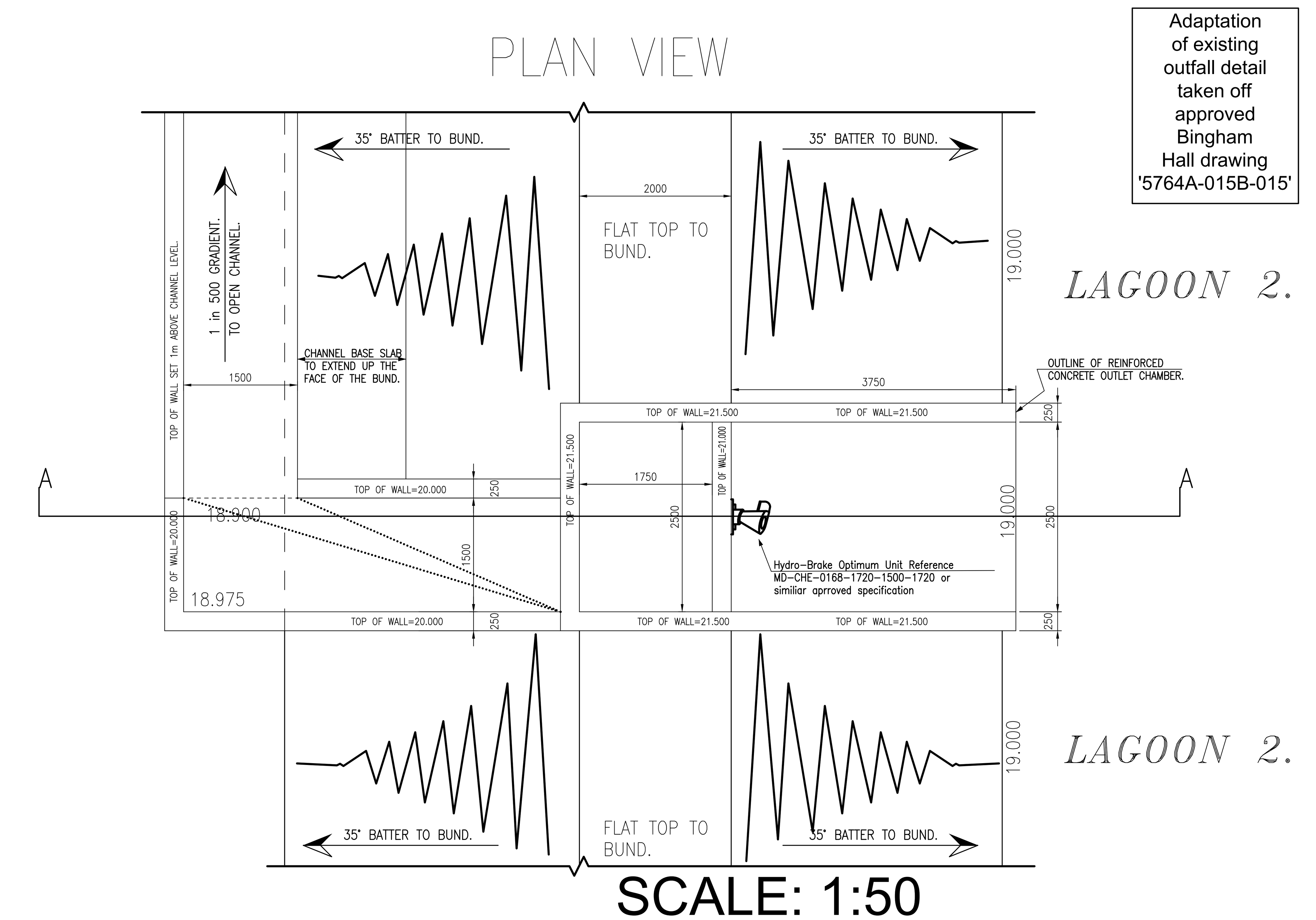
BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

