DRAINAGE DESIGN STRATEGY

Battery Storage Facility, Desford Road, Leicestershire

020496
RPS-DES-SI-XX-RP-D-0300
P01
05 February 2021

rpsgroup.com

Document status

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Contents

1 INTRODUCTION

1.1 RPS has been commissioned by Statera Energy to produce a Drainage Design Strategy (DDS) report for a proposed new Battery Storage facility close to an existing National Grid substation site located off Desford Road, Leicestershire, Northamptonshire, following Planning Consent issued by Blaby District Council, Application Number 17/1223/FUL, dated 13 October 2017.

1.2 The proposed development site, approximately 1.23Ha in size, comprises a large securely fenced compound area containing a number of battery / MVPS metal storage containers, together with a separate adjoining securely fenced electricity transformer unit and control / metering housing along with an associated access road for maintenance vehicles. The site will be fully secured against access by the general public and shall in general not be manned. The development will be electrically connected to the existing nearby National Grid substation to provide a new off-line power storage facility. Please refer to **Appendix I** for the Proposed Masterplan.

1.3 The purpose of the Drainage Design Strategy is to set out the design strategy for surface water drainage to be adopted for construction of the works proposed for this site, addressing specifically Conditions 4 and 5 of the aforementioned planning consent. This report has been produced in conjunction with the following RPS documents which form part of the approved planning consent -

- Flood Risk Assessment for the development, RPS Report JER1292 Rev v1 Battery Facility Desford Road, Enderby dated September 2017.
- Drainage Impact Assessment for the development, RPS Report NK018770/DIA09 Rev P02 Battery Facility, Desford Road, Enderby dated 08 September 2017.

1.4 The development will be operated remotely, and so will not generate any foul drainage water. There is no requirement for any foul drainage provision on this site and as such this element has been excluded from the report.

1.5 The contents of this report are to be read in conjunction with all supporting drawings and/or documents referenced herein, appended to this report or submitted in support of the planning application for this development.

2 EXISTING SITE DRAINAGE

2.1 The site is located approximately 170m to the east of an existing National Grid sub-station site, situated some 1.9km to the west of M1 Junction 21 on the outskirts of Leicester. The approximate National Grid Reference is 452710mE, 300350mN. Vehicles access the site from the B582 Desford Road, roughly 40m to the south of the main development boundary.

2.2 The development is set in a rural location to the west of Leicester, roughly 0.5 km to the north of the M69 motorway and 1.5 km to the north of the town of Enderby. The site itself is currently used for agricultural purposes and is surrounded by extensive areas of farmland to the north & west, the boundaries comprising hedgerows and small trees. Just beyond Desford Road to the south is a business park, itself forming the northern extents of Enderby and divided by the nearby motorway.

2.3 A topographical survey of the site was produced by Phoenix Survey Services Ltd in July 2017. According to the survey, the existing site exhibits a fall from west to east in the region of 1:45, with levels varying between 99.21m AOD close to Desford Road down to 94.94m AOD at the eastern boundary hedge. Please refer to **Appendix II** for a copy of the survey drawing.

2.4 The site and its immediate surroundings are laid to farmland, therefore surface water run-off control measures currently in existence are limited to shallow land drains and a network of small open ditches laid to the perimeter of existing fields. It is understood that one such ditch exists along the northern / eastern site boundary, into which two existing piped outfalls have been identified. The ditch is believed to flow in an easterly direction towards Beggars Lane, approximately 140m to the east of the site. It is apparent that the site lies within the 12.608 km^2 catchment area for the Lubbesthorpe Brook, a tributary of the River Soar, itself situated some 3.6 km to the east of the development.

2.5 Following a review of the publicly available British Geological Society information, the site is understood to be underlain by superficial Till deposits (Diamicton), comprising sandy, silty clays, above a Triassic Rock formation. Based on the presence of impermeable soil strata, it is unlikely that infiltration would be a viable technique for surface water disposal. Indeed, in-situ infiltration testing carried out at the site by Terra Consult in September 2017 confirmed this assumption. Four individual trial pits were dug to a depth of 2.0m below ground level with a resulting infiltration rate of 0.001m/hr, which is considered to be too low to support infiltration as the primary method of surface water disposal. Please refer to **Appendix V** for a copy of the Terra Consult report.

3 DESIGN CONSTRAINTS / PARAMETERS

3.1 SURFACE WATER DRAINAGE DESIGN CONSTRAINTS

Constraints placed on the design of surface water drainage serving the proposed development are as follows:

- Runoff from new development impermeable areas to be discharged at QBar, requiring consideration of on-site surface water attenuation provision for extreme rainfall events.
- Surface water drainage discharge will be limited to direct discharge to the adjacent watercourse. While the surface water discharge hierarchy indicates that infiltration should be the first method to be considered, in-situ testing ruled out soakaways as a viable option. The next method in the hierarchy is discharge to watercourse, which is the option selected for this development.
- Below ground electricity supply and distribution cabling associated with the development may impose restrictions on location and depth of below ground surface water drainage pipework runs.
- Due to the site being remotely operated, and potentially unoccupied for long periods of time, the proposed drainage system needs to provide resilience against occasional blockages or malfunction and have minimal maintenance requirements.
- Detailed drainage design will be undertaken in accordance with CIRIA C753 'The SuDS Manual' and any additional requirements set out by Leicestershire County Council as Lead Local Flood Authority, and the Environment Agency.
- Due to the topography of the site and the Developer's proposals to construct landscaped earth mounds along the southern boundary of the development, a significant area of the site will be cut off in terms of surface run-off. It will therefore be necessary to provide a land drainage system to collect these flows and direct them into the proposed system to maintain continuity of flow and so as not to exacerbate potential flooding.

3.2 SURFACE WATER DRAINAGE DESIGN VARIABLES

The attenuation volume required to restrict the surface water runoff rate from the additional low permeable surfacing to the existing QBar rate for a 1 in 100 year rainfall event plus climate change (+40%) has been determined using the industry standard Micro Drainage software using the following design parameters:

Catchment Area: Approximately 1.23Ha for the development, plus 0.97Ha for offsite flows:

- M5-60: 20.0mm
- Ratio R: 0.40
- SAAR: 700mm
- SOIL: 0.450
- Cv (proportion of rainfall forming surface water runoff): 0.562 Summer, 0.887 Winter
- QBar Rate: 5.40L/s for the development, plus 4.30L/s for offsite flows
- No infiltration losses

The drainage system was modelled within Micro Drainage as a tank/pond with controlled discharge via vortex flow control. The Micro Drainage calculations are included in **Appendix IV**.

The surface water attenuation volume required to limit runoff to the existing QBar runoff rate of 9.70 L/s from a 1 in 100 year storm event plus a 40% allowance for climate change has been determined to be approximately 2,094m^3 for the site.

4 PROPOSED SURFACE WATER DRAINAGE

4.1 The proposed new surface water drainage system will be designed using Micro Drainage modelling software, taking account of current planning guidance, Lead Local Flood Authority (LLFA) and Environment Agency (EA) guidance to prevent uncontrolled flooding of the site and surrounding area.

4.2 Proposed development impermeable areas are as shown on RPS drawing **NK020496-RPS-DES-XX-DR-D-0301**, which is included in **Appendix II**. Based on the Proposed Masterplan approximately 2,590m² of the site will be impermeable, which equates to around 12% when including the offsite catchment area.

4.3 Surface water runoff from the proposed development will be collected as follows:

i. Impermeable surfaced hardstanding and site access roads – lateral filter drains which will convey the run-off into the pond.

ii. Permeable gravel areas, unbound stone access roads and hardstandings, battery container roofs – direct infiltration via the granular pavement medium onto a geotextile drainage blanket, allowing lateral drainage flows into a collector pipe, or direct discharge into filter drains and/or the pond.

iii. Impermeable building roof areas – traditional gravity gutters and downpipes, connected via underground gravity pipework into the pond.

4.4 Surface water runoff will be collected by a series of on-site filter drains, designed in accordance with the recommendations of CIRIA C753 SuDS Manual. Each filter drain will feature a 150mm diameter perforated pipe near the base of the structure to facilitate conveyance of the inflows, as well as a sacrificial layer of single sized aggregate at surface level to act as a silt trap and thus help prevent blockage. In addition to the surface level aggregate layer, access sumps will be installed at regular intervals to enable maintenance inspection and jetting of the pipework as required. The filter media surrounding the perforated pipe will be wrapped in geotextile sheet to prevent the migration of fines and the system can provide treatment to the run-off through filtering out fine sediments, metals and hydrocarbons. Downstream of the filter drains it is proposed to install a proprietary Vortex Grit Separator, 'Aquaswirl' by SDS Ltd or similar equivalent, to provide additional quality treatment to the flows. Prior to outfall, an attenuation basin will be constructed, designed in accordance with the SuDS Manual. This feature will provide adequate storage for all storm events up to and including the 1 in 100 year return period with an additional 40% for climate change and will also provide a final element of treatment to the surface water run-off through the use of a permanent pool below the outfall invert level.

4.5 The interrupted offsite flows will be intercepted by a cut-off ditch adjacent to the soft landscaped earth bund to the west of the site access road, which will be fitted with a 50mm diameter orifice plate at the outfall before controlled flows are conveyed into the development drainage system.

4.6 Discharge of surface water from the site will be controlled to the QBar rate of 9.7L/s for all return periods through the use of a vortex hydrobrake flow control device fitted immediately upstream of the proposed outfall into the adjacent watercourse.

4.7 Proposed finished levels on site are generally similar to the existing topography, so overland flows would be similar to the pre-development situation and so an exceedance event would not exacerbate surface water flooding. The inclusion of a cut-off drain at the southern boundary will assist with preventing any possible inundation due to the presence of the landscaped bund.

4.8 The proposed surface water drainage layout is shown on RPS drawing **NK020496-RPS-DES-XX-DR-D-0300**. Details of overland flow routes are shown on RPS drawing **NK020496-RPS-DES-XX-DR-D-0301,** both of which are included in **Appendix III**.

4.9 The proposed surface water flows shall be restricted to QBar prior to discharge from the site, which has been calculated using Micro Drainage Source Control. Calculations for this together with detailed Micro Drainage Network design calculations for the proposed network are included in **Appendix IV**.

Return Period	Q_{BAR} (l/s)	Q_2 (l/s)	Q_{30} (l/s)	Q_{100} (l/s)
Greenfield Run-off (L/s/Ha)	9.7	8.7	18.9	24.9

Source Control Greenfield Runoff Calculation Summary

4.10 In conclusion, the only surcharging in the system indicated during 1 in 2 year simulation relate to close proximity to storage structures as well as the existing 100mm diameter outfall pipe. No flooding has been generated during either the 1 in 30 year, or 1 in 100 year return period simulation, the latter including an additional 40% allowance for climate change.

5 CONSTRUCTION STAGE DRAINAGE

5.1 During construction of the development, including the proposed temporary contractors compound area, the main contractor will be responsible for management and disposal of rainwater runoff generated from the site in its temporary condition.

5.2 The contractor shall develop a Construction Environmental Management Plan (CEMP), which will address pollution management and control in relation to site plant and vehicles, raw materials storage and waste generation, to ensure that all surface water runoff generated in the temporary condition will be free of contamination.

5.3 The site will be subject to topsoil strip and bulk earthworks to prepare the site to the correct level for development. The contractor shall provide temporary drainage containment measures as illustrated within Section 6 of CIRIA C532 'Control of Pollution from Construction Sites', to contain runoff within the development site boundary, ensuring that these measures are sized appropriately, and that means to remove excess surface water are available for use at all times.