WRc Approved PT/329/0412

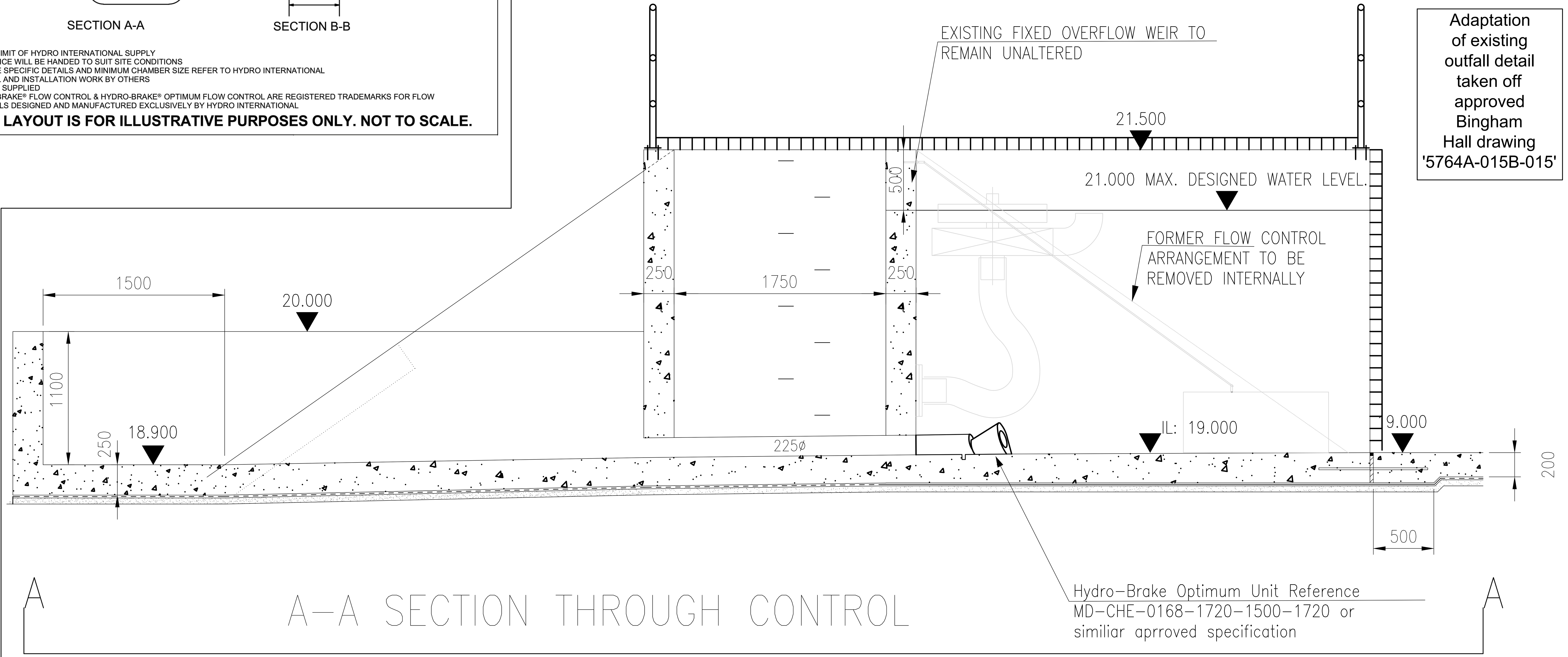


IMPORTANT: LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.



Adaptation of existing outfall detail taken off approved Bingham Hall drawing '5764A-015B-015'



Adaptation of existing outfall detail taken off approved Bingham Hall drawing '5764A-015B-015'

SCALE: 1:20

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Safety, Health & Environment Information

In addition to the hazards / risks normally associated with the types of work detailed on this drawing take note below. It is assumed that all works on this drawing will be carried out by a competent contractor, working, where appropriate, to an appropriate method statement.

Construction risks	Maintenance/Cleaning risks	Demolition/Adaption risks

Rev	Description	By	Ckd	Date
P01	First Issue	JP		28.03.23 2

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Client: RWE Generation UK

Project: Aberthaw Quarry Restoration

Title: Outfall Construction Details

Status	Scale	Date Created
Preliminary	AS INDICATED	20.03.2023

Task Team Manager	Information Author	Task Information Manager
SAS	JP	SAS

Document Number: AAC5891-RPS-xx-xx-DR-C-105-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P01

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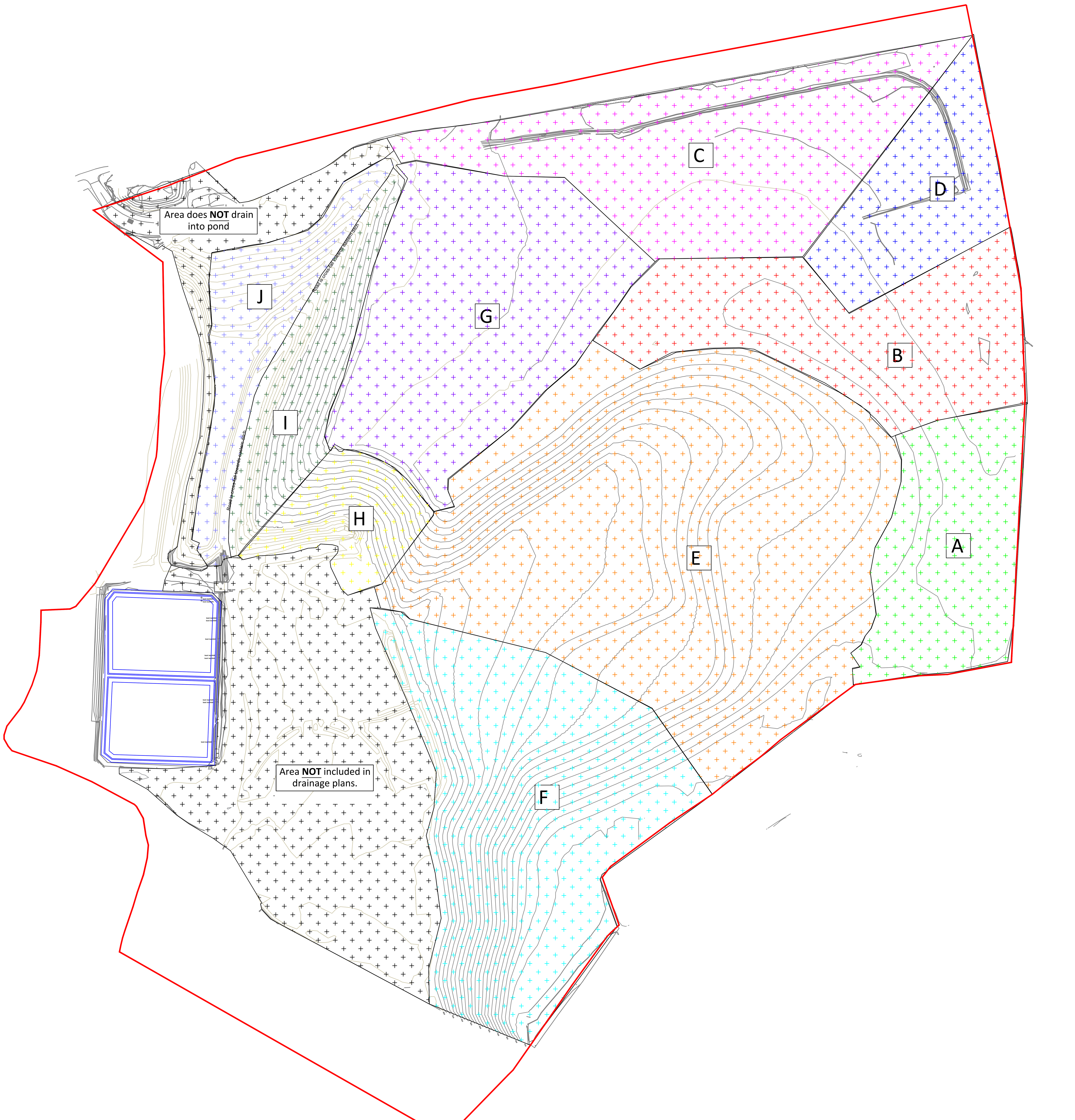

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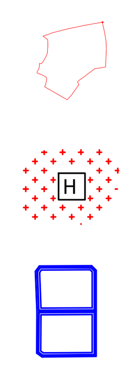

Region	Gross Area (m^2)	Equivalent Impermeable Area (m^2)
A	19571.54	3327.16
B	27027.31	4594.64
C	34290.76	5829.43
D	15030.98	2555.27
E	79547.56	13523.09
F	43902.44	7463.41
G	36519.08	6208.24
H	8371.33	1423.13
I	12010.99	2041.87
J	12240.41	2080.87
TOTAL	288512.40	49047.11
AREA **NOT** INCLUDED IN REDEVELOPMENT PLANS	44092.07	N/A
AREA **NOT** DRAINING INTO POND	10656.59	N/A

Note. For the purposes of inputting drainable areas into Microdrainage to enable simulations of the proposed drainage infrastructure to be assessed, an "equivalent" impermeable area has been used. This has been estabilished through an assessment of the HOST class for the restored soils with a heavy PFA concentration, and equates to 17% of the gross area will generate surface water runoff from rainfall.

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Rev	Description	By	Ckd	Date
P04	Site boundary included on drawing.	JP		10.10.23
P03	Updated proposed levels included in drawing	JP		25.05.23
P02	Drawing updated to reflect new proposed contours and drainage areas.	JP		27:03:23
P01	First Issue	JP		15:09:22

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T: +44 121 622 8520 **E:** rpswlv@rpsgroup.com

Client: RWE Generation UK

Project: Aberthaw Quarry Restoration

Title: Surface Water Drainage Areas

Status	Scale	Date Created
Preliminary	1:1500 @A1	05.08.2022
Task Team Manager	**Information Author**	**Task Information Manager**
SAS	JP	SAS

Document Number
AAC5891-RPS-xx-xx-DR-C-112-01
Project Code - Originator - Zone - Level - Type - Role - Drawing Number

RPS Project Number	Suitability	Revision
AAC5891	S4	P04

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Appendix C
Ground Investigation Data 2022

Element Materials Technology
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Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

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F: +44 (0) 1244 833781
W: www.element.com

RPS
6th Floor
20 Farringdon Street
London
EC4A 4AB

Attention :	[redacted]
Date :	21st December, 2022
Your reference :	JFR 2782
Our reference :	Test Report 22/18275 Batch 1
Location :	Aberthaw quarry
Date samples received :	5th November, 2022
Status :	Final Report
Issue :	1

Twelve samples were received for analysis on 5th November, 2022 of which eight were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:

[redacted]

Project Manager

Element Materials Technology

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw quarry
Contact: [redacted]
EMT Job No: 22/18275