6 WATER QUALITY / POLLUTION CONTROL

6.1 As discussed in Section 4 of the report, the surface water drainage system will feature a number of SuDS measures that will be designed in accordance with CIRIA C753. As well as controlling the quantity of surface water run-off from the site, these features will also address water quality to prevent the discharge of potential pollutants or suspended solids into the water environment downstream of the development.

6.2 Table 26.2 of CIRIA C753 extracted below identifies pollution hazard indices for the varying land usage pertinent to this development -

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Notes

1 Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009).

2 These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help determine the most appropriate approach to the development of a design solution.

6.3 Whilst there is no specific category which exactly fits this development, the proposals are industrial in nature, so it is considered that applying a High Hazard Level would be the most appropriate land use classification.

6.4 Table 26.3 indicates indicative pollution hazard level mitigation indices for different SuDS measures -

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Notes

1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.

2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.

3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.

4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.

5 See Chapter 14 for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: http://tinyurl.com/qf7yuj7

6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

6.5 It can be seen from the information shown in the table below, that pollution mitigation provision would be afforded through the use of filter drains together with an 'Aquaswirl' vortex grit separator together with the proposed attenuation pond.

Pollution	Pollution Hazard	SuDS Component	TSS	Metals	Hydro-carbons
Hazard Indices	High	-	0.8	0.8	0.9
SuDS Mitigation	-	Filter Drain	0.4	0.4	0.4
	-	'Aquaswirl'	0.8 [1]	0.5 [1]	0.7 [1]
	-	Pond	0.7*	0.7*	0.5*
Total SuDS Mitigation	-	-	1.15	1.0	1

Mitigation indices for the 'Aquaswirl' proprietary system provided by SDS Ltd. [1]

When designing in accordance with the SuDS Manual (Ciria C753), when two or more devices are used in sequence to target the same pollutant, only half of the mitigation index of the subsequent components should be allowed in the calculation.

7 MAINTENANCE

7.1 The following table indicates the maintenance activities that will need to be implemented by the site operator to ensure continued satisfactory operation of the site drainage system. The maintenance activities would be split into three categories, namely Regular, Occasional & Remedial, as detailed in the table below -

TABLE 32.1 Typical key SuDS components operation and maintenance activities (for full specifications, see Chapters 11–23)

Operation and maintenance activity	SuDS component												
	Pond	Wetland	Detention basin	Infiltration basin	Soakaway	Infiltration trench	Filter drain	Modular storage	Pervious pavement	Swale/bioretention/ trees	Filter strip	Green roofs	Proprietary treatment systems
Regular maintenance													
Inspection	■	■	■	■	■	■	■	■	■	■	■	■	■
Litter and debris removal	■	■	■	■	□	■	■	□	■	■	■		□
Grass cutting	■	■	■	■	□	■	■	□	□	■	■		
Weed and invasive plant control	□	□	□	□		□	□		□		□	■	
Shrub management (including pruning)	□	□	□	□					□	□	□		
Shoreline vegetation management	■	■	□										
Aquatic vegetation management	■	■	□										
Occasional maintenance													
Sediment management[1]	■	■	■	■	■	■	■	■	■	■	■		■
Vegetation replacement	□	□	□	□						□	□	■	
Vacuum sweeping and brushing									■				
Remedial maintenance													
Structure rehabilitation /repair	□	□	□	□	□	□	□	□	□	□	□	□	
Infiltration surface reconditioning				□	□	□	□		□	□	□		

Key
■ will be required
□ may be required

Notes
1 Sediment should be collected and managed in pre-treatment systems, upstream of the main device.

7.2 There may be one-off requirements sometimes referred to as "establishment maintenance", particularly for planting (e.g. weeding and watering) which are defined in the soft landscape proposals for the site. Regular maintenance will consist of basic tasks carried out on a frequent and predictable schedule, including inspections/monitoring, silt or oil removal (if required more frequently than once per year), vegetation management, sweeping of surfaces and litter/debris removal.

7.3 Occasional maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis that the regular tasks. Remedial maintenance comprises the intermittent tasks that may be required to rectify faults associated with system, although the likelihood of faults can be minimised by good design, construction and regular maintenance activities. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, so timings are difficult to predict.

7.4 In addition to general cleaning of roof gutters and downstream sediment traps, the following Table 16.1 and Table 23.1 of CIRIA C753 indicate the minimum required maintenance regime that requires to be implemented post construction for the SuDS elements that will comprise the bulk of the proposed drainage system. In addition, Table 14.2 indicates the potential maintenance requirements for the proprietary 'Aquaswirl' separators, however specific maintenance advice should be sought from the manufacturer to supplement this.

TABLE 16.1 Operation and maintenance requirements for 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
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (eg 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

TABLE 23.1 Operation and maintenance requirements for ponds and wetlands

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – public areas	Monthly (during growing season)
	Cut the meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices eg penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1 m above water level	Annually
	Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay.	Every 1–5 years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays.	Every 5 years, or as required
Occasional maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, eg every 25–50 years
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair / rehabilitate inlets, outlets and overflows.	As required

TABLE 14.2 An example of operation and maintenance requirements for a proprietary treatment system

Maintenance schedule	Required action	Typical frequency
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	Remove sediment, oil, grease and floatables	As necessary – indicated by system inspections or immediately following significant spill
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six monthly
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months

APPENDIX I – PROPOSED MASTERPLAN

Sightline Masterplan 207_MP_01 Revision C, dated September 2017

STATERA ENERGY

Site boundary (Area = 15,532m²)	2.5m high steel security palisade fencing
Existing hedgerows and trees	Bell Mouth Entrance (Area = 133 m²)
	Hardstanding (Area = 833 m²)
Sight lines	Access Road (Area 446 m²)
Existing trees	Acoustic fencing 4-5m high
	Filter drains
	Surface drainage
+96.50	Proposed spot heights

Revision Date Comment

Rev A 21.11.17 Extent of ownership added, bund height and width increased, hedge reinforcement shown.
Rev B 21.11.17 Rabbit proof fencing added.
Rev C: 28.11.17Contractors parking increased to 26 car spaces. 6 permanent car spaces shown adjacent to the control room.

ON BEHALF
Statera Energy

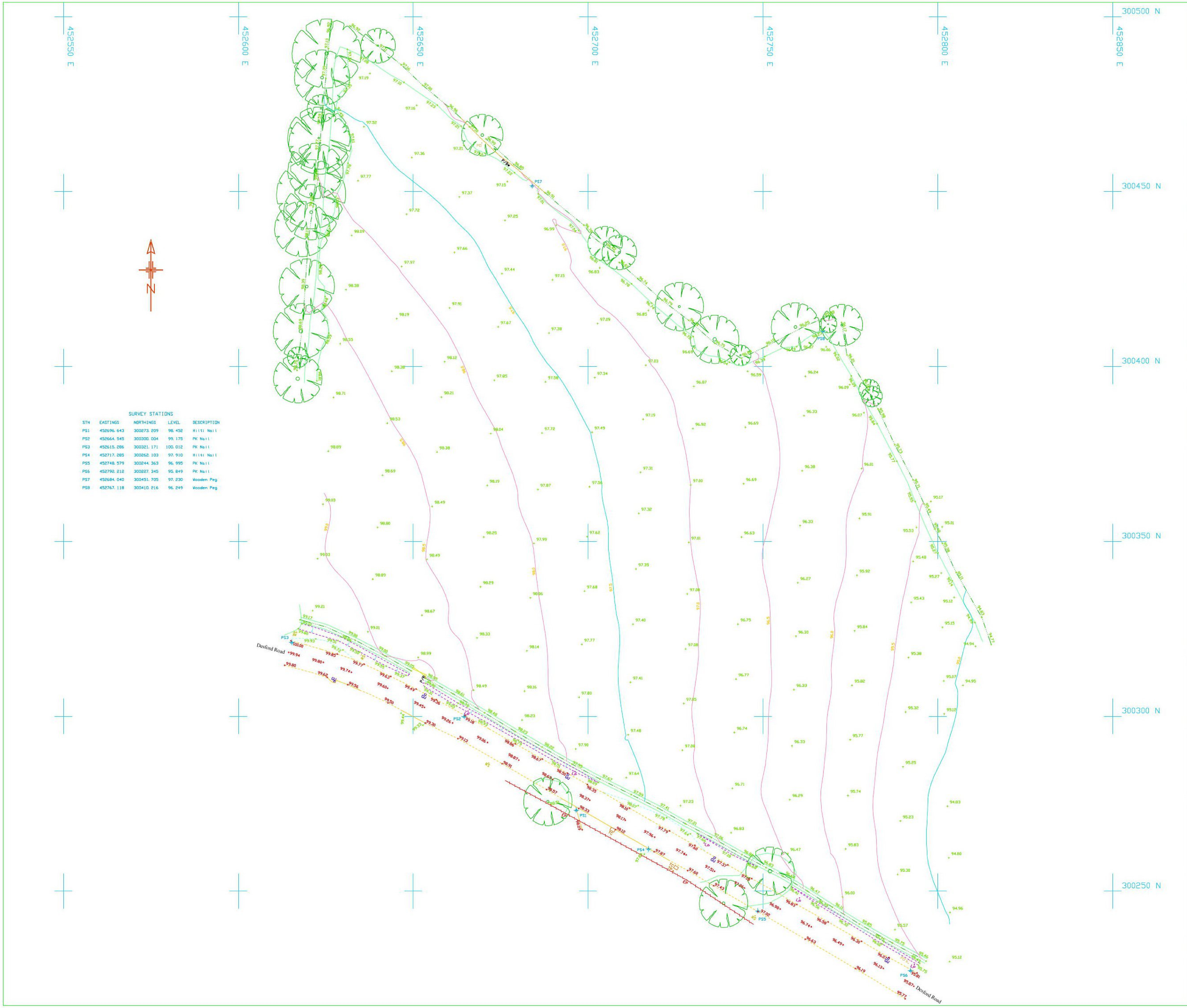
DATE	13 September 2017
SCALE	1 : 500 @ A1
DWG No	207__MP__01 Rev C
APPROVED	CMcD

PROJECT
Proposed battery based electricity storage facility, Desford Road, Enderby

TITLE
Block Plan

APPENDIX II – TOPOGRAPHICAL SURVEY

Phoenix Survey Services Ltd S4258-01, dated July 2017



SURVEY STATIONS

STN	EASTINGS	NORTHINGS	LEVEL	DESCRIPTION
PS1	452696.643	300273.209	98.452	Hilti Nail
PS2	452664.545	300300.004	99.175	PK Nail
PS3	452615.286	300321.171	100.012	PK Nail
PS4	452717.285	300262.103	97.910	Hilti Nail
PS5	452748.579	300244.363	96.995	PK Nail
PS6	452792.212	300227.345	95.849	PK Nail
PS7	452684.040	300451.705	97.230	Wooden Peg
PS8	452767.118	300410.216	96.249	Wooden Peg

SURVEY NOTES

1. THE SURVEY GRID (OSGB36) WAS ESTABLISHED WITH GPS AND THEN A ONE POINT SITE CENTRED TRANSFORMATION CARRIED OUT TO ELIMINATE SCALE FACTOR. IN ORDER TO RE-ESTABLISH THE SITE GRID THEN THE EXISTING SURVEY CONTROL STATIONS SHOWN MUST BE USED