Report : **Solid**

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

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-4	5-8	9-12	13-16	20-23	24-26	30-32	33-35					
Sample ID	SS-1	TP1	TP2	TP3	TP14	TP15	TP17	TP18					
Depth		1.00	1.00	0.35	1.00	1.00	1.00	1.00					
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T					
Sample Date	01/11/2022	01/11/2022	01/11/2022	01/11/2022	02/11/2022	02/11/2022	02/11/2022	02/11/2022					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	1	1	1	1					
Date of Receipt	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022			LOD/LOR	Units	Method No.
Arsenic #	-	-	-	-	10.4	8.4	15.0	11.8			<0.5	mg/kg	TM30/PM15
Cadmium #	-	-	-	-	0.3	0.2	0.3	<0.1			<0.1	mg/kg	TM30/PM15
Chromium #	-	-	-	-	41.5	43.2	52.6	52.1			<0.5	mg/kg	TM30/PM15
Copper #	-	-	-	-	25	39	24	12			<1	mg/kg	TM30/PM15
Lead #	-	-	-	-	22	48	24	11			<5	mg/kg	TM30/PM15
Mercury #	-	-	-	-	0.2	<0.1	<0.1	<0.1			<0.1	mg/kg	TM30/PM15
Molybdenum #	1.4	1.8	1.3	2.2	-	-	-	-			<0.1	mg/kg	TM30/PM15
Nickel #	-	-	-	-	24.8	16.3	21.7	12.6			<0.7	mg/kg	TM30/PM15
Selenium #	-	-	-	-	<1	<1	<1	<1			<1	mg/kg	TM30/PM15
Water Soluble Boron #	1.5	0.9	1.3	1.3	-	-	-	-			<0.1	mg/kg	TM74/PM32
Zinc #	-	-	-	-	67	72	67	30			<5	mg/kg	TM30/PM15
PAH MS													
Naphthalene #	-	-	-	-	<0.04	0.18	<0.04	<0.04			<0.04	mg/kg	TM4/PM8
Acenaphthylene	-	-	-	-	<0.03	<0.03	<0.03	<0.03			<0.03	mg/kg	TM4/PM8
Acenaphthene #	-	-	-	-	<0.05	<0.05	<0.05	<0.05			<0.05	mg/kg	TM4/PM8
Fluorene #	-	-	-	-	<0.04	0.07	<0.04	<0.04			<0.04	mg/kg	TM4/PM8
Phenanthrene #	-	-	-	-	<0.03	0.27	0.07	<0.03			<0.03	mg/kg	TM4/PM8
Anthracene #	-	-	-	-	<0.04	0.05	<0.04	<0.04			<0.04	mg/kg	TM4/PM8
Fluoranthene #	-	-	-	-	<0.03	0.17	0.15	<0.03			<0.03	mg/kg	TM4/PM8
Pyrene #	-	-	-	-	<0.03	0.18	0.11	<0.03			<0.03	mg/kg	TM4/PM8
Benzo(a)anthracene #	-	-	-	-	<0.06	0.15	0.15	<0.06			<0.06	mg/kg	TM4/PM8
Chrysene #	-	-	-	-	<0.02	0.25	0.12	<0.02			<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	-	-	-	-	<0.07	0.25	0.19	<0.07			<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	-	-	-	-	<0.04	0.11	0.08	<0.04			<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	-	-	-	-	<0.04	0.09	0.07	<0.04			<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	-	-	-	-	<0.04	<0.04	<0.04	<0.04			<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	-	-	-	-	<0.04	0.09	0.06	<0.04			<0.04	mg/kg	TM4/PM8
PAH 16 Total	-	-	-	-	<0.6	1.9	1.0	<0.6			<0.6	mg/kg	TM4/PM8
Benzo(b)fluoranthene	-	-	-	-	<0.05	0.18	0.14	<0.05			<0.05	mg/kg	TM4/PM8
Benzo(k)fluoranthene	-	-	-	-	<0.02	0.07	0.05	<0.02			<0.02	mg/kg	TM4/PM8
PAH Surrogate % Recovery	-	-	-	-	103	102	101	102			<0	%	TM4/PM8
TPH CWG													
Aliphatics													
>C5-C6 (HS_1D_AL) #	-	-	-	-	<0.1	<0.1 [SV]	<0.1	<0.1 [SV]			<0.1	mg/kg	TM36/PM12
>C6-C8 (HS_1D_AL) #	-	-	-	-	<0.1	<0.1 [SV]	<0.1	<0.1 [SV]			<0.1	mg/kg	TM36/PM12
>C8-C10 (HS_1D_AL)	-	-	-	-	<0.1	<0.1 [SV]	<0.1	<0.1 [SV]			<0.1	mg/kg	TM36/PM12
>C10-C12 (EH_CU_1D_AL) #	-	-	-	-	<0.2	6.7	<0.2	<0.2			<0.2	mg/kg	TM5/PM8/PM16
>C12-C16 (EH_CU_1D_AL) #	-	-	-	-	<4	28	<4	<4			<4	mg/kg	TM5/PM8/PM16
>C16-C21 (EH_CU_1D_AL) #	-	-	-	-	<7	97	<7	<7			<7	mg/kg	TM5/PM8/PM16
>C21-C35 (EH_CU_1D_AL) #	-	-	-	-	<7	264	<7	21			<7	mg/kg	TM5/PM8/PM16
Total aliphatics C5-35 (EH+HS_CU_1D_AL)	-	-	-	-	<19	396	<19	21			<19	mg/kg	TM5/TM36/PM8/PM12/PM16

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw quarry
Contact: [redacted]
EMT Job No: 22/18275

Report : Solid

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

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-4	5-8	9-12	13-16	20-23	24-26	30-32	33-35			LOD/LOR	Units	Method No.
Sample ID	SS-1	TP1	TP2	TP3	TP14	TP15	TP17	TP18					
Depth		1.00	1.00	0.35	1.00	1.00	1.00	1.00					
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T					
Sample Date	01/11/2022	01/11/2022	01/11/2022	01/11/2022	02/11/2022	02/11/2022	02/11/2022	02/11/2022					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	1	1	1	1					
Date of Receipt	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022	05/11/2022					
TPH CWG													
Aromatics													
>C5-EC7 (HS_1D_AR)#	-	-	-	-	<0.1	<0.1 [SV]	<0.1	<0.1 [SV]			<0.1	mg/kg	TM36/PM12
>EC7-EC8 (HS_1D_AR)#	-	-	-	-	<0.1	<0.1 [SV]	<0.1	<0.1 [SV]			<0.1	mg/kg	TM36/PM12
>EC8-EC10 (HS_1D_AR)#	-	-	-	-	<0.1	<0.1 [SV]	<0.1	<0.1 [SV]			<0.1	mg/kg	TM36/PM12
>EC10-EC12 (EH_CU_1D_AR)#	-	-	-	-	<0.2	4.0	<0.2	<0.2			<0.2	mg/kg	TM5/PM8/PM16
>EC12-EC16 (EH_CU_1D_AR)#	-	-	-	-	<4	25	<4	<4			<4	mg/kg	TM5/PM8/PM16
>EC16-EC21 (EH_CU_1D_AR)#	-	-	-	-	<7	111	<7	<7			<7	mg/kg	TM5/PM8/PM16
>EC21-EC35 (EH_CU_1D_AR)#	-	-	-	-	<7	421	<7	<7			<7	mg/kg	TM5/PM8/PM16
Total aromatics C5-35 (EH+HS_CU_1D_AR)#	-	-	-	-	<19	561	<19	<19			<19	mg/kg	TM5/TM36/PM8/PM12/PM16
Total aliphatics and aromatics(C5-35) (EH+HS_CU_1D_Total)	-	-	-	-	<38	957	<38	<38			<38	mg/kg	TM5/TM36/PM8/PM12/PM16
MTBE#	-	-	-	-	<5	<5 [SV]	<5	<5 [SV]			<5	ug/kg	TM36/PM12
Benzene#	-	-	-	-	<5	<5 [SV]	<5	<5 [SV]			<5	ug/kg	TM36/PM12
Toluene#	-	-	-	-	<5	<5 [SV]	<5	<5 [SV]			<5	ug/kg	TM36/PM12
Ethylbenzene#	-	-	-	-	<5	<5 [SV]	<5	<5 [SV]			<5	ug/kg	TM36/PM12
m/p-Xylene#	-	-	-	-	<5	<5 [SV]	<5	<5 [SV]			<5	ug/kg	TM36/PM12
o-Xylene#	-	-	-	-	<5	<5 [SV]	<5	<5 [SV]			<5	ug/kg	TM36/PM12
Natural Moisture Content	-	-	-	-	36.2	12.9	21.3	22.1			<0.1	%	PM4/PM0
Chloride#	16	9	12	13	-	-	-	-			<2	mg/kg	TM38/PM20
pH#	8.43	8.76	8.71	8.24	-	-	-	-			<0.01	pH units	TM73/PM11

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Element Materials Technology

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw quarry
Contact: [redacted]
EMT Job No: 22/18275

Report : **CEN 10:1 2-Batch**

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

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-4	5-8	9-12								LOD/LOR	Units	Method No.
Sample ID	SS-1	TP1	TP2										
Depth		1.00	1.00										
COC No / misc													
Containers	V J T	V J T	V J T										
Sample Date	01/11/2022	01/11/2022	01/11/2022										
Sample Type	Soil	Soil	Soil										
Batch Number	1	1	1										
Date of Receipt	05/11/2022	05/11/2022	05/11/2022										
Dissolved Boron (C2)	0.089	0.014	0.053								<0.012	mg/l	TM30/PM14
Dissolved Boron (C8)	0.014	<0.012	<0.012								<0.012	mg/l	TM30/PM14
Dissolved Boron (A2)	0.178	0.028	0.106								<0.024	mg/kg	TM30/PM14
Dissolved Boron (A2-10)	0.27	<0.12	<0.12								<0.12	mg/kg	TM30/PM14

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

Mass of sample taken (kg) =	0.203	Moisture Content Ratio (%) =	15.8
Mass of dry sample (kg) =	0.175	Dry Matter Content Ratio (%) =	86.3
Particle Size <4mm =	>95%		

EMT Job No	**22/18275**	**Landfill Waste Acceptance Criteria Limits**		
Sample No	**12**			
Client Sample No	**TP2**	**Inert Waste Landfill**	**Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill**	**Hazardous Waste Landfill**
Depth/Other	**1.00**			
Sample Date	**01/11/2022**			
Batch No	**1**			
Solid Waste Analysis				
Total Organic Carbon (%)	-	3	5	6
Loss on Ignition (%)	-	-	-	10
Sum of BTEX (mg/kg)	-	6	-	-
Sum of 7 PCBs (mg/kg)	-	1	-	-
Mineral Oil (mg/kg)	-	500	-	-
PAH Sum of 17(mg/kg)	-	100	-	-
pH (pH Units)	-	-	>6	-
ANC to pH 7 (mol/kg)	-	-	to be evaluated	to be evaluated
ANC to pH 4 (mol/kg)	-	-	to be evaluated	to be evaluated

Eluate Analysis	**Conc^n in 2:1 eluate**	**Conc^n in 8:1 eluate**	**2:1 conc^n leached**	**Cumulative 10:1 conc^n leached**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
	C_2	**C_8**	**A_2**	**A_{2-10}**			
	mg/l		**mg/kg**		**mg/kg**		
Arsenic	<0.0025	<0.0025	<0.005	<0.025	0.5	2	25
Barium	0.020	<0.003	0.040	0.03	20	100	300
Cadmium	<0.0005	<0.0005	<0.001	<0.005	0.04	1	5
Chromium	<0.0015	<0.0015	<0.003	<0.015	0.5	10	70
Copper	<0.007	<0.007	<0.014	<0.07	2	50	100
Mercury	<0.0006	<0.0006	<0.0012	<0.006	0.01	0.2	2
Molybdenum	0.005	<0.002	0.010	<0.02	0.5	10	30
Nickel	<0.002	<0.002	<0.004	<0.02	0.4	10	40
Lead	<0.005	<0.005	<0.01	<0.05	0.5	10	50
Antimony	<0.002	<0.002	<0.004	<0.02	0.06	0.7	5
Selenium	<0.003	<0.003	<0.006	<0.03	0.1	0.5	7
Zinc	<0.003	<0.003	<0.006	<0.03	4	50	200
Chloride	1.4	<0.3	2.8	<3	800	15000	25000
Fluoride	0.6	<0.3	1.2	<3	10	150	500
Sulphate as SO4	49.6	2.7	99	107	1000	20000	50000
Total Dissolved Solids	118	<35	236	<350	4000	60000	100000
Phenol	<0.01	<0.01	<0.02	<0.1	1	-	-
Dissolved Organic Carbon	2	<2	<4	<20	500	800	1000

Leachate Information		
Date Prepared	09/11/2022	10/11/2022
pH (pH Units)	8.19	7.85
Conductivity (µS/cm)	245	57
Temperature (°C)	18.5	19.5
Volume Leachant (Litres)	0.322	1.4
Volume of Eluate VE1 (Litres)	0.300	

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

Mass of sample taken (kg) =	0.195	Moisture Content Ratio (%) =	11.4
Mass of dry sample (kg) =	0.175	Dry Matter Content Ratio (%) =	89.7
Particle Size <4mm =	>95%		