2. SURVEY LEVELS ESTABLISHED BY GPS TO OS DATUM

SURVEY KEY

House – Building
Survey Control Station
Wall – Wall
Hedge
Kerbline
R/Wall – Retaining Wall
Verge/Edge of Track etc
P/W – Fence (with description)

Chestnut Paling	C/P	Overhead Line	
Close Boarded	C/B	Footpath	
Corrugated Iron	C/I	Sewer Line	
Chain Link	C/L	Water/Ditch etc	
Crash Barrier	CBr	Gate	
Concrete Panel	Con/P	Stile	
Hit and Miss	H/M	Individual Tree	
Interwoven	Iwn		
Paling	Pal		
Post & Wire	P/W		
Post & Rail	P/R		
Post & Chain	P/C		
Overlap	O/L		
Iron Railings	I/R		
Post & Barbed Wire	P/Bw		
Electric	Elc		
Hoarding	Hrd		
Post & Wire Mesh	P/M		
Picket (Wooden)	P/K		
Trip Rail	T/R	Unable To Raise	UTR
Trellis Fence	T/F	Fire Escape	F/Esc
Palisade Fence	P/F	Drop Kerb	DK
Floor Level	FL	Stone Surface	Stone
Eaves Level	EL	Gravel Surface	Gravel
Ridge Level	RL	Concrete Surface	Conc
Tarmac Surface	Tarmac	Rough Ground	R/Grnd
Grass/Lawn	Grass	Granite Setts/Cobbles	Cobbles
Paving Slabs	Paving	Tactile Paving	T/Pav

STREET FURNITURE

Belisha Beacon	BB	Marker Post	Mkr
Borehole	BH	Mile Post	MP
Bollard	BL	Pillar Box	PB
Bus Stop	BS	Pipe	Pi
Drain	Dr	Parking Meter	PM
Electric Pole	EP	Post	PO
Flood Light	FL	Rodding Eye	RE
Flagstaff	FS	Reflector Post	RP
Gate Post	GP	Road Sign	RS
Gully	GU	Stop Cock	SC
Gas Valve	GV	Stop Tap	ST
Inspection Cover	IC	Sign	SI
Litter Bin	LB	Stump	SU
Lamp Post	LP	Stop Valve	SV
Traffic Light	TL	Telegraph Pole	TP
Manhole	MH	Vent Pipe	VP
Name Plate	NP	Telecommunication	TC
Fire Hydrant	FH	Water Tap	Tap
Wash Out	WO	Kerb Outlet	KO
Water Meter	WM	Air Valve	AV
Cable Television	TV	Tel Call Box	TCB
Earth Rod	ER	Trial Pit	T/P
Speed Camera	SPD	Closed Circuit TV	CT
Cellar Light	Ce/L	Multi Utility Pole (EP,LP,&TP)	MUP

TECHNICAL NOTES

INFORMATION SHOWN ON THIS DRAWING IS SURVEYED TO THE ACCURACY OF THE BASE SCALE SHOWN IN THE LEGEND.

MAN ENTRY TO SEWERS HAS NOT BEEN UNDERTAKEN. DEPTHS, PIPE SIZES ARE MEASURED/ESTIMATED FROM THE GROUND. ALL SEWER DETAILS TO BE CHECKED WITH LOCAL AUTHORITY RECORDS OR ON SITE PRIOR TO COMMENCEMENT OF WORKS.

BOUNDARIES SHOWN ARE PHYSICAL FEATURES AND MAY NOT REPRESENT LEGALLY CONVEYED OWNERSHIP

ALL TREE HEIGHTS AND SPREADS ARE APPROXIMATE. TREE TYPES WHICH HAVE BEEN IDENTIFIED SHOULD BE CHECKED BY A TREE SPECIALIST.

WHERE ADJACENT BUILDINGS HAVE BEEN SURVEYED REMOTELY NOT ALL EXTERNAL WALLS MAYBE SHOWN DUE TO OBSTRUCTIONS ALONG LINE OF SIGHT

REV	DATE	DESCRIPTION	BY	APP.

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49 William Road, Long Buckby, Northampton NN6 7YS
Tel 07876 658389 or 07810 752133
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Client
STATERA ENERGY

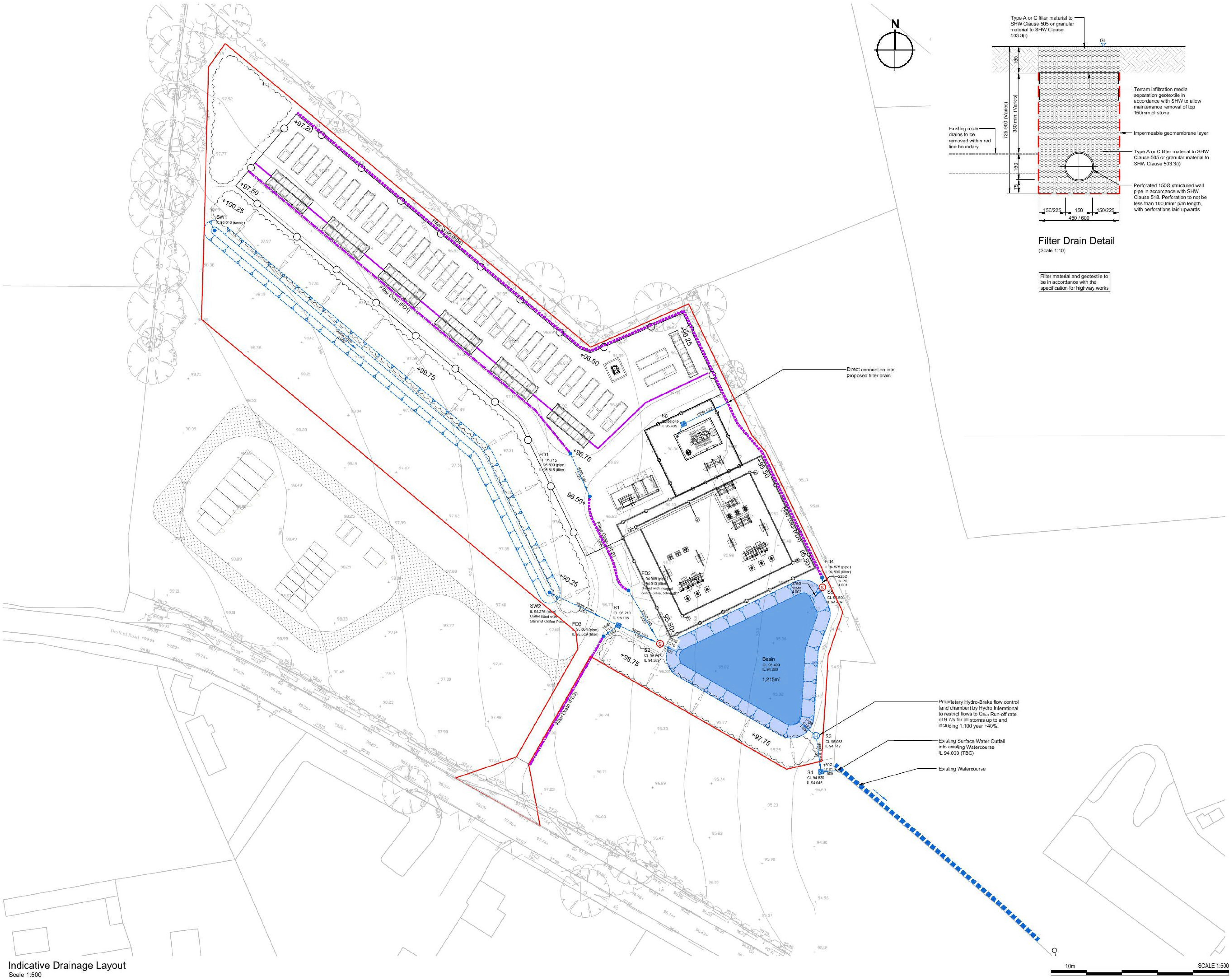
Project Title
Desford Road
Enderby

Drawing Title
Topographical Survey

Drawn	Checked	Approved
GRA	ALB	GRA
Date 07/07/2017	**Scale** 1/500	**Sheet Size** A1
Drg. No. S4258-01	**Rev**	

APPENDIX III – RPS DRAWINGS

RPS Drawings 020496-RPS-DES-XX-DR-D-0300-P01 and 0301-P01, dated February 2021



Indicative Drainage Layout
Scale 1:500

The contractor is to survey all drainage connection points to satisfy himself all inverts used in the design are accurate. Any descrepancies are to be reported to the engineer immediately where further advice will be given.

Notes

1. This drawing has been prepared in accordance with the scope of RPS's appointment with its client and is subject to the terms and conditions of that appointment. RPS accepts no liability for any use of this document other than by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.
3. This drawing should be read in conjunction with all other relevant drawings and specifications.

Key:

- Planning boundary
- SW Sewer (I/D & Gradient)
- SW Manhole
- HydroBrake ® flow control unit
- MicroDrainage model pipe number
- MicroDrainage model node
- Proposed Vortex Grit Separator unit
- Filter drain - Type A (450mm wide)
- Filter drain - Type B (600mm wide)

Rev	Description	By	Ckd	Date
P01	First Issue.	CW	DW	02.02.21

MAKING COMPLEX EASY

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Client

STATERA ENERGY
DEVELOP – FINANCE
ENERGY INFRASTRUCTURE

Project: Statera Energy Drainage Schemes 2021

Title: Desford Road - Proposed Drainage Layout

RPS Project Number	Scale @ A1	Date Created
NK020496	1:500	02.02.2021
Task Team Manager	**Information Author**	**Task Information Manager**
GB	CW	DW

Status: S2 (Suitable for Information)

Document Number: 020496-RPS-DES-XX-DR-D-0300
Revision: P01

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

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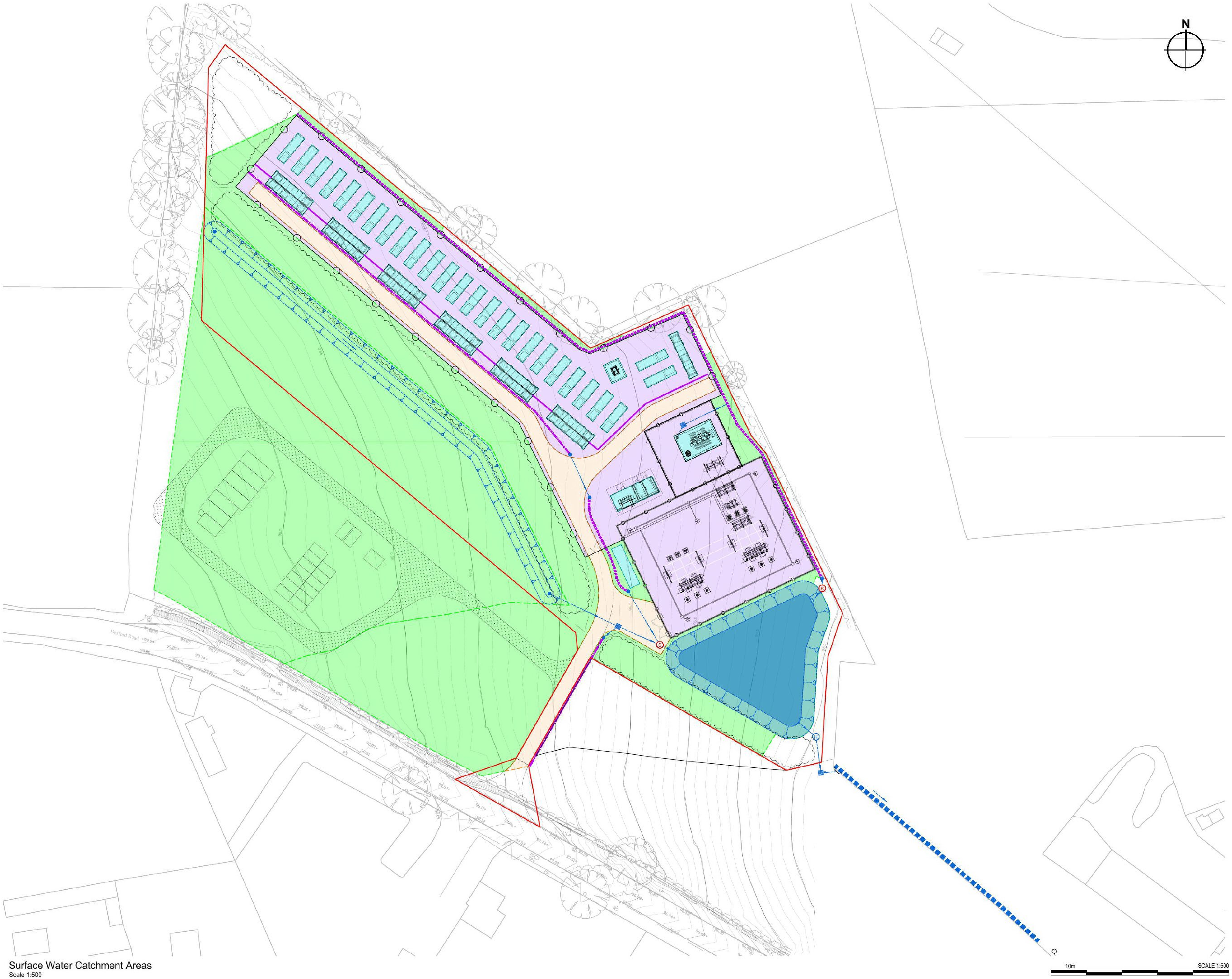

Surface Water Catchment Areas

Scale 1:500

Notes

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2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.
3. This drawing should be read in conjunction with all other relevant drawings and specifications.

Surface Water Catchment Key

4,725m²	Gravel
14,690m²	Landscaping
19,415m²	Total Permeable Area
1,263m²	Roof / Structure Drainage Area
1,327m²	Stone Access Track
2,590m²	Total Impermeable Area
22,005m²	Total Catchment Area

The contractor is to survey all drainage connection points to satisfy himself all inverts used in the design are accurate. Any descrepancies are to be reported to the engineer immendiately where further advice will be given.

Rev	Description	By	Ckd	Date
P01	First Issue.	CW	DW	02.02.21

RPS — MAKING COMPLEX EASY

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Client: STATERA ENERGY — DEVELOP – FINANCE ENERGY INFRASTRUCTURE

Project: Statera Energy Drainage Schemes 2021

Title: Desford Road - Surface Water Catchment Areas

RPS Project Number	Scale @ A1	Date Created
NK020496	1:500	02.02.2021
Task Team Manager	**Information Author**	**Task Information Manager**
GB	CW	DW

Status: S2 (Suitable for Information)

Document Number	Revision
020496-RPS-DES-XX-DR-D-0301	P01

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

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APPENDIX IV – RPS DESIGN CALCULATIONS

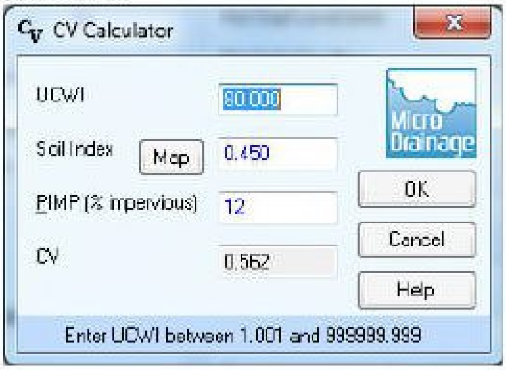
TECHNICAL NOTE D001: CV Calculation

The following calculations provide CV [Run-off Coefficient] values for summer and winter, to be used within the design.

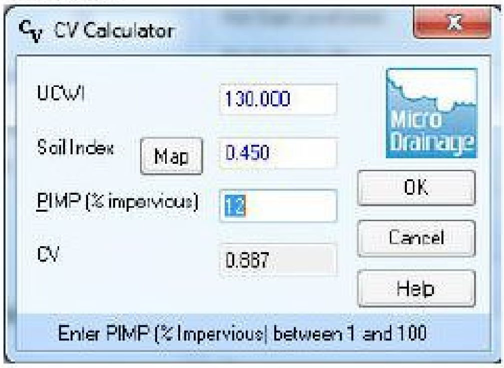
CV=PR/PIMP where:

> **PR** = 0.829 PIMP + 25.0 SOIL + 0.078 UCWI – 20.7
> **PIMP** = surface intended to drain to the storm sewer [2,590m²/22,005m²= 0.12]
> **SOIL** = 0.45
> **UCWI** = antecedent wetness conditions (mm) [80 for summer, 130 for winter]

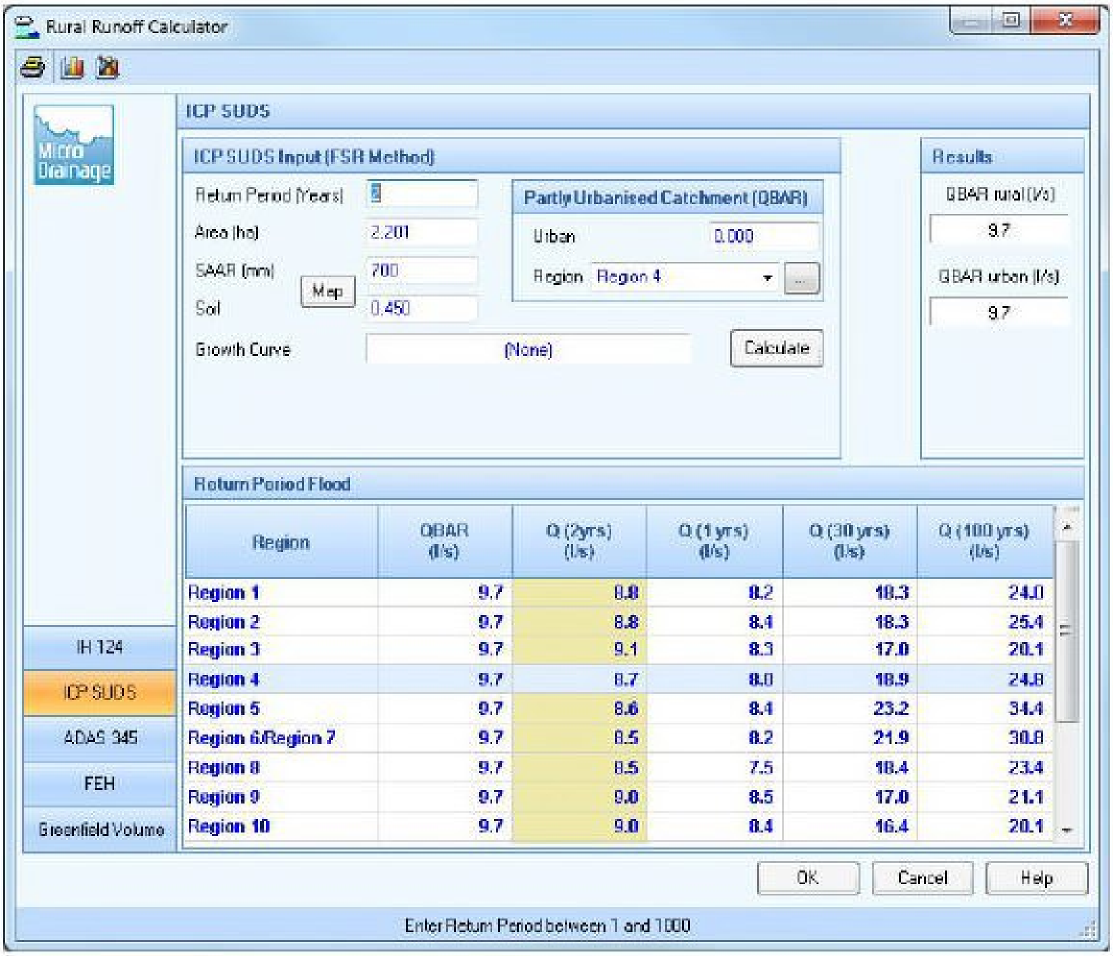
Summer CV



Winter CV

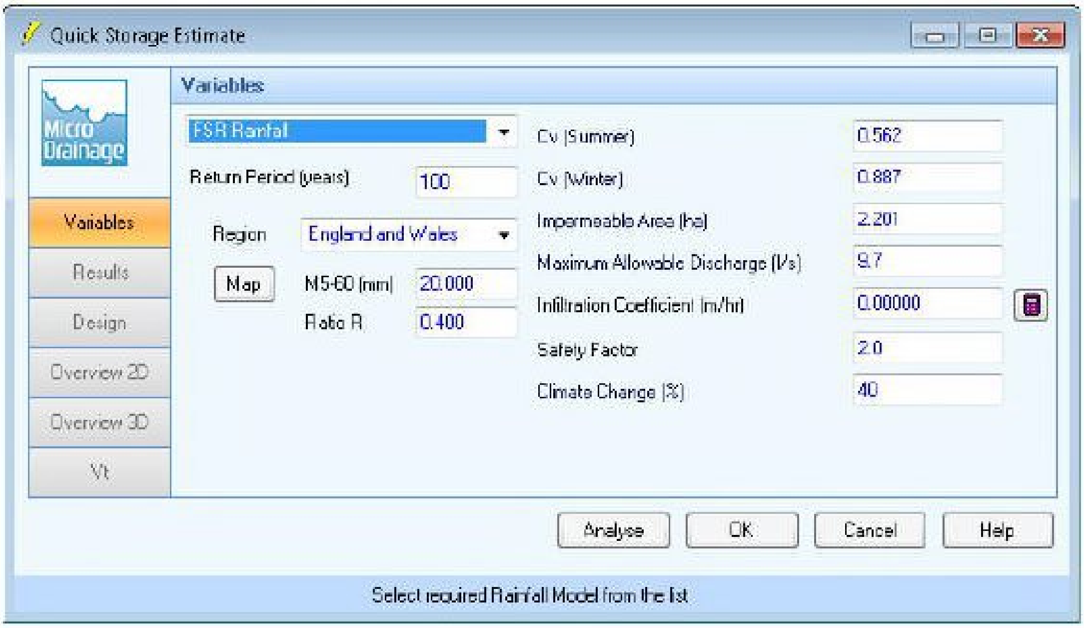


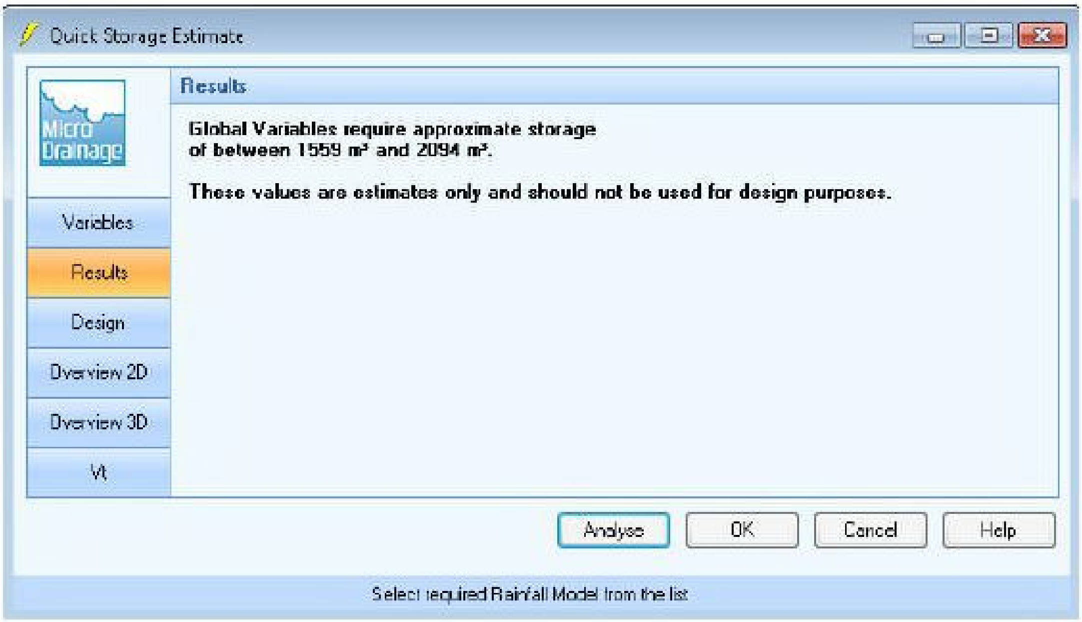
Greenfield Run-off – Q_{BAR} Calculation