EMT Job No	**22/18275**				**Landfill Waste Acceptance Criteria Limits**		
Sample No	**4**						
Client Sample No	**SS-1**				**Inert Waste Landfill**	**Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill**	**Hazardous Waste Landfill**
Depth/Other							
Sample Date	**01/11/2022**						
Batch No	**1**						
Solid Waste Analysis							
Total Organic Carbon (%)	-				3	5	6
Loss on Ignition (%)	-				-	-	10
Sum of BTEX (mg/kg)	-				6	-	-
Sum of 7 PCBs (mg/kg)	-				1	-	-
Mineral Oil (mg/kg)	-				500	-	-
PAH Sum of 17(mg/kg)	-				100	-	-
pH (pH Units)	-				-	>6	-
ANC to pH 7 (mol/kg)	-				-	to be evaluated	to be evaluated
ANC to pH 4 (mol/kg)	-				-	to be evaluated	to be evaluated
Eluate Analysis	**Conc^n in 2:1 eluate**	**Conc^n in 8:1 eluate**	**2:1 conc^n leached**	**Cumulative 10:1 conc^n leached**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
	C_2	**C_8**	**A_2**	**A_{2-10}**			
	mg/l		**mg/kg**		**mg/kg**		
Arsenic	<0.0025	<0.0025	<0.005	<0.025	0.5	2	25
Barium	0.026	0.005	0.052	0.09	20	100	300
Cadmium	<0.0005	<0.0005	<0.001	<0.005	0.04	1	5
Chromium	<0.0015	<0.0015	<0.003	<0.015	0.5	10	70
Copper	<0.007	<0.007	<0.014	<0.07	2	50	100
Mercury	<0.0006	<0.0006	<0.0012	<0.006	0.01	0.2	2
Molybdenum	0.025	0.003	0.050	0.07	0.5	10	30
Nickel	<0.002	<0.002	<0.004	<0.02	0.4	10	40
Lead	<0.005	<0.005	<0.01	<0.05	0.5	10	50
Antimony	<0.002	<0.002	<0.004	<0.02	0.06	0.7	5
Selenium	<0.003	<0.003	<0.006	<0.03	0.1	0.5	7
Zinc	<0.003	<0.003	<0.006	<0.03	4	50	200
Chloride	1.9	<0.3	3.8	3	800	15000	25000
Fluoride	0.4	<0.3	0.8	<3	10	150	500
Sulphate as SO4	69.8	4.2	140	154	1000	20000	50000
Total Dissolved Solids	184	<35	368	<350	4000	60000	100000
Phenol	<0.01	<0.01	<0.02	<0.1	1	-	-
Dissolved Organic Carbon	2	<2	<4	<20	500	800	1000

Leachate Information		
Date Prepared	09/11/2022	10/11/2022
pH (pH Units)	8.30	7.48
Conductivity (µS/cm)	303	65
Temperature (°C)	17.5	19.2
Volume Leachant (Litres)	0.33	1.4
Volume of Eluate VE1 (Litres)	0.300	

Mass of sample taken (kg) =	0.206	Moisture Content Ratio (%) =	17.4
Mass of dry sample (kg) =	0.175	Dry Matter Content Ratio (%) =	85.2
Particle Size <4mm =	>95%		

EMT Job No	**22/18275**				**Landfill Waste Acceptance Criteria Limits**		
Sample No	**8**						
Client Sample No	**TP1**				**Inert Waste Landfill**	**Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill**	**Hazardous Waste Landfill**
Depth/Other	**1.00**						
Sample Date	**01/11/2022**						
Batch No	**1**						
Solid Waste Analysis							
Total Organic Carbon (%)	-				3	5	6
Loss on Ignition (%)	-				-	-	10
Sum of BTEX (mg/kg)	-				6	-	-
Sum of 7 PCBs (mg/kg)	-				1	-	-
Mineral Oil (mg/kg)	-				500	-	-
PAH Sum of 17(mg/kg)	-				100	-	-
pH (pH Units)	-				-	>6	-
ANC to pH 7 (mol/kg)	-				-	to be evaluated	to be evaluated
ANC to pH 4 (mol/kg)	-				-	to be evaluated	to be evaluated
Eluate Analysis	**Conc^n in 2:1 eluate**	**Conc^n in 8:1 eluate**	**2:1 conc^n leached**	**Cumulative 10:1 conc^n leached**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
	C_2	**C_8**	**A_2**	**A_{2-10}**			
	mg/l		**mg/kg**		**mg/kg**		
Arsenic	<0.0025	<0.0025	<0.005	<0.025	0.5	2	25
Barium	<0.003	<0.003	<0.006	<0.03	20	100	300
Cadmium	<0.0005	<0.0005	<0.001	<0.005	0.04	1	5
Chromium	<0.0015	<0.0015	<0.003	<0.015	0.5	10	70
Copper	<0.007	<0.007	<0.014	<0.07	2	50	100
Mercury	<0.0006	<0.0006	<0.0012	<0.006	0.01	0.2	2
Molybdenum	<0.002	<0.002	<0.004	<0.02	0.5	10	30
Nickel	<0.002	<0.002	<0.004	<0.02	0.4	10	40
Lead	<0.005	<0.005	<0.01	<0.05	0.5	10	50
Antimony	<0.002	<0.002	<0.004	<0.02	0.06	0.7	5
Selenium	<0.003	<0.003	<0.006	<0.03	0.1	0.5	7
Zinc	0.007	<0.003	0.014	<0.03	4	50	200
Chloride	0.5	0.5	1.0	5	800	15000	25000
Fluoride	<0.3	<0.3	<0.6	<3	10	150	500
Sulphate as SO4	9.1	1.2	18	26	1000	20000	50000
Total Dissolved Solids	91	36	182	454	4000	60000	100000
Phenol	<0.01	<0.01	<0.02	<0.1	1	-	-
Dissolved Organic Carbon	<2	<2	<4	<20	500	800	1000

Leachate Information		
Date Prepared	10/11/2022	12/11/2022
pH (pH Units)	7.98	6.96
Conductivity (µS/cm)	156	58
Temperature (°C)	18.5	18.2
Volume Leachant (Litres)	0.32	1.4
Volume of Eluate VE1 (Litres)	0.300	

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

Mass of sample taken (kg)	-	Moisture Content Ratio (%) =	32.0
Mass of dry sample (kg) =	0.09	Dry Matter Content Ratio (%) =	75.8
Particle Size <4mm =	>95%		