Region	QBAR (l/s)	Q (2yrs) (l/s)	Q (1 yrs) (l/s)	Q (30 yrs) (l/s)	Q (100 yrs) (l/s)
Region 1	9.7	8.8	8.2	18.3	24.0
Region 2	9.7	8.8	8.4	18.3	25.4
Region 3	9.7	9.1	8.3	17.0	20.1
Region 4	9.7	8.7	8.0	18.9	24.8
Region 5	9.7	8.6	8.4	23.2	34.4
Region 6/Region 7	9.7	8.5	8.2	21.9	30.8
Region 8	9.7	8.5	7.5	18.4	23.4
Region 9	9.7	9.0	8.5	17.0	21.1
Region 10	9.7	9.0	8.4	16.4	20.1

Quick Storage Estimate – 1:100 year RP + 40% CC





STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	30	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.400	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	65	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.178	4-8	0.353	8-12	0.660	12-16	0.010

Total Area Contributing (ha) = 2.201

Total Pipe Volume (m³) = 1191.859

Network Design Table for Storm

- Indicates pipe length does not match coordinates
« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	10.000	0.100	100.0	0.000	5.00	0.0	0.600		o	100	Pipe/Conduit	
1.001	5.151	0.349	14.8	0.202	0.00	0.0	0.600		o	150	Pipe/Conduit	
2.000	149.531	0.305	490.3	0.825	5.00	0.0		0.045	1 _/	2000	1:1 Ditch	

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	65.00	5.22	95.734	0.000	0.0	0.0	0.0	0.77	6.0	0.0
1.001	65.00	5.25	95.634	0.202	0.0	0.0	0.0	2.64	46.6	35.6
2.000	65.00	11.39	96.016	0.825	0.0	0.0	0.0	0.39	269.1	145.2

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
2.001	14.074	0.141	99.8	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
1.002	12.841	0.553	23.2	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
3.000	10.000	0.100	100.0	0.000	5.00	0.0	0.600		o	100	Pipe/Conduit	
3.001	13.235	0.217	61.0	0.188	0.00	0.0	0.600		o	150	Pipe/Conduit	
3.002	29.461	0.685	43.0	0.000	0.00	0.0	0.600		o	150	Pipe/Conduit	
3.003	17.479#	0.256	68.3	0.057	0.00	0.0	0.600		o	150	Pipe/Conduit	
1.003	5.222#	0.031	168.5	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
4.000	10.000	0.100	100.0	0.000	5.00	0.0	0.600		o	100	Pipe/Conduit	
4.001	2.750	0.016	170.0	0.571	0.00	0.0	0.600		o	225	Pipe/Conduit	
4.002	4.243#	0.018	235.7	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
1.004	6.431	0.053	121.3	0.358	0.00	0.0	0.600		o	150	Pipe/Conduit	
1.005	10.163	0.102	99.6	0.000	0.00	0.0	0.600		o	150	Pipe/Conduit	
1.006	4.489	0.045	99.8	0.000	0.00	0.0	0.600		o	100	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)
2.001	65.00	11.54	95.276	0.825	0.0	0.0	0.0	1.57	111.2«	145.2
1.002	65.00	11.60	95.135	1.027	0.0	0.0	0.0	3.28	231.6	180.8
3.000	65.00	5.22	95.990	0.000	0.0	0.0	0.0	0.77	6.0	0.0
3.001	65.00	5.39	95.890	0.188	0.0	0.0	0.0	1.29	22.8«	33.1
3.002	65.00	5.71	95.673	0.188	0.0	0.0	0.0	1.54	27.2«	33.1
3.003	65.00	5.95	94.988	0.245	0.0	0.0	0.0	1.22	21.5«	43.1
1.003	65.00	11.68	94.582	1.272	0.0	0.0	0.0	1.21	85.4«	223.9
4.000	65.00	5.22	94.675	0.000	0.0	0.0	0.0	0.77	6.0	0.0
4.001	65.00	5.26	94.575	0.571	0.0	0.0	0.0	1.00	39.8«	100.5
4.002	65.00	5.32	94.409	0.571	0.0	0.0	0.0	1.18	129.9	100.5
1.004	65.00	11.79	94.200	2.201	0.0	0.0	0.0	0.91	16.1«	387.5
1.005	65.00	11.96	94.147	2.201	0.0	0.0	0.0	1.01	17.8«	387.5
1.006	65.00	12.06	94.045	2.201	0.0	0.0	0.0	0.77	6.0«	387.5

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006		94.734	94.000	94.000	0	0

Online Controls for Storm

Orifice Manhole: SW2, DS/PN: 2.001, Volume (m^3): 1187.3

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 95.276

Orifice Manhole: FD2 Outfall, DS/PN: 3.003, Volume (m^3): 0.5

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 94.988

Hydro-Brake Optimum® Manhole: POND, DS/PN: 1.004, Volume (m^3): 2.3

Unit Reference	MD-SHE-0141-9700-1200-9700
Design Head (m)	1.200
Design Flow (l/s)	9.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	141
Invert Level (m)	94.200
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	9.7
Flush-Flo™	0.354	9.7
Kick-Flo®	0.773	7.9
Mean Flow over Head Range	-	8.4

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	5.1	1.200	9.7	3.000	15.0	7.000	22.4
0.200	9.2	1.400	10.4	3.500	16.1	7.500	23.2
0.300	9.6	1.600	11.1	4.000	17.2	8.000	23.9
0.400	9.7	1.800	11.7	4.500	18.2	8.500	24.6
0.500	9.5	2.000	12.3	5.000	19.1	9.000	25.3
0.600	9.2	2.200	12.9	5.500	20.0	9.500	26.0
0.800	8.0	2.400	13.5	6.000	20.8		
1.000	8.9	2.600	14.0	6.500	21.7		

Storage Structures for Storm

Filter Drain Manhole: FD3 Outfall, DS/PN: 1.001

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.075
Safety Factor	2.0	Number of Pipes	1
Porosity	0.32	Slope (1:X)	52.0
Invert Level (m)	95.560	Cap Volume Depth (m)	0.750
Trench Width (m)	0.4	Cap Infiltration Depth (m)	0.000
Trench Length (m)	41.7		

Filter Drain Manhole: FD1 Outfall, DS/PN: 3.001

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.075
Safety Factor	2.0	Number of Pipes	1
Porosity	0.30	Slope (1:X)	166.0
Invert Level (m)	95.815	Cap Volume Depth (m)	0.750
Trench Width (m)	0.4	Cap Infiltration Depth (m)	0.000
Trench Length (m)	120.0		

Filter Drain Manhole: FD2 Outfall, DS/PN: 3.003

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.075
Safety Factor	2.0	Number of Pipes	1
Porosity	0.32	Slope (1:X)	43.0
Invert Level (m)	94.920	Cap Volume Depth (m)	0.750
Trench Width (m)	0.6	Cap Infiltration Depth (m)	0.000
Trench Length (m)	29.5		

Filter Drain Manhole: FD4 Outfall, DS/PN: 4.001

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.075
Safety Factor	2.0	Number of Pipes	1
Porosity	0.32	Slope (1:X)	122.1
Invert Level (m)	94.500	Cap Volume Depth (m)	0.750
Trench Width (m)	0.6	Cap Infiltration Depth (m)	0.000
Trench Length (m)	219.7		

Tank or Pond Manhole: POND, DS/PN: 1.004

Invert Level (m) 94.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	779.3	1.200	1246.3

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 5
Number of Online Controls 3 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 0.400
Region England and Wales Cv (Summer) 0.562
M5-60 (mm) 20.000 Cv (Winter) 0.887

Margin for Flood Risk Warning (mm) 100.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	FD3 Dummy	15 Winter	2	+0%				
1.001	FD3 Outfall	15 Winter	2	+0%	30/15 Summer			
2.000	SW1	15 Winter	2	+0%				
2.001	SW2	180 Winter	2	+0%	2/15 Summer			
1.002	S1	15 Winter	2	+0%				
3.000	FD1 Dummy	30 Winter	2	+0%				
3.001	FD1 Outfall	60 Winter	2	+0%	2/15 Summer			
3.002	FD2 Dummy	360 Winter	2	+0%				
3.003	FD2 Outfall	360 Winter	2	+0%	2/15 Summer			
1.003	S2	15 Winter	2	+0%	30/15 Winter			
4.000	FD4 Dummy	120 Winter	2	+0%				
4.001	FD4 Outfall	15 Winter	2	+0%	2/15 Summer			
4.002	S5	15 Winter	2	+0%	30/15 Winter			
1.004	POND	720 Winter	2	+0%	2/30 Winter			
1.005	S3	720 Winter	2	+0%				
1.006	S4	720 Winter	2	+0%	2/15 Winter			

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	FD3 Dummy	95.739	-0.095	0.000	0.00		0.0	OK*	
1.001	FD3 Outfall	95.744	-0.040	0.000	0.88		32.4	OK*	
2.000	SW1	96.234	-1.772	0.000	0.02		149.1	OK	
2.001	SW2	96.193	0.617	0.000	0.05		4.9	SURCHARGED*	
1.002	S1	95.225	-0.210	0.000	0.20		36.6	OK	
3.000	FD1 Dummy	96.090	0.000	0.000	0.04		0.2	SURCHARGED*	
3.001	FD1 Outfall	96.506	0.466	0.000	0.57		13.0	SURCHARGED*	
3.002	FD2 Dummy	95.823	0.000	0.000	0.17		4.7	SURCHARGED*	
3.003	FD2 Outfall	95.670	0.532	0.000	0.24		5.2	SURCHARGED*	
1.003	S2	94.770	-0.112	0.000	0.72		41.0	OK	
4.000	FD4 Dummy	94.775	0.000	0.000	0.04		0.2	SURCHARGED*	
4.001	FD4 Outfall	95.045	0.245	0.000	2.45		73.2	SURCHARGED*	
4.002	S5	94.693	-0.091	0.000	0.93		73.1	OK	
1.004	POND	94.547	0.197	0.000	0.69		9.3	SURCHARGED	
1.005	S3	94.274	-0.023	0.000	0.59		9.3	OK	
1.006	S4	94.239	0.094	0.000	1.79		9.3	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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	5
Number of Online Controls	3	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	0.400
Region	England and Wales	Cv (Summer)	0.562
M5-60 (mm)	20.000	Cv (Winter)	0.887

Margin for Flood Risk Warning (mm)	100.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	FD3 Dummy	30 Winter	30	+0%				
1.001	FD3 Outfall	15 Winter	30	+0%	30/15 Summer			
2.000	SW1	240 Winter	30	+0%				
2.001	SW2	240 Winter	30	+0%	2/15 Summer			
1.002	S1	15 Winter	30	+0%				
3.000	FD1 Dummy	60 Winter	30	+0%				
3.001	FD1 Outfall	480 Winter	30	+0%	2/15 Summer			
3.002	FD2 Dummy	60 Winter	30	+0%				
3.003	FD2 Outfall	60 Winter	30	+0%	2/15 Summer			
1.003	S2	15 Winter	30	+0%	30/15 Winter			
4.000	FD4 Dummy	120 Winter	30	+0%				
4.001	FD4 Outfall	15 Winter	30	+0%	2/15 Summer			
4.002	S5	15 Winter	30	+0%	30/15 Winter			
1.004	POND	720 Winter	30	+0%	2/30 Winter			
1.005	S3	720 Winter	30	+0%				
1.006	S4	720 Winter	30	+0%	2/15 Winter			

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	FD3 Dummy	95.834	0.000	0.000	0.26		1.6	SURCHARGED*	
1.001	FD3 Outfall	96.262	0.478	0.000	1.53		56.7	SURCHARGED*	
2.000	SW1	96.495	-1.511	0.000	0.01		54.9	OK	
2.001	SW2	96.495	0.919	0.000	0.06		5.7	SURCHARGED*	
1.002	S1	95.253	-0.182	0.000	0.33		61.2	OK	
3.000	FD1 Dummy	96.090	0.000	0.000	0.13		0.8	SURCHARGED*	
3.001	FD1 Outfall	96.565	0.525	0.000	0.24		5.4	SURCHARGED*	
3.002	FD2 Dummy	95.823	0.000	0.000	0.36		9.8	SURCHARGED*	
3.003	FD2 Outfall	95.670	0.532	0.000	0.42		9.1	SURCHARGED*	
1.003	S2	94.911	0.029	0.000	1.19		68.2	SURCHARGED	
4.000	FD4 Dummy	94.775	0.000	0.000	0.04		0.2	SURCHARGED*	
4.001	FD4 Outfall	95.250	0.450	0.000	3.94		117.8	SURCHARGED*	
4.002	S5	94.838	0.054	0.000	1.49		117.7	SURCHARGED	
1.004	POND	94.832	0.482	0.000	0.71		9.7	SURCHARGED	
1.005	S3	94.287	-0.010	0.000	0.61		9.7	OK	
1.006	S4	94.249	0.104	0.000	1.85		9.7	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 5
Number of Online Controls 3 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 0.400
Region England and Wales Cv (Summer) 0.562
M5-60 (mm) 20.000 Cv (Winter) 0.887

Margin for Flood Risk Warning (mm) 100.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	FD3 Dummy	120 Winter	100	+40%				
1.001	FD3 Outfall	15 Winter	100	+40%	30/15 Summer			
2.000	SW1	480 Winter	100	+40%				
2.001	SW2	480 Winter	100	+40%	2/15 Summer			
1.002	S1	1440 Winter	100	+40%				
3.000	FD1 Dummy	120 Winter	100	+40%				
3.001	FD1 Outfall	60 Winter	100	+40%	2/15 Summer			
3.002	FD2 Dummy	120 Winter	100	+40%				
3.003	FD2 Outfall	120 Winter	100	+40%	2/15 Summer			
1.003	S2	1440 Winter	100	+40%	30/15 Winter			
4.000	FD4 Dummy	120 Winter	100	+40%				
4.001	FD4 Outfall	30 Winter	100	+40%	2/15 Summer			
4.002	S5	1440 Winter	100	+40%	30/15 Winter			
1.004	POND	1440 Winter	100	+40%	2/30 Winter			
1.005	S3	960 Summer	100	+40%				
1.006	S4	960 Summer	100	+40%	2/15 Winter			

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	FD3 Dummy	95.834	0.000	0.000	0.06		0.3	SURCHARGED*	
1.001	FD3 Outfall	96.310	0.526	0.000	2.41		89.2	SURCHARGED*	
2.000	SW1	96.908	-1.098	0.000	0.01		58.3	OK	
2.001	SW2	96.908	1.332	0.000	0.07		6.6	FLOOD RISK*	
1.002	S1	95.365	-0.070	0.000	0.06		11.8	OK	
3.000	FD1 Dummy	96.090	0.000	0.000	0.18		1.1	SURCHARGED*	
3.001	FD1 Outfall	96.565	0.525	0.000	0.64		14.6	SURCHARGED*	
3.002	FD2 Dummy	95.823	0.000	0.000	0.39		10.6	SURCHARGED*	
3.003	FD2 Outfall	95.670	0.532	0.000	0.64		13.8	SURCHARGED*	
1.003	S2	95.360	0.478	0.000	0.31		17.8	SURCHARGED	
4.000	FD4 Dummy	94.775	0.000	0.000	0.08		0.5	SURCHARGED*	
4.001	FD4 Outfall	95.250	0.450	0.000	6.03		180.4	SURCHARGED*	
4.002	S5	95.357	0.573	0.000	0.20		16.1	SURCHARGED	
1.004	POND	95.357	1.007	0.000	0.71		9.6	FLOOD RISK	
1.005	S3	94.287	-0.010	0.000	0.61		9.7	OK	
1.006	S4	94.249	0.104	0.000	1.85		9.7	SURCHARGED	

APPENDIX V – SOAKAWAY TESING

Terra Consult Infiltration Report, dated November 2017

TerraConsult

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Your Ref
Our Ref 3633/LR01-1/SB/CSE

10th November 2017

Statera Energy Ltd.
3rd Floor,
239 High Street Kensington,
London,
W8 6SA

BY E-MAIL ONLY

For the attention of Mr. Oliver Troup

Dear Oliver,

Desford Road, Enderby, Leicester, LE19 4AT –Infiltration Tests

1. Introduction

TerraConsult Limited was commissioned to carry out a series of infiltration tests for the assessment of the suitability for using soakaways for a proposed development on a parcel of land to the north of Desford Road, Enderby, Leicestershire.

Four trial pits (TP1 to TP4) were excavated using JCB 3CX excavator to depth 2.0m below ground level (bgl) at the locations shown in Appendix A. Photographs of the trial pits are presented in Appendix B. A single infiltration test was carried out in each location and these results are presented in Appendix C.

2. Site Location

The site is about 7 km to the southwest of Leicester. The site is currently grassed field and is located to the northwest of an existing Substation to the east of Beggars Lane. Access is gained from Desford Road towards Beggars Lane.

3. Anticipated Ground Conditions

From the BGS maps of the area the ground is Glacial Till (slightly sandy slightly gravely Clay) overlying mudstone bedrock (Triassic Edwalton Member). The Glacial Till is expected to be more than 15 m thick.

4. Strata Encountered

The infiltration tests were carried out on the 9h November 2017. All four trial pits (TP1 to TP4) were positioned in the locations identified by Statera Energy in their email dated on the 7th November 2017 and shown in Appendix A. The ground was described in accordance with BS5930:2015.

Table 1 : Summary of Ground Conditions

Location	Stratum Depths (m)		Stratum Description
TP1	0.00	0.30	Soft brown mottled dark grey and orange slightly gravelly CLAY with numerous rootlets. Gravel subangular to rounded fine to coarse of sandstone, quartzite and flint. (TOPSOIL)
	0.30	1.20	Soft to firm orange brown and light grey brown mottled slightly sandy slightly gravelly CLAY. Gravel subangular to rounded fine to medium of sandstone, mudstone, quartzite and flint. (GLACIAL TILL)
TP2	0.00	0.25	Soft brown mottled dark grey and orange slightly gravelly CLAY with numerous rootlets. Gravel subangular to rounded fine to coarse of sandstone, mudstone, quartzite and flint. (TOPSOIL)
	0.25	0.70	Firm orange brown and red brown mottled slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel subangular to rounded fine to medium of sandstone, quartzite and flint. (GLACIAL TILL)
	0.70	1.20	Stiff brown mottled grey and orange brown slightly gravelly CLAY with rare cobbles. Gravel subangular to rounded fine to medium of sandstone, chalk and flint. Rare fine gravel of coal. Cobbles were of sandstone. (GLACIAL TILL)
TP3	0.00	0.25	Soft brown mottled dark grey and orange slightly gravelly CLAY with numerous rootlets. Gravel subangular to rounded fine to coarse of sandstone and flint. (TOPSOIL)
	0.25	1.20	Firm brown and grey mottled slightly sandy slightly gravelly CLAY. Gravel subangular to rounded fine to course of sandstone, chalk and flint. (GLACIAL TILL)
TP4	0.00	0.30	Soft brown slightly gravelly CLAY with numerous rootlets. Gravel subangular to rounded fine to coarse of sandstone, quartzite and flint. (TOPSOIL)
	0.30	1.20	Firm brown and grey mottled slightly sandy slightly gravelly CLAY with rare cobbles. Gravel subangular to rounded fine to medium of sandstone, chalk and flint. Rare fine gravel of coal. Cobbles were of sandstone. (GLACIAL TILL)

Prior to commencing the work it was assessed that the groundwater level is likely to be relatively high at the site given the gently sloping site and the pond present off site to the north. Therefore the pits were to be relatively shallow. No groundwater entries were encountered in TP2 and TP4. However, groundwater was present at a depth of 1.10 m in TP1 and at 1.20 m in TP3. It should also be noted that the ground was a clay and this indicates that the likely permeability and infiltration rate of the ground would be very poor and that water entries into the trial pits would not reflect the longer term at rest groundwater level which will be higher than this.

On completion of the soakaway tests, each trial pit was backfilled and reinstated with arisings and topsoil.

5. Soakaway/Infiltration Tests

The soakaway tests were carried out in accordance with the methodology prescribed in BRE 365 (2016) and BS6297:2007+A1:2008, with results from each soakaway test presented in Appendix C. Prior to carrying out the tests, the dimensions of the holes were accurately measured using a tape measure and recorded. No underground or overhead services were noted on site and the landowner did not know of any field drains are present within the field.

All four tests were undertaken within the superficial deposits. The trial pits remained stable and maintained their dimensions whilst being filled with water. No gravel was used to stablise the hole for the tests.

Due to time constraints and the speed at which the water drained away only one test per location was carried out.

The Tests were all run for a period of 5.5 to 6 hours and all had a negligible drop during this period. It is assessed that the infiltration rate will be in the region of 0.001 m/hr. Therefore the infiltration tests all indicated that the ground was suitable for soakaways.