			Landfill Waste Acceptance Criteria Limits		
EMT Job No	**22/18275**				
Sample No	**16**				
Client Sample No	**TP3**		**Inert Waste Landfill**	**Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill**	**Hazardous Waste Landfill**
Depth/Other	**0.35**				
Sample Date	**01/11/2022**				
Batch No	**1**				
Solid Waste Analysis					
Total Organic Carbon (%)	-		3	5	6
Loss on Ignition (%)	-		-	-	10
Sum of BTEX (mg/kg)	-		6	-	-
Sum of 7 PCBs (mg/kg)	-		1	-	-
Mineral Oil (mg/kg)	-		500	-	-
PAH Sum of 17(mg/kg)	-		100	-	-
pH (pH Units)	-		-	>6	-
ANC to pH 7 (mol/kg)	-		-	to be evaluated	to be evaluated
ANC to pH 4 (mol/kg)	-		-	to be evaluated	to be evaluated

Eluate Analysis	**10:1 conc^{n} leached**		Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg		
	C_{10}	**A_{10}**			
	mg/l	**mg/kg**	**mg/kg**		
Arsenic	0.0670	0.670	0.5	2	25
Barium	0.024	0.24	20	100	300
Cadmium	<0.0005	<0.005	0.04	1	5
Chromium	<0.0015	<0.015	0.5	10	70
Copper	<0.007	<0.07	2	50	100
Mercury	<0.001	<0.01	0.01	0.2	2
Molybdenum	<0.002	<0.02	0.5	10	30
Nickel	<0.002	<0.02	0.4	10	40
Lead	<0.005	<0.05	0.5	10	50
Antimony	<0.002	<0.02	0.06	0.7	5
Selenium	0.005	0.05	0.1	0.5	7
Zinc	<0.003	<0.03	4	50	200
Chloride	1.2	12	800	15000	25000
Fluoride	<0.3	<3	10	150	500
Sulphate as SO4	2.3	23	1000	20000	50000
Total Dissolved Solids	41	410	4000	60000	100000
Phenol	<0.01	<0.1	1	-	-
Dissolved Organic Carbon	<2	<20	500	800	1000

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw quarry
Contact: [redacted]

Note:

Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Asbestos sub-samples are retained for not less than 6 months from the date of analysis unless specifically requested.

The LOQ of the Asbestos Quantification is 0.001% dry fibre of dry mass of sample.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

Where trace asbestos is reported the amount of asbestos will be <0.1%.

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analyst Name	Date Of Analysis	Analysis	Result
22/18275	1	TP14	1.00	23	Catherine Coles	09/11/2022	**General Description (Bulk Analysis)**	soil,stone
					Catherine Coles	09/11/2022	**Asbestos Fibres**	NAD
					Catherine Coles	09/11/2022	**Asbestos ACM**	NAD
					Catherine Coles	09/11/2022	**Asbestos Type**	NAD
22/18275	1	TP15	1.00	26	Catherine Coles	09/11/2022	**General Description (Bulk Analysis)**	black soil, stone
					Catherine Coles	09/11/2022	**Asbestos Fibres**	Fibre Bundles
					Catherine Coles	09/11/2022	**Asbestos Fibres (2)**	Free Fibres
					Catherine Coles	09/11/2022	**Asbestos ACM**	NAD
					Catherine Coles	09/11/2022	**Asbestos ACM (2)**	NAD
					Catherine Coles	09/11/2022	**Asbestos Type**	Amosite
					Catherine Coles	09/11/2022	**Asbestos Type (2)**	Chrysotile
					Matthew Turner	20/12/2022	**Total ACM Gravimetric Quantification (% Asb)**	<0.001 (mass %)
					Matthew Turner	20/12/2022	**Total Detailed Gravimetric Quantification (% Asb)**	<0.001 (mass %)
					Matthew Turner	20/12/2022	**Total Gravimetric Quantification (ACM + Detailed) (% Asb)**	<0.001 (mass %)
					Matthew Turner	20/12/2022	**Asbestos PCOM Quantification (Fibres)**	<0.001 (mass %)
					Matthew Turner	20/12/2022	**Asbestos Gravimetric & PCOM Total**	<0.001 (mass %)
22/18275	1	TP17	1.00	32	Catherine Coles	09/11/2022	**General Description (Bulk Analysis)**	soil,stone
					Catherine Coles	09/11/2022	**Asbestos Fibres**	NAD
					Catherine Coles	09/11/2022	**Asbestos ACM**	NAD
					Catherine Coles	09/11/2022	**Asbestos Type**	NAD
22/18275	1	TP18	1.00	35	Catherine Coles	09/11/2022	**General Description (Bulk Analysis)**	soil,stone
					Catherine Coles	09/11/2022	**Asbestos Fibres**	NAD
					Catherine Coles	09/11/2022	**Asbestos ACM**	NAD
					Catherine Coles	09/11/2022	**Asbestos Type**	NAD

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw quarry
Contact: [redacted]

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
No deviating sample report results for job 22/18275						

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

EMT Job No.: 22/18275

SOILS and ASH

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

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

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

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

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

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

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

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

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

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

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

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

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

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

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

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

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

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics mathematically subtracted
#2	EU_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 22/18275

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes		AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.			AR	Yes
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM0	No preparation is required.			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes

EMT Job No: 22/18275

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM0	No preparation is required.			AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AD	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM65	Asbestos Bulk Identification method based on HSG 248 Second edition (2021)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM74	Analysis of water soluble boron (20:1 extract) by ICP-OES.	PM32	Hot water soluble boron is extracted from dried and ground samples using a 20:1 ratio.	Yes		AD	Yes
TM131	Quantification of Asbestos Fibres and ACM based on HSG 248 Second edition:2021, HSG 264 Second edition:2012, HSE Contract Research Report No.83/1996, MDHS 87:1998, WM3 1st Edition v1.1:2018	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	Yes