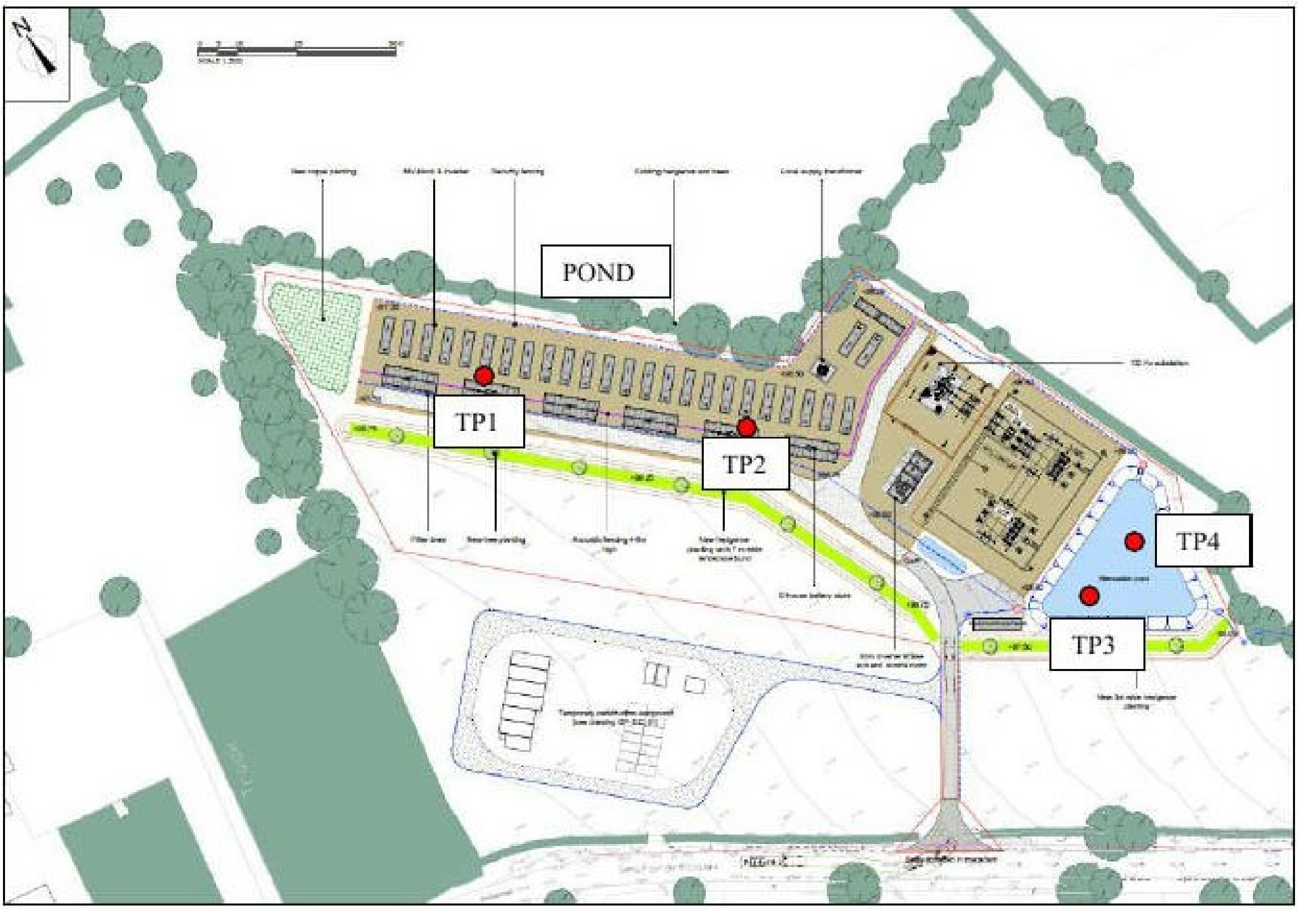
Yours sincerely,
For and on behalf of TerraConsult Ltd,

[redacted]

C S Eccles
Director

APPENDIX A

TEST LOCATIONS



APPENDIX B

TRIAL PIT PHOTOGRAPHS

Photograph 1: TP1

Photograph 2: TP1 Spoil

Photograph 3: TP2

Photograph 4: TP2 Spoil

Photograph 5: TP3

Photograph 6: TP3 Spoil

Photograph 7: TP4

Photograph 8: TP4 Spoil

APPENDIX C

INFILTRATION TEST DATA AND RESULTS

Client:	Statera Energy Ltd.	TerraConsult
Project Name:	Desford Road	
Project No:	3633	

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2016 and BS6297:2007+A1:2008

CALCULATION OF SOIL INFILTRATION RATE

Soakaway SA **TP1** - Test **1**

Test carried out with stone in pit

Elapsed Time minutes	Depth to water mm
0	260
0.5	260
1	260
1.5	260
3	260
5	260
6	260
8	260
10	260
20	260
30	260
40	260
45	260
50	260
60	260
90	260
105	260
120	260
150	260
180	260
220	260
290	260
360	270

Size of Soakaway

Length	1100	mm
Width	500	mm
Gravel Thickness	None	mm
Depth to water	260	mm
Depth to base	1200	mm

Depth at start of test	260
Depth at end of test	270

75% full level	495	mm
50% full level	730	mm
25% full level	965	mm

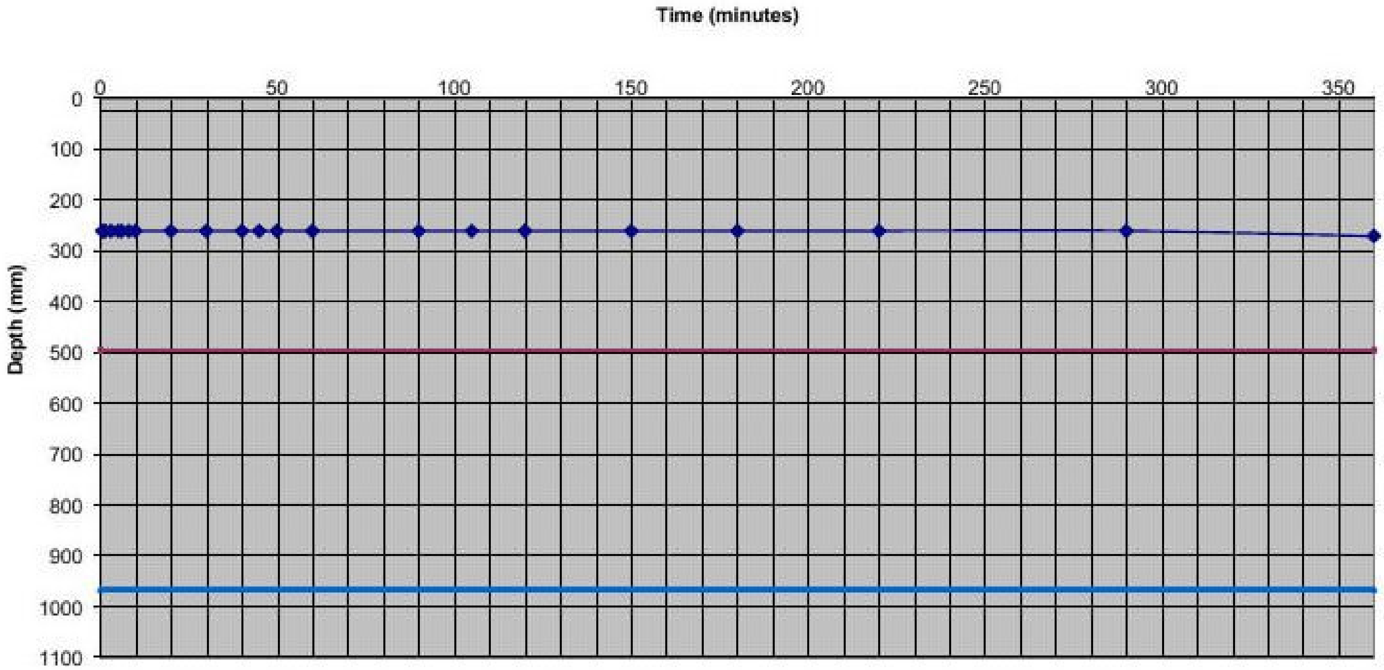
Base area of pit	m^2	0.550
Mean surface area through which outflow occurs	m^2	2.054
Volume outflow between 75 and 25% effective depth	m^3	0.078

From the graph:	
tp 75 min	-
tp 25 min	-

% void space in granular fill	No Gravel

Soil infiltration rate, f, $m^3/m^2/s$ =
Soil infiltration rate, f, m/hr =
Percolation Value, vp, s/mm =

Very Poor infiltration rate. Insufficient fall in water level to calculate. Infiltration rate expected to be around 0.001 m/hr



Calculation made by CSE

Client:	**Statera Energy Ltd.**	**TerraConsult**
Project Name:	**Desford Road**	
Project No:	**3633**	

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2016 and BS6297:2007+A1:2008

CALCULATION OF SOIL INFILTRATION RATE

Soakaway SA TP2 **- Test** 1

Test carried out with stone in pit

Elapsed Time minutes	Depth to water mm
0	280
0.5	280
1	280
1.5	280
3	280
5	280
6	280
8	280
10	280
16	280
21	280
42	280
46	280
55	280
64	280
92	280
105	280
120	280
150	280
180	280
220	280
290	280
330	285

Size of Soakaway

Length	1300	mm
Width	600	mm
Gravel Thickness	None	mm
Depth to water	260	mm
Depth to base	1200	mm

Depth at start of test	280
Depth at end of test	285

75% full level	495	mm
50% full level	730	mm
25% full level	965	mm

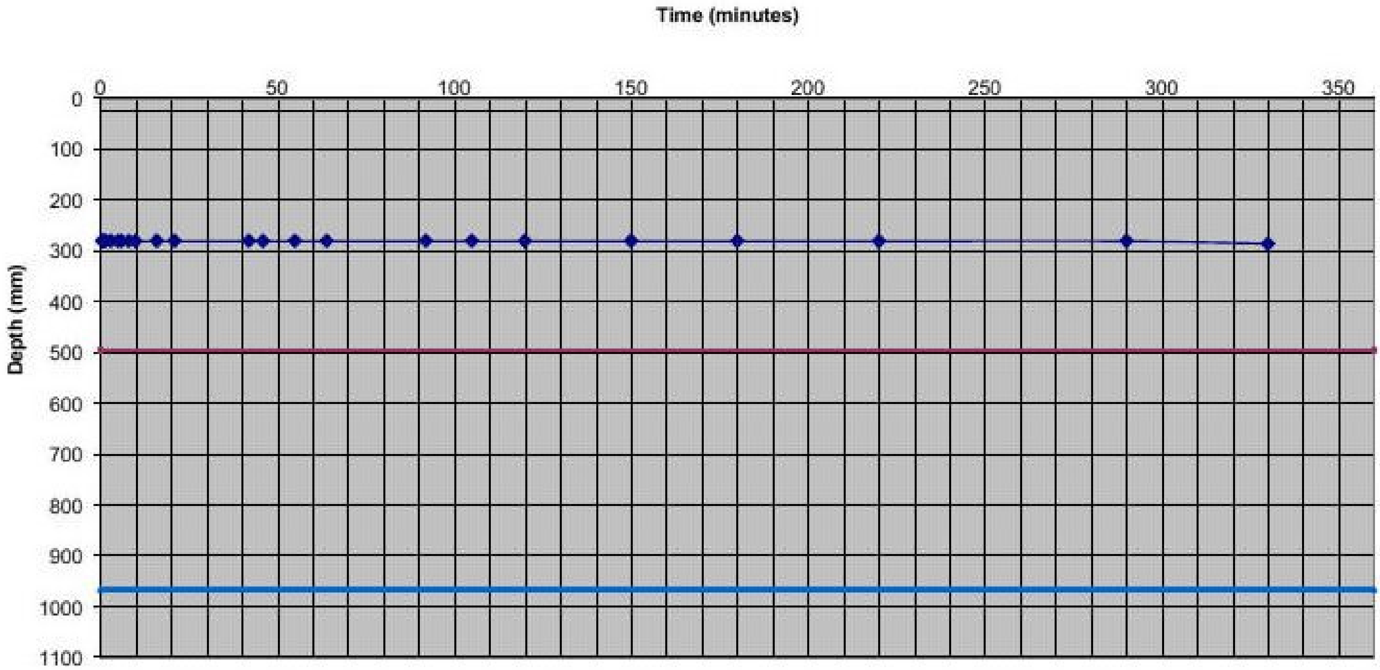
Base area of pit	m^2	0.780
Mean surface area through which outflow occurs	m^2	2.566
Volume outflow between 75 and 25% effective depth	m^3	0.110

From the graph:	
tp 75 min	-
tp 25 min	-

% void space in granular fill	**No Gravel**

Soil infiltration rate, f, $m^3/m^2/s$ =
Soil infiltration rate, f, m/hr =
Percolation Value, vp, s/mm =

Very Poor infiltration rate. Insufficient fall in water level to calculate. Infiltration rate expected to be around 0.001 m/hr



Calculation made by CSE

Client:	Statera Energy Ltd.	TerraConsult
Project Name:	Desford Road	
Project No:	3633	

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2016 and BS6297:2007+A1:2008

CALCULATION OF SOIL INFILTRATION RATE Soakaway SA TP3 - Test 1

Test carried out with stone in pit

Elapsed Time minutes	Depth to water mm
0	265
0.5	265
1	265
1.5	265
3	265
5	265
7	265
9	265
11	265
18	265
30	265
40	265
45	265
50	265
60	265
90	265
105	265
120	265
150	265
190	265
210	270
285	270
340	270

Size of Soakaway

Length	1200	mm
Width	600	mm
Gravel Thickness	None	mm
Depth to water	265	mm
Depth to base	1200	mm

Depth at start of test	280
Depth at end of test	1200

75% full level	499	mm
50% full level	733	mm
25% full level	966	mm

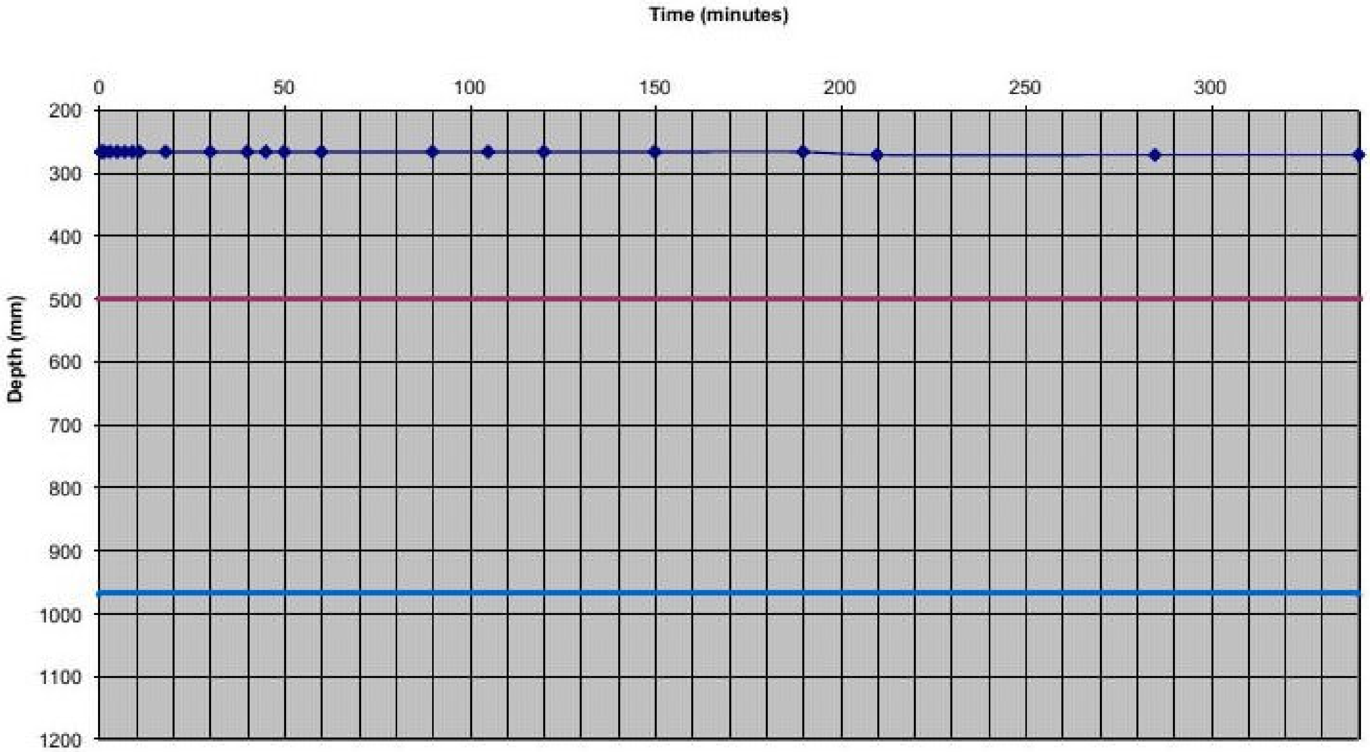
Base area of pit	m^2	0.720
Mean surface area through which outflow occurs	m^2	-0.963
Volume outflow between 75 and 25% effective depth	m^3	0.101

From the graph:	
tp 75 min	1
tp 25 min	45

% void space in granular fill	**No Gravel**

Soil infiltration rate, f, $m^3/m^2/s$ =
Soil infiltration rate, f, m/hr =
Percolation Value, vp, s/mm =

Very Poor infiltration rate. Insufficient fall in water level to calculate. Infiltration rate expected to be around 0.001 m/hr



Calculation made by LM

Client:	**Statera Energy Ltd.**	**TerraConsult**
Project Name:	**Desford Road**	
Project No:	**3633**	

SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2016 and BS6297:2007+A1:2008

CALCULATION OF SOIL INFILTRATION RATE

Soakaway SA TP4 **- Test** 1

Test carried out with stone in pit

Elapsed Time minutes	Depth to water mm
0	310
0.5	310
1	310
1.5	310
3	310
5	310
7	310
8	310
10	310
17	310
29	310
38	310
42	310
48	310
62	310
90	310
110	310
160	310
180	310
240	310
380	310
310	310
350	315

Size of Soakaway

Length	1200	mm
Width	600	mm
Gravel Thickness	None	mm
Depth to water	310	mm
Depth to base	1200	mm

Depth at start of test	310
Depth at end of test	315

75% full level	533	mm
50% full level	755	mm
25% full level	978	mm

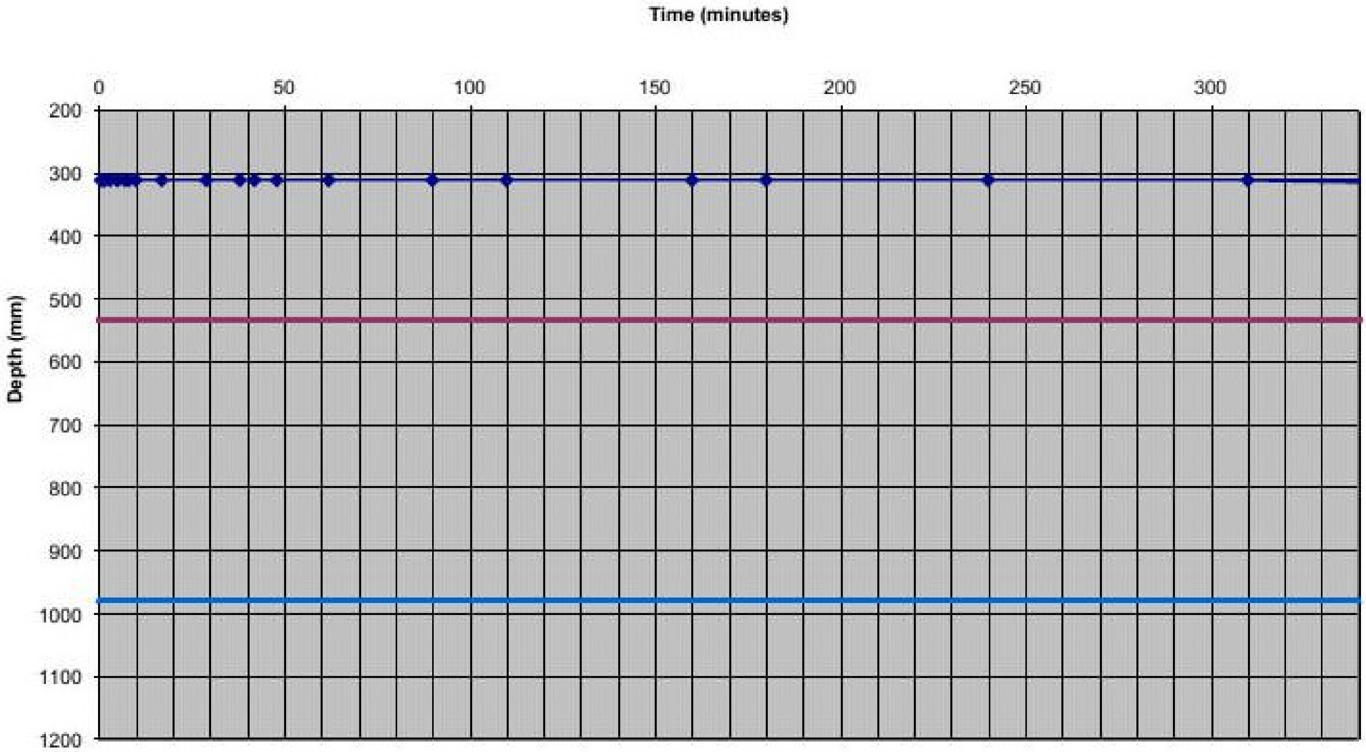
Base area of pit	m^2	0.720
Mean surface area through which outflow occurs	m^2	-0.882
Volume outflow between 75 and 25% effective depth	m^3	0.096

From the graph:	
tp 75 min	1
tp 25 min	45

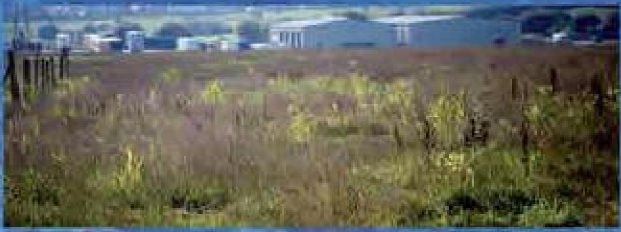
% void space in granular fill	**No Gravel**

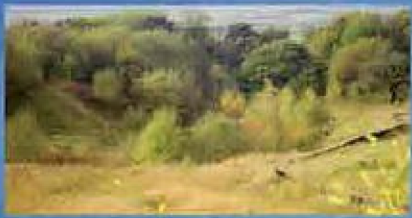
Soil infiltration rate, f, $m^3/m^2/s$ =
Soil infiltration rate, f, m/hr =
Percolation Value, vp, s/mm =

Very Poor infiltration rate. Insufficient fall in water level to calculate. Infiltration rate expected to be around 0.001 m/hr



Calculation made by LM

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