EMT Job No: 22/18275

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM170	Determination of Trace Metals by ICP-MS (Inductively Coupled Plasma – Mass Spectrometry): Modified USEPA Method 200.8, Rev. 5.4, 1994; Modified EPA Method 6020A, Rev.1, Feb 2007; Modified BS EN ISO 17294-2:2016	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	PM18	Modified method BS EN12457-3:2002 . As received solid samples are leached with water in a 2:1 water to solid ratio for 6 hours, the same aliquot of solid is then re-leached with water in an 8:1 water to solid ratio for 18 hours, the moisture content of the sample is included in the ratio. This preparation produces two eluates.			AR	Yes
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	

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RPS
2 Callaghan Square
Cardiff
CF10 5AZ

Attention :	[redacted]
Date :	8th November, 2022
Your reference :	JFR 2782
Our reference :	Test Report 22/18168 Batch 1
Location :	Aberthaw Quarry
Date samples received :	1st November, 2022
Status :	Final Report
Issue :	1

Two samples were received for analysis on 1st November, 2022 of which two were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:

[redacted]

Project Manager

Element Materials Technology

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw Quarry
Contact: [redacted]
EMT Job No: 22/18168

Report : **Liquid**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-4	5-8	LOD/LOR	Units	Method No.
Sample ID	E05/03-1	E05/03-2			
Depth					
COC No / misc					
Containers	H HN N P	H HN N P			
Sample Date	01/11/2022	01/11/2022			
Sample Type	Liquid	Liquid			
Batch Number	1	1			
Date of Receipt	01/11/2022	01/11/2022			
Dissolved Aluminium	<20	<20	<20	ug/l	TM30/PM14
Dissolved Antimony	<2	<2	<2	ug/l	TM30/PM14
Dissolved Arsenic	<2.5	<2.5	<2.5	ug/l	TM30/PM14
Dissolved Boron	1817	1691	<12	ug/l	TM30/PM14
Dissolved Cadmium	<0.5	<0.5	<0.5	ug/l	TM30/PM14
Dissolved Calcium	561.1$_{AA}$	558.7$_{AA}$	<0.2	mg/l	TM30/PM14
Total Dissolved Chromium	<1.5	<1.5	<1.5	ug/l	TM30/PM14
Dissolved Copper	<7	<7	<7	ug/l	TM30/PM14
Total Dissolved Iron	38	72	<20	ug/l	TM30/PM14
Dissolved Magnesium	324.2$_{AA}$	328.2$_{AA}$	<0.1	mg/l	TM30/PM14
Dissolved Manganese	57	57	<2	ug/l	TM30/PM14
Dissolved Mercury	<1	<1	<1	ug/l	TM30/PM14
Dissolved Molybdenum	1452	1355	<2	ug/l	TM30/PM14
Dissolved Nickel	<2	<2	<2	ug/l	TM30/PM14
Dissolved Potassium	20.7	19.7	<0.1	mg/l	TM30/PM14
Dissolved Selenium	<3	<3	<3	ug/l	TM30/PM14
Dissolved Sodium	1405.1$_{AA}$	1244.6$_{AA}$	<0.1	mg/l	TM30/PM14
Dissolved Vanadium	<1.5	<1.5	<1.5	ug/l	TM30/PM14
Dissolved Zinc	4	11	<3	ug/l	TM30/PM14
Fluoride	1.1	1.1	<0.3	mg/l	TM173/PM0
Sulphate as SO4	807.7	730.0	<0.5	mg/l	TM38/PM0
Chloride	2306.2	2310.7	<0.3	mg/l	TM38/PM0
Nitrate as NO3	0.7	0.4	<0.2	mg/l	TM38/PM0
Nitrite as NO2	<0.02	<0.02	<0.02	mg/l	TM38/PM0
Nitrate as N	0.16	0.08	<0.05	mg/l	TM38/PM0
Total Oxidised Nitrogen as N	<0.2	<0.2	<0.2	mg/l	TM38/PM0
Ammoniacal Nitrogen as N	0.52	0.64	<0.03	mg/l	TM38/PM0
Hexavalent Chromium	<0.006	<0.006	<0.006	mg/l	TM38/PM0
Total Alkalinity as CaCO3	224	368	<1	mg/l	TM75/PM0
Electrical Conductivity @20C	7586	7304	<2	uS/cm	TM76/PM0
pH	7.49	7.53	<0.01	pH units	TM73/PM0
Total Organic Carbon	<2	<2	<2	mg/l	TM60/PM0
Total Nitrogen	1.0	1.6	<0.5	mg/l	TM38/TM125/PM0
Total Cations	116.32$_{AA}$	109.52$_{AA}$	<0.00	mmolc/l	TM30/PM14
Total Anions	86.36	87.75	<0.00	mmolc/l	TM0/PM0
% Cation Excess	14.78	11.04		%	TM0/PM0

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Element Materials Technology

Notification of Deviating Samples

Client Name: RPS
Reference: JFR 2782
Location: Aberthaw Quarry
Contact: [redacted]

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
No deviating sample report results for job 22/18168						

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

EMT Job No.: 22/18168

SOILS and ASH

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

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

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

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

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

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

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

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

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

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

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

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

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

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

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

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

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

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

ABBREVIATIONS and ACRONYMS USED

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SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range
AA	x10 Dilution

EMT Job No: 22/18168

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM0	Not available	PM0	No preparation is required.				
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified				
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM0	No preparation is required.				
TM38/TM125	Total Nitogen/Organic Nitrogen by calculation	PM0	No preparation is required.				
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.				
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.				
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.				
TM76	Modified US EPA method 120.1 (1982). Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.				
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.